Issues of the Adoption of HIT related Standards at the Decision-Making Stage of Six Tertiary Healthcare Organisations in Saudi Arabia

By

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A Doctoral Thesis Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University

October 2011

Abstract

Due to interoperability barriers between clinical information systems, healthcare organisations are facing potential limitations with regard to acquiring the benefits such systems offer; in particular, in terms of reducing the cost of medical services. However, to achieve the level of interoperability required to reduce these problems, a high degree of consensus is required regarding health data standards. Although such standards essentially constitute a solution to the interoperability barriers mentioned above, the level of adoption of these standards remains frustratingly low. One reason for this is that health data standards are an authoritative field in which marketplace mechanisms do not work owing to the fact that health data standards developed for a particular market cannot, in general, be applied in other markets without modification.

Many countries have launched national initiatives to develop and promote national health data standards but, although certain authors have mapped the landscape of the standardisation process for health data in some countries, these studies have failed to explain why the healthcare organisations seem unwilling to adopt those standards. In addressing this gap in the literature, a conceptual model of the adoption process of HIT related standards at the decision-making stage in healthcare organisations is proposed in this research. This model was based on two predominant theories regarding IT related standards in the IS field: Rogers' paradigm (1995) and the economics of standards theory. In addition, the twenty one constructs of this model resulted from a comprehensive set of factors derived from the related literature; these were then grouped in accordance with the Technology-Organisation–Environment (TOE), a well-known taxonomy within innovation adoption studies in the IS field. Moving from a conceptual to an empirical position, an interpretive, exploratory, multiple-case study methodology was conducted in Saudi Arabia to examine the proposed model. The empirical qualitative evidence gained necessitated some revision to be made to the proposed model. One factor was abandoned, four were modified and eight new factors were added. This consistent empirical model makes a novel contribution at two levels. First, with regard to the body of knowledge in the IS area, this model offers an in-depth understanding of the adoption process of HIT related standards which the literature still lacks. It also examines the applicability of IS theories in a new area which allows others to relate their experiences to those reported. Secondly, this model can be used by decision makers in

Abdullah Ibrahim Alkraiji 2011

the healthcare sector, particularly those in developing countries, as a guideline while planning for the adoption of health data standards.

Abdullah Ibrahim Alkraiji 2011

Acknowledgements

In the name of Allah, the Most Gracious and the Most Merciful Alhamdulillah, all praises to Allah for allowing me to complete this thesis.

Dedication

I dedicate this thesis to my Mother, Fatimah, and to the spirit of my father, Ibrahim, to whom I am indebted for the rest of my life.

I also dedicate this thesis to my lovely wife, Sumaia, for her patience and support; to my children, Ibrahim, Suliman, Samer and Fatimah, who pray for me always; to my sisters, Roqaya, Rehab and Raghad; and my brothers, Adel, Ali, Adnan and Azam, who encouraged me and who have taken care of my Mother while I have been in the UK.

Publications

Reviewed Conference Papers

Alkraiji, A., Jackson, T. & Murray, I., 2011. Health Data Standards and the Adoption Process: Preliminary Findings of a Qualitative Study in Saudi Arabia. *Proceedings of the SQM Conference,* Loughborough University, Loughborough, UK, April 18-19.

Alkraiji, A., Jackson, T. & Murray, I., 2010. Health Data Standards and Barriers to the Widespread Adoption of Health Information Technology. *Proceedings of the SQM Conference*, London, UK, March 29-30.

Alkraiji, A., Jackson, T. & Murray, I., 2010. Identifying and Modelling the Critical Success Factors that Affect the Adoption of Health Information Technology Related Standards. *Proceedings of the EMCIS Conference*, Abu Dhabi, UAE, April 12-13.

Journal Papers

Alkraiji, A. I, Jackson, T. W. & Murray, I. R., 2011. Health data standards and adoption process: Preliminary findings of a qualitative study in Saudi Arabia. *Campus-Wide Information Systems*, 28(5), pp. 345-359.

Table of Contents

Abdullah Ibrahim Alkraiji 2011

Abdullah Ibrahim Alkraiji 2011

XI

XIII

Abdullah Ibrahim Alkraiji 2011

List of Tables

Abdullah Ibrahim Alkraiji 2011

Abdullah Ibrahim Alkraiji 2011

List of Figures

XVIII

Abdullah Ibrahim Alkraiji 2011

Abdullah Ibrahim Alkraiji 2011

Glossary of Abbreviations

AAMSI	American Association for Medical Systems and Informatics
ACR	American College of Radiology
ADT	Admission, Discharge and Transfer
AFH	Armed Forces Hospital
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CAP	College of American Pathologists
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CCOW	Clinical Context Object Workgroup
CCR	Continuity of Care Record
CDA	Clinical Document Architecture
CDS	Clinical Decision Support
CEN	European Committee for Standardisation
CfH	Connecting for Health
CHIMA	Chinese Hospital Information Management Association
CHISS	Chinese Health Information Standardization Society
CPOE	Computerized Physician Order Entry
DICOM	Digital Imaging and Communications in Medicine
DOI	Diffusion of Innovations
EDI	Electronic Data Interchange
EHR	Electronic Health Record
EMBS	Engineering in Medicine and Biology Society
GEHR	Good European Health Report
HIMSS	Health Information Management and Systems Society

HIPAA	Health Insurance Portability and Accountability Act
HIS	Hospital Information System
HIT	Health Information Technology
HL7	Health Level Seven
ICD	International Classification of Diseases
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronic Engineers
IHE	Integrating the Healthcare Enterprise
IS	Information System
ISO	International Organisation for Standardisation
IT	Information Technology
KFMC	King Fhad Medical City
KFSH&RC	King Faisal Specialist Hospital and Research Centre
KKUH	King Khalid University Hospital
KSA	Kingdom of Saudi Arabia
LOINC	Logical Observation Identifiers, Names and Codes
MEDIX	Medical Data Interchange
MIB	Medical Information Bus
MoH	Ministry of Health
NCPDP	National Council for Prescription Drug Program
NEMA	National Electrical Manufacturers Association
NGHA	National Guard Health Affairs
NHIN	National Health Information Network
NHS	National Health Service
PACS	Picture Archiving and Communication Systems

PCI	Perceived Characteristics of Innovating
PDF	Portable Document Format
RIM	Reference Information Model
RIS	Radiology Information System
SAHI	Saudi Association for Health Informatics
SDO	Standard Development Organisation
SFH	Security Forces Hospital
SNOMED-CT	Systematized Nomenclature of Medicine Clinical Terminology
SNOP	Systematized Nomenclature of Pathology
TAM	Technology Acceptance Model
TC	Technical Committee
TOE	Technology-Organisation-Environment
TPB	Theory of Planned Behaviour
TR	Technical Report
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
WHO	World Health Organisation
XML	Extensible Markup Language

Chapter One: Introduction

1.1 Introduction

This chapter begins with an overview of the interoperability barriers that exist between health information technology applications, which is the result of a lack of consensus concerning health data standards. It then describes the issues and current state of affairs surrounding health data standards. Following this, the adoption and use of health data standards are described and then the current position regarding the adoption of health information technology in Saudi Arabia is outlined. The motivation, scope, questions, aims, objectives and significance of this research are then identified and stated. This chapter concludes with a breakdown of the overall structure of this thesis.

1.2 Background

The adoption of multifunctional health information technology (HIT) applications can yield real benefits for nations in terms of aspects such as increased delivery of care based on guidelines, enhanced monitoring and surveillance activities, a reduction in medication errors, decreased rates of potentially redundant or inappropriate care, and reductions in the cost of medical services (Chaudhry *et al.* 2006). HIT can be defined as "the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making" (Thompson & Brailer 2004, p. 38). However, creating a better-functioning HIT infrastructure requires, among other things, a complete electronic health record (EHR) that is available at the point and time of care (Hammond 2005). Today, an EHR system is thought to be the heart of the HIT infrastructure (Grimson *et al.* 2000). The International Organisation for Standardisation (ISO) ISO/TC 215 (2003, p. 8) defined an EHR system as "a repository of longitudinal information regarding the health of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorised users. Its primary purpose is the support of continuing, efficient and quality integrated healthcare and it contains information which is retrospective, concurrent and prospective."

1

EHR is thought not to be a goal in itself, but as a tool for supporting the continuity of care and, consequently, the quality, accessibility and efficiency of healthcare delivery (Iakovidis 1998). However, this requires a suitable level of interoperability between the communicating applications. Interoperability means that the communication language must be understandable by the systems at the receiving end of a communication (Hammond 2005) and the interoperability required to allow a "mix-and-match" environment requires a certain level of standardisation for the health data (Hammond 2005). ISO/IEC Guide 2 (1996) defined 'standards' as: "documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose." Today, health data standards are expected to be a vital solution to the obstacles and issues facing interoperability, medical data exchange and the widespread deployment of HIT applications (Zhang *et al.* 2007; Berler *et al.* 2006). This was also confirmed by Brender *et al.* (2006) who advocated that aspects of standardisation should be accorded special attention during the implementation of future national EHR programs.

1.3 The Reality Regarding Health Data Standards

Despite that health data standards are fundamental for creating a robust and interoperable HIT infrastructure, such standards have not evolved to anywhere near the extent that standards have in other major industries, such as the banking industry, for example (Hammond 2005). The review of the literature revealed a variety of reasons for this. First, by its nature, healthcare is a complex system with many independent and interrelated components (Khoumbati *et al.* 2006; Plsek & Greenhalgh 2001). Secondly, clinical information itself is very complex. For example, the SNOMED Clinical Terms Coding System alone defines more than 350,000 clinical concepts and there are many other coding systems (Eichelberg *et al.* 2005). Thirdly, health data standards are constantly evolving and changing, unlike those in other industries and, for example, medical science is currently placing great emphasis on genomics which requires the integration of biomedical information with the HIT applications (Begoyan 2007). Fourthly, no serious international efforts for consolidating and harmonising the development of health data standards have been made yet (Hammond 2005).

The literature also revealed that the adoption of health data standards remains frustratingly low among healthcare IT vendors and healthcare providers where do they exist (Hammond 2005). For example, Zhang *et al.* (2007) claimed that healthcare organisations considering investing in standardisation cannot gain benefit directly; as a result, they prefer to invest in the IT infrastructure (e.g. networks, platforms) rather than in standardisation. The literature explained some justifications for this. First, health data standards often describe information architectures in rather more general and abstract terms than is required by engineers designing and implementing systems (Carr & Moore 2003). Secondly, there is no reliable way for professionals seeking to acquire or upgrade systems to specify a level of adherence to communication standards sufficient to achieve truly efficient interoperability (Carr & Moore 2003). Thirdly, there is no clear road map for applying the vast body of technical information assembled by standards' groups to solve specific clinical problems. Therefore, it frequently requires a major effort to achieve significant integration of multiple systems, even when all the systems involved comply with established standards (Hammond 2005; Carr & Moore 2003). Fourthly, there is a wide range of health data standards available today on domain-specific and domain-neutral levels. This has resulted in multiple standards which makes it difficult for healthcare organisations to know the standards to which they should pay attention, the ones they should embrace, and those which they should adopt (Chheda 2007; Hammond 2005). Fifthly, the proliferation of standards means they sometimes overlap and conflict. This has the potential for confusion which, in turn, hampers market transparency and leads to users and vendors not implementing any standards at all whilst waiting for the situation to resolve (Jenders 2007).

Today, the standardisation of health data is thought of as a necessity for every country. This must be undertaken by governments, and both funding and support are needed from them (Zhang *et al.* 2007). The literature explained the importance of the role of governments from different perspectives. First, the standardisation of health data is an authoritative field in which market mechanisms do not work as there is always a need to develop a new standard or to customise an available one to fit local and national needs (Zhang *et al.* 2007). Secondly, health data standards on their own do not guarantee the acceptability and sustainability of an HIT infrastructure (Chheda 2007). Thirdly, standardisation is never merely the smooth technical application of specifications. It is rather a complex balance between different types of requirement including organisational, social and managerial aspects (Mykkänen & Tuomainen 2008). Fourthly, attempting to define in advance all the standards required for

3

managing and exchanging medical information is not feasible. Instead, "just-in-time" standards, with the ability to produce quickly standards which are effective and acceptable, are felt to be the most appropriate solution for making progress toward interoperability (Hammond 2005). Fifthly, the development of interoperable standards, not only technically defines a method of interoperation between the different systems in a network, but, most importantly, represents a proposal for the future of complex socio-technical systems in the shape of a national network (Williams *et al.* 2004).

1.4 The Adoption of Health Data Standards

Many countries have launched initiatives and programmes to foster the adoption of HIT related standards. For example, the Canadian government launched an initiative known as the Canada Health Infoway. According to Dorda *et al.* (2005), Infoway had a total capital infusion of 1.2 billion Canadian Dollars from the federal government in order to embrace a seven-year plan to have interoperable EHR systems in place across 50% of Canada's population by 2009. The UK government has established a national project known as Connecting for Health (CfH). This project aims to have a centralised and interoperable HIT infrastructure as the foundation of nationwide applications running over a new broadband infrastructure (Williams *et al.* 2004). Moreover, a number of different standards have been used for clinical messaging across healthcare systems, such as CEN ENV 13606 and HL7 V2 (Williams *et al.* 2004). In addition, the CfH team decided to become involved in the existing standardisation initiatives rather than focusing their resources on developing their own standards to support their patient care system (Williams *et al.* 2004).

The Chinese government has launched several national initiatives concerning standardisation for health data. For example, a study by Zhang *et al.* (2007) mapped the landscape of the current activities undertaken by the government in China for such standardisation. According to this study, the Chinese Health Information Standardisation Society (CHISS) was assigned the task of producing and advocating the adoption of standards relevant to health data. Another task also undertaken by the Chinese Hospital Information Management Association (CHIMA) was to develop a set of health data standards for hospital information systems. Many of the identified standards derived from or paid reference to international standards, such as ICD-10, LOINC, HL7 and DICOM. Deutsch *et al.* (2010) analysed the national EHR programs of various countries, including those of England, Germany, Canada, Denmark and

Australia, with regard to the most common critical aspects of national EHR programmes as documented in these programs. According to this study, the standardisation of health data is regarded as a core task of EHR programme in most of those countries. In addition, the standardisation of health data was labelled as problematic in two countries: Denmark and Australia.

However, the adoption of health data standards in most developing countries is still questionable because of the lack of government action and plans, as well as the dearth of relevant studies. For example, Saudi Arabia is a newcomer to the area of advanced HIT practices and solutions, and each part of the Kingdom's healthcare service provision is at a different stage in terms of the implementation of HIT applications. This, in turn, has led to a large number of different HIT applications being used independently without ever being connected to each other. Medical information is still widely scattered; it is collected at different times and by different people or information systems which makes it difficult to understand, compare and exchange (Altuwaijri 2008). In this regard, the Saudi e-Health Conference in 2008 emphasised the importance of building a national e-health strategy for the country, developing the specifications and standards for the HIT applications and EHR systems, and building national registries for common diseases and epidemics (Altuwaijri 2008). In addition, Dr. Mohammed Alyemeni (Saudi e-Health 2010), Advisor to the Minister of Health and General Supervisor of ICT in the Ministry of Health, emphasised that health data standards constitute the first building block in developing an e-health system in Saudi Arabia and asserted that thought should first be given to how different medical groups might discuss and agree on the standards required before approaching the concept of e-health.

1.6 Motivation for this Research

Recently, there has been growing recognition by the Saudi government and commission authorities that a robust HIT infrastructure could contribute significantly to addressing delivery problems with regard to the health services. This can be seen in several initiatives and projects which have been launched in this regard such as the Saudi Ministry of Health allocated 4 Billion Saudi Riyals (1.1 billion USD) to the development of e-health programmes within the next four consecutive years (2008-2011) (Qurban & Austria 2008). However, these projects will only widen the gap and increase the complexity of the interoperability between HIT applications owing to the proprietary nature of HIT application

5

standards. Practice and research have shown that the development of national specifications and standardisation for health data is the first step in achieving an interoperable HIT infrastructure and thereafter the development of a national e-health and EHR programme. In this regard, Haux (2006) explained that, since HIT applications are generally developed to enhance opportunities for global access to health services and medical knowledge, the need for institutional and national HIT strategies is seen as essential.

Without a set of national health data standards, health information handling will remain as a stand-alone application and this will hinder the exchange of medical information. Thus, there is an immediate need to carry out studies to alert healthcare authorities to the importance of undertaking the development of health data standards before establishing a national EHR system in order to establish credible standards for the next decade, to maximise interoperability across the health sector, and to decrease the risks associated with the implementation of non-standard applications (Hovenga 2008; Hammond 2005). Such studies should examine the current status of the adoption of HIT related standards in national hospitals and should investigate both the enabling and inhibiting factors which are influencing their adoption, not only from a technical point of view, but also from organisational, managerial and social perspectives. This will help healthcare authorities and strategic planners to understand the actual state of affairs concerning health data standards in Saudi Arabia, allowing them to minimise the negatives and maximise the positives associated with the adoption of HIT related standards.

1.7 Scope of the Research

Within the IT community, standards are required for varying degrees of interoperability between information systems (IS) which are all working to varying numbers of standards. Due to this diversity, the scope of this research covers only those health data standards that are explained in detail, together with their classifications, in Chapter Three: but a broad generalisation is beyond the scope of this research. In addition, those standards have been evaluated in terms of the decision-making stage in the adoption process in Saudi healthcare organisations while, of Saudi healthcare organisations, six hospitals have been involved in this research: the National Guard Health Affairs (NGHA), King Faisal Specialist Hospital and Research Centre (KFSH&RC), Riyadh Armed Forces' Hospital (RAFH), the Security Forces' Hospital (SFH), Riyadh University Hospitals (RUHs) and King Fhad Medical City

6

(KFMC). These hospitals were chosen because they are the major healthcare organisations in Saudi Arabia, they have a more advanced HIT infrastructure with the highest IT budgets, they have and recruit well-qualified people with regard to both IT and health informatics, and they are considered to be the main supporters of e-health initiatives (Altuwaijri 2008). Last but not least, they are involved in the pilot project run by the Council of Health Services concerning the exchange of health information.

1.8 Research Questions

The following questions were formulated to act as a basis for this research:

1. What is the current status of health data standards in Saudi healthcare organisations?

    a) What are the standards that are currently adopted in Saudi healthcare organisations?
    b) How are the current health data standards adopted and supported in Saudi healthcare organisations?
    c) What are the roles of the current health data standards in Saudi healthcare organisations?

2. What are the critical factors influencing the adoption process of health data standards in Saudi healthcare organisations?

    a) What are the barriers regarding the adoption of health data standards?
    b) What are the enabling factors regarding the adoption of health data standards?

3. What steps should be undertaken by Saudi healthcare organisations to promote the adoption of HIT related standards?
4. How can the Saudi government help healthcare organisations to increase the adoption of HIT related standards in Saudi healthcare organisations?

1.9 Aim and objectives of the research

The principle purpose of this study is to investigate, at the decision-making stage, the adoption of health data standards that are required to initiate interoperable HIT infrastructures in healthcare organisations. To achieve this purpose, nine interconnected objectives needed to be achieved in order to fulfil the aforementioned aim. These objectives are as follows:

7

Objective 1: To conduct a comprehensive literature review related to health data standards.

Objective 2: To review the existing adoption models and consider how these models could be extended or modified to reflect the adoption process of HIT related standards at the decision-making stage.

Objective 3: To develop a theoretical model, based on the models identified in Objective 2, of the critical factors influencing the adoption of HIT related standards in healthcare organisations at the decision-making stage.

Objective 4: To identify the current health data standards adopted in Saudi healthcare organisations.

Objective 5: To assess how the current health data standards in Saudi healthcare organisations are adopted and are being supported.

Objective 6: To examine the roles of the current health data standards adopted in Saudi healthcare organisations.

Objective 7: To identify both the barriers and enabling factors regarding the adoption of health data standards in Saudi healthcare organisations.

Objective 8: To develop and validate a model of reference for the adoption of HIT related standards.

Objective 9: To draw, from the lessons learned, a set of recommendations to help in promoting the adoption of HIT related standards in healthcare organisations, to point out the limitations of this work and indicate directions for future research.

1.10 The Significance of the Research

The initial literature review highlighted that there is no empirical research into the factors that have an impact on the adoption of HIT related standards and, in particular, none within the Saudi healthcare context. This means that academics and practitioners, who are devoted to the on-going use of these standards, still lack a significant body of evidence with regard to the factors that influence their adoption. This reaffirms the need for a more in-depth study to investigate the adoption of HIT related standards at the decision-making stage in healthcare

8

organisations. Thus, this research has important implications for both academics and practitioners. From an academic perspective, the importance of this study lies in two areas: first, most enterprise adoption studies have primarily focused their efforts on established and already well-understood IT and therefore little research has been conducted related to the adoption and implementation of healthcare IT or issues related to standardisation and data exchange (Basole 2008). Secondly, the technology adoption paradigm in developing nations, which still remains a complex and important phenomenon, has received only a small amount of research attention (Al-Gahtani, 2003). From a practitioner's point of view, Grechenig *et al.* (2008), in their study of interoperability in national e-health strategies in a Middle Eastern State, pointed out that the integration of existing systems and infrastructure can be much more demanding and resource consuming than building from scratch. They also added that developing nations have fewer predefined IT infrastructures that have to be integrated and therefore can more definitely implement their overall national plan for e-health. Thus, the importance of this research, from a practitioner's point of view, lies in two areas. First, it provides decision-makers in Saudi healthcare organisations with a better understanding of the adoption processes for health data standards in order to design an appropriate strategy for integrating them. Secondly, the outcomes of this study can be a reference for other strategic planners in the health sector in developing countries and can be used to promote the adoption of HIT related standards in those nations.

1.11 Layout of the Thesis

Phillips and Pugh (2000, pp. 58-72) stated that a PhD thesis is made up of four elements: the background theory, focal theory, data theory and contribution. According to Phillips and Pugh (2000, pp. 58-72), the background theory focuses on assessing the field of research which, in this case, is the adoption of HIT related standards, and identifying the problem domain which, in this research, is the factors influencing the adoption of HIT related standards at the decision-making stage. The focal theory concentrates mainly on carrying the academic discussion forward, based on the background theory, to generate or develop a conceptual model and method. The data theory deals with the methodology used to conduct the research, together with the relevance and validity of the materials that are used to achieve the research objectives. The contribution element focuses on an evaluation of the importance of the research and its novelty by adding to the body of knowledge in the related field. In fulfilling this, the thesis consists of nine chapters, as shown in Figure 1.1. These are:

- ❒ **Chapter One: Introduction – Background Theory:** The purpose of this chapter is to highlight the issues, need and motivation for the research and then to develop the research's questions, aims and objectives. These are required to guide the process of the research.

- ❒ **Chapter Two: An Overview of Saudi Arabia and the Health Sector – Background Theory:** The aim of the chapter is to give an overview of the Kingdom of Saudi Arabia, to describe its healthcare system and to explain the current status of HIT in Saudi Arabia; this also validates the importance of this kind of research.

- ❒ **Chapter Three: Health Data Standards – Background Theory:** This chapter provides a more detailed review of health data standards. It highlights the importance of health data standards and different classifications of their types. Following this, it presents the most well-known organisations that develop and promote health data standards.

- ❒ **Chapter Four: Literature Review of Innovation Adoption – Background Theory:** This chapter reviews the literature by assessing in more depth the innovation adoption models in order to offer evidence and support from the literature describing innovation adoption at the decision-making stage in organisations. It also discusses the previous studies concerning the adoption process of IT related standards and so identifies the gap within studies related to HIT standards that this research seeks to fill.

- ❒ **Chapter Five: Research Methodology – Data Theory:** This chapter discusses the overall research philosophy applied in this research. In doing so, a qualitative research framework was constructed in order to ensure that all relevant research options were considered as a series of top-down stages. In addition, a case study research strategy framework, which is a set of procedures that are both open-ended and rigorous, was constructed in order to lessen the complexity of the social setting under investigation.

- ❒ **Chapter Six: Research Conceptual Model - Focal Theory:** In this chapter, which is based on the Diffusion of Innovation (DOI) theory and the theory surrounding the Economics of Standards, the research concept is developed. Then, a critical review of the literature is carried out to identify the critical factors; these are then linked to the appropriate category in the conceptual model.

- ❒ **Chapter Seven: Data Analysis – Contribution:** This chapter carries out the analysis of the collected qualitative data. In doing so, a hybrid approach, which includes thematic and cross-case analysis, is conducted to draw conclusions from the empirical evidence. With respect to the research questions, this chapter discusses the current status of health data

standards in Saudi healthcare organisations, their roles, and the barriers and enabling factors in their adoption.

❒ **Chapter Eight: Discussion – Contribution:** The purpose of this chapter is to draw some lessons learned from the cases. In addition, the critical factors identified in the analysis are discussed in accordance with the literature to validate further the empirical findings. Moreover, the proposed model is modified and validated to be a reference for the adoption of HIT related standards.

❒ **Chapter Nine: Conclusion – Contribution:** The principle aims of this chapter are to present a set of recommendations to promote the adoption of health data standards in healthcare organisations, in particular in Saudi Arabia, and also to explain how this research contributes to the body of knowledge through the development of a model of the critical factors influencing the adoption of HIT related standards at the decision-making stage in healthcare organisations. This chapter also presents some of the limitations of this study and suggestions for further research.
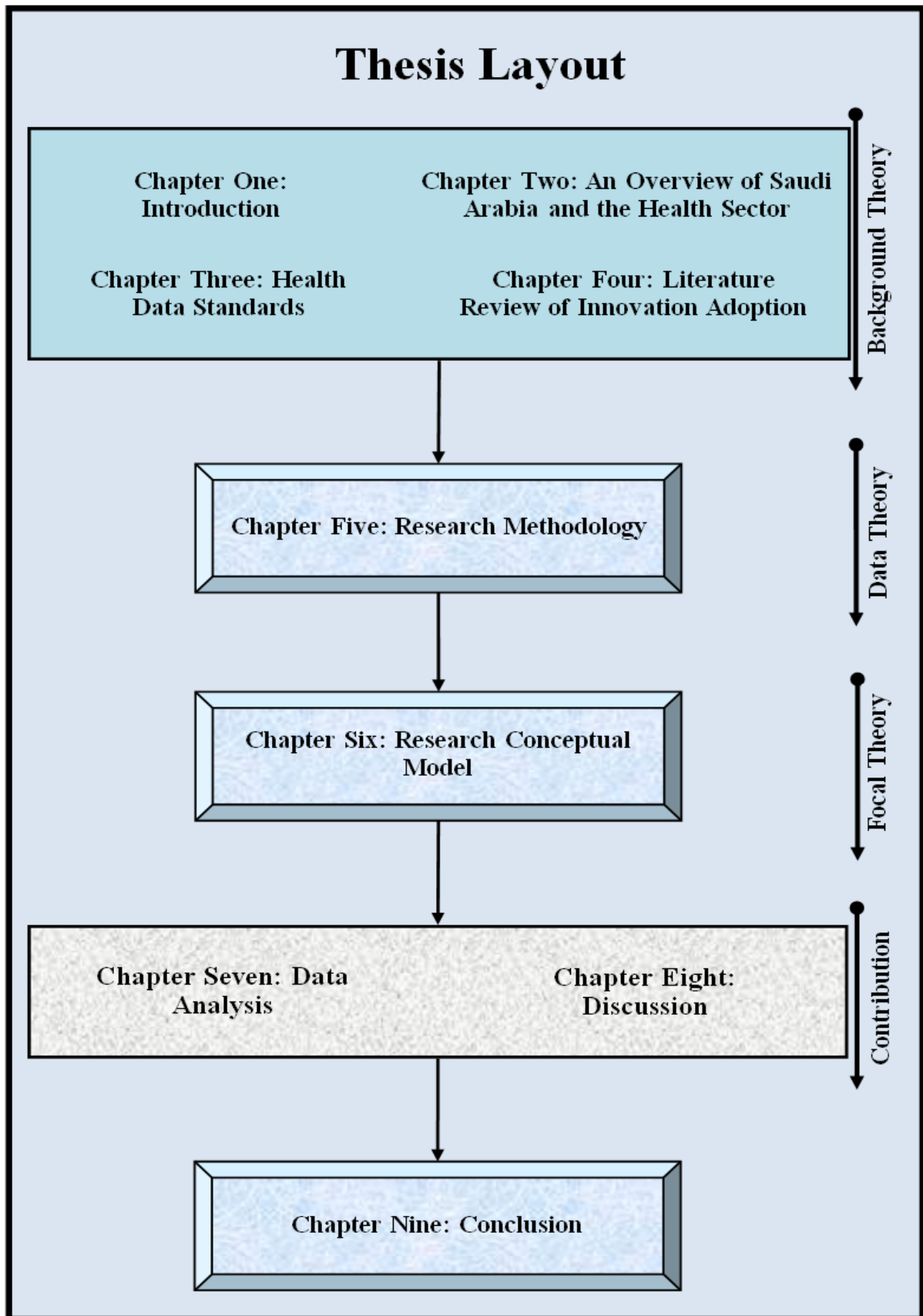
Figure 1.1: The structure of the thesis layout, in accordance with the research elements of Phillips and Pugh (2000, pp. 58-72).

Chapter Two: An Overview of Saudi Arabia and the Health Sector

2.1 Introduction

This chapter briefly presents an overview of Saudi Arabia and the health sector. However, because of the breadth of the subject matter, this chapter covers only four main points. First, it gives some information concerning the background of Saudi Arabia; secondly, the present status of ICT in Saudi Arabia is highlighted; thirdly, the healthcare system and related entities are presented; and, finally, the e-health concept that has been introduced into the Saudi health community is described and explained. This chapter concludes with a summary of the main points raised.

2.2 Background of Saudi Arabia

Founded in 1932 by King Abdulaziz Al-Saud, the Kingdom of Saudi Arabia (KSA) is the largest country of the Arabian Peninsula since it covers an area of more than 2,150,000 square kilometres (830,000 square miles); this represents nearly 80% of the Arabian Peninsula (Ministry of Economy and Planning 2010a; Ministry of Foreign Affairs 2006). The vital importance of the Kingdom's location, as can be seen in the map in Figure 2.1, is as a bridge between Africa, the Western world and Asia. Although, the climate in Saudi Arabia varies from one region to another, it is generally very hot in summer and very cold in winter (Ministry of Economy and Planning 2010a). In mid-2007, the Kingdom's total population amounted to 23.98 million with a 2.3% annual increase. Of this population, 72.9% are Saudis, 27.1% non-Saudis, 67.1% are Saudis below 30 years of age and 37.2% are below 15 years of age (Ministry of Economy and Planning 2010b).

The importance of the Kingdom of Saudi Arabia rests on two factors. First, it is a land of the two Holy Mosques, at Makkah and Medinah, for millions of followers of Islam across the world. Secondly, it is a land of opportunities for a large number of expatriates from Asia, Europe and the US since Saudi Arabia has the largest oil reserves and ranks as the largest exporter of petroleum in the world. In addition, Saudi Arabia is considered to be the largest free market economy in the Middle East and North Africa since it holds a share of approximately 25% of the total Arab gross domestic product (Ministry of Economy and

13

Planning 2010c). Thus, the Saudi government plays a major role in the nation's economic activities through the public sector and, owing to the solid nature of the national economy, Saudi Arabia has also seen major improvements over the past 40 years within all fields in terms of socio-economic development (Al-Shehry *et al.* 2006).

In 1992, the Basic Law declared that Saudi Arabia is a monarchy ruled by the sons and grandsons of the Kingdom's founder, King Abdulaziz Al-Saud. In addition, Islam acts as the fundamental base of Saudi law that derives from the Qur'an and the Sunnah of Prophet Muhammad (Department of States 2010). Saudi Arabian culture revolves around the Islamic religion and the tribal system; these are perceived to be key determiners of the norms, patterns, traditions, obligations, privileges and practices of society in the Kingdom (Al-Saggaf 2004). In addition, the forces mentioned above still affect the different activities and aspects of life in Saudi Arabia at both an individual and organisational level (Al-Shehry *et al.* 2006).

Figure 2.1: Location of Saudi Arabia (The World Factbook 2010).

14

2.3 Information and Communication Technology (ICT) in Saudi Arabia

ICT plays a significant role in all contemporary economies and thus the Saudi government has given it top priority. The Saudi government promotes the use of ICT in the economy through its imports and its trade and industrial activities, as well as by its own consumption. Government policies encourage the adoption and implementation of up-to-date, advanced IT systems in both public and private organisations; therefore, the use of IT systems in the banking, oil and petrochemical fields in Saudi Arabia is considered the most advanced in the world. However, in a country such as Saudi Arabia, the diffusion of ICT applications is complex because it is often associated with problems that are not only technical, but that are also cultural, political, economic, educational and social. Therefore, the application of ICT in Saudi Arabia is still relatively young when compared to certain developed countries such as the USA, the UK, Japan or Canada (Al-Shehry 2008). In this regard, the Ministry of Communication and Information Technology was formed in 2003 and the Saudi National Plan for ICT was declared in 2005 to control, regulate and develop ICT services and plans in Saudi Arabia (Al-Shehry 2008).

The Saudi National Plan for ICT reflects the determination of the government to support the transformation to e-government; however, great effort is needed if this is to be translated into reality. As part of this plan, the e-Government initiative was created in 2005, the main focus of which was to use ICT to reform public organisations. In addition, the ICT plan also included other major objectives, such as enhancing e-readiness in the public sector, developing an e-society, and introducing IT training programmes to the Kingdom's citizens. Following on from this, the Saudi e-government (or the "Yesser") programme was designed to improve the productivity of public organisations, to offer government services simply and conveniently to citizens and businesses, and to provide accurate information in a timely fashion (AlSabti 2005). E-government was perceived to be the major vehicle which would take the public sector into the information age and so the main objective of the Yesser project was to facilitate the transformation of both the public and private sectors in Saudi Arabia to apply e-government by supporting the different public and private organisations with methodologies, standards, data and knowledge (AlSabti 2005).

In addition, the Saudi government opened up the telecommunication sectors to privatisation in 2007 in order to improve the development of the Kingdom's ICT infrastructure (Al-Shehry

2008). The Saudi government also realised that it was necessary to reduce computer illiteracy among its citizens and this was addressed in two ways: the first was by providing a computer for every household at a low cost and the second was to introduce ICT courses into public schools (Al-Shehry 2008). Through these government initiatives, ICT services have spread and improved while their cost has gradually decreased. According to the Ministry of Communication and Information Technology (2009), the number of internet users has grown from 1 million in 2001 to approximately 10 million in 2009, with an annual increase of 33%.

2.4 The Healthcare System in Saudi Arabia

The Ministry of Health (MoH) is the main government agency entrusted with the provision of preventive, curative and rehabilitative medical services in Saudi Arabia. Its functions include strategic planning, formulating specific health policies, supervising all health service delivery programmes, and monitoring and controlling all other health-related activities (Ministry of Health 2009). However, health services in Saudi Arabia began only in the early 1950s when the MoH was established and the first campaign against malaria was launched. Following this, the healthcare system in Saudi Arabia developed slowly until 1980 when there was a period of rapid of expansion in every sector in the Kingdom because of growth and improvements in the economy (Al-Yousuf *et al.* 2002). In the early 1980s, the concept of primary healthcare became popular and today, the MoH runs a three-tier healthcare system comprising primary, secondary and tertiary levels which correspond respectively to health centres, general hospitals and specialist hospitals (Al-Yousuf *et al.* 2002).

Under the overall umbrella of the MoH, there are 20 health regions with each one being led by a General Director of Regional Health Services; the policies, plans and programmes of the MoH are implemented through this structure. However, the directorates are reasonably autonomous in terms of the recruitment, welfare, training, discipline, supervision and evaluation of their staff. Nonetheless, some responsibilities are shared with the MoH as and when necessary (Al-Yousuf *et al.* 2002). In addition to the MoH, there are two other entities in charge of the provision of healthcare services; these include other governmental bodies (e.g. Army hospitals, the National Guard Hospitals and University hospitals) and the private (for profit) health sector (Altuwaijri 2008). These sectors are responsible for the provision of healthcare services to both Saudi citizens and expatriates. According to the Ministry of Health (2007), the MoH provides 58% of healthcare services, with the remaining portion

being shared between other governmental bodies (23%) and the private sector (19%). Figure 2.2 shows the provision of healthcare services in Saudi Arabia through the three providers including MoH, other governmental bodies and the private sector. In spite of this development in the healthcare sector, the delivery and management of health services to Saudi communities and regions is a truly complex task. Saudi Arabia spans a large geographical area with fragmented healthcare systems whose quality of care varies considerably between its diverse and scattered regions.
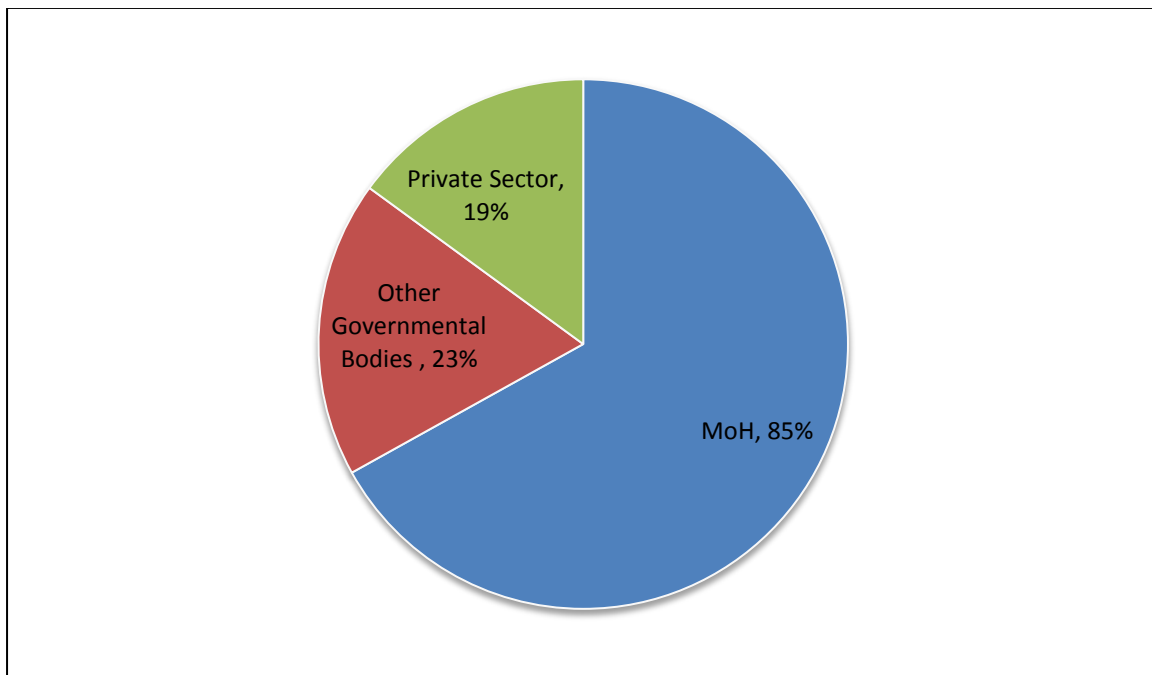
Figure 2.2: Healthcare providers in Saudi Arabia and their provision portion

According to the Ministry of Health (2009), the total number of hospitals in Saudi Arabia is 387. Some of these hospitals are advanced medicinal healthcare organisations which provide a variety of sophisticated treatments such as open-heart surgery, kidney transplants and cancer therapies. The total number of beds in all hospitals is 53,519, with the number of beds in MoH hospitals being 31,420; this corresponds to 58.7% of the total number of beds in the Kingdom. There are 2.2 beds per 1,000 persons, equating to one bed for 453 people. The total number of physicians in the Kingdom (including dentists) is 47,919; 21.6% of these are Saudi. The total number of dentists is 6,049 (excluding those working in private clinics) and 21.1% of these (1,275) are Saudi. The total number of pharmacists is 15,043 (excluding those working in the private sector); 1,875 pharmacists (12.5%) are Saudi while 99% of the pharmacists working in private pharmacies are non-Saudi. The total number of nurses is

17

93,735, 28.8% of whom are Saudi and allied health personnel number 51,288 in total, with 59.1% being of Saudi nationality.

2.4.1 Health and Medical Education

In Saudi Arabia, many health professionals are foreign, making English the main language in the health sector; this makes communication with patients difficult. However, a gradual change has been taking place, with increased numbers of Saudi nationals becoming qualified and taking up employment in the health sector. There is also a government plan to update the scientific efficiency of national personnel and to encourage them to gain specialist skills in the different health and medical fields. The health institutes have been updated and some have changed to become colleges of health science to offer graduates from general secondary schools and secondary health institutes the opportunity to achieve an education at a distinguished level. The curriculum, methods of training, field and practical practice, are all continuously updated (Ministry of Health 2007). According to the Ministry of Health (2009), the number of health colleges was then 31 (15 for males and 16 for females) and the total number of students attending these colleges was 13,369; of these, 44% were female students. Regarding University Medical Education, which is controlled by the Ministry of Higher Education, the number of students attending university medical and health colleges in 2009 was 20,177; 43.5% of these were female students (Ministry of Health 2009).

2.4.2 Health Insurance System

Because of the strength of the national economy over the past four decades, the Kingdom has recruited millions of people from different nations to work in Saudi Arabia to help in the socio-economic development of all fields. These expatriates, who account for approximately 28% of the total population of Saudi Arabia (Al-Shehry 2008), were traditionally provided with free medical care according to the Kingdom's healthcare policy which decrees that medical care should be provided to all citizens and foreigners without charge. However, this policy has had a detrimental effect on the delivery of healthcare services in the Kingdom because of the high rate of population growth and the high cost of healthcare. As a result, the Saudi Arabian government has looked for alternative resources to finance its healthcare services and, in a renewed effort to free the government from some of the financial burden of providing free medical care to foreign workers in the Kingdom, a law was passed to

implement mandatory health insurance for all foreign workers in the Kingdom. In this regard, a cooperative health insurance system was created in 1999; it aims to provide healthcare services, to supervise the insurance sector, and to organise health services for all residents of Saudi Arabia (Al Sharif 2008).

The Cooperative Medical Insurance Council is an independent government body created by a resolution from the King's Council. It is charged with the responsibility to work in the best interests of patients, and to regulate and guide both treatment providers and insurance companies. It ensures best practice is followed and punishes transgressions. A further role is also to keep patients informed by acting as a liaison between the healthcare insurance industry and patients. The motivation for the introduction of this system was to enable foreign workers to receive healthcare using private facilities, to relieve the financial pressure on the government healthcare facilities, to contribute to the growth and involvement of the private sector in providing healthcare through the establishment of hospitals and clinics, and to maintain the quality of healthcare services. The present insurance market in Saudi Arabia is estimated to be worth SR 7 billion ($1.87 billion). Medical and car insurance are considered to be the largest components of the insurance market with the total number of people registered under the national health insurance scheme having risen to 2.64 million. It is expected that SR 30 billion ($8 billion) will be invested every year into the medical insurance market and around 7,000 new job opportunities will open up in insurance every 12 months (Al Sharif 2008).

2.4.3 Saudi Medical Commissions and Societies

Certain medical commissions have been established for the purpose of introducing various types of medical service in Saudi Arabia. For example, the Saudi Council of Health Services, chaired by the Minister of Health and with a membership of representatives from both the private and government health sectors, was established in 2002 to fulfil the following functions: to prepare the Kingdom's healthcare strategies; to ensure that regulations for the operation of hospitals are administered in accordance with the principles of economic management and in line with performance and quality standards; and to develop and adopt systems to ensure the coordination and integration of policies among all the authorities responsible for the provision of healthcare (Council of Health Services 2010a). The Saudi Commission for Health Specialists was established in 1992 to enhance performance, to

develop vocational skills, and to encourage and enrich scientific thought and practice in the various health disciplines (Saudi Commission for Health Specialists 2010). In addition, numerous different medical societies have been established in Saudi Arabia by different government organisations. All of these medical societies are non-profit-making scientific and medical organisations and each society has a board of directors who meet on a periodic basis. There is a membership fee, which is renewable annually, and this membership is open to both Saudis and non-Saudis. Those societies were created in the Kingdom to promote and regulate specialist professions using an academic and scientific approach (Saudi Council of Health Services 2010b). Appendix A lists the major medical societies in Saudi Arabia.

2.5 The Current Status of HIT in Saudi Arabia

The adoption of ICT applications in the Saudi health sector constitutes a promising initiative to promote the advancement and improve the quality of the delivery of medical services. According to Qurban and Austria (2008), the MoH conducted a study to assess the benefits of developing the e-health concept in Saudi Arabia (2006-2007), particularly in terms of financial parameters. This study found that the government would save around 10-15 % of its annual health budget if it adopted e-health. In addition, the EHR system was expected to facilitate the further development of the medical insurance market. Altuwaijri (2008), in his study of Saudi e-health initiatives, reported some of the benefits of e-health to physicians, ancillary departments (such as pharmacies, laboratories and radiology units), nursing staff, patients and management. For example, physicians' prescriptions are produced electronically, preventing incorrect interpretations of handwritten orders. Physicians also have full control over the instruction processes, offering the benefit of real time alerts; this enhances the quality of the medical services and reduces the time required for locating and reading patients' charts. For those in ancillary departments, the resources which are freed up by the decreases in administrative tasks give staff more time to provide better care and improve regulatory compliance measures. From a managerial perspective, information moves around the organisation instantly; this, in turn, reduces the turnaround time for medication delivery, for obtaining and processing lab work, for scheduling and completing radiology examinations, and for performing other tasks.

Despite the promised benefits offered by HIT applications in the Saudi health sector, the movement towards e-health in Saudi Arabia is still very slow and is lagging behind other

sectors in the Kingdom, such as the banking and oil industries (Altuwaijri 2008). This is because Saudi Arabia is still lacking the fundamental attributes required to be ready for the application of such advanced clinical information systems. In this regard, Al-Solbi and Mayhew (2005) asserted that the health sector in Saudi Arabia is still lagging behind other developing countries in terms of being ready for e-health, showing there is a need for a clear e-health plan and an adequate budget. Further evidence comes from a study by Qurban and Austria (2008) who highlighted that the maturity of the Saudi e-Health system is at level two which means that a limited number of HIT applications have been implemented by the hospitals. This study asserts that the Saudi e-health system should be at least at level three; this means that a type of EHR, telemedicine and teleconferencing services should be established with widespread use of other HIT applications in hospitals and clinics. Altuwaijri (2008) emphasised that the Saudi health authorities must acknowledge the important role of HIT applications in the delivery of medical services through the establishment of a national programme for promoting the adoption of advanced clinical information systems by the health sector.

In addition, Altuwaijri (2008) explained the current status of HIT in the three healthcare providers in Saudi Arabia. According to this study, the majority of MoH hospitals around the Kingdom lack an adequate and proper ICT infrastructure owing to insufficient funding. Similarly, most of the private clinics and hospitals lack the minimum requirements in terms of their HIT infrastructure while most of the systems in the private sector place more emphasis on financial applications such as billing systems. In contrast, most of the governmental care bodies are equipped with the most recent and advanced clinical information systems for three reasons: first, they have an adequate annual budget allocated by the government and so the financing of HIT projects is not an issue; secondly, they have the most highly qualified professionals in Saudi Arabia because of the availability of the required budget; and thirdly, they are considered to be the most advanced healthcare providers in Saudi Arabia and so the government is keen to maintain the positions of these hospitals in accordance with international key performance indicators. Unfortunately, the number of these hospitals is still small, they are located in major cities, and moreover, they are overloaded with patients.

2.6 Summary

In the last 40 years, Saudi Arabia has witnessed a dramatic improvement in almost all its sectors, including the health sector, because of the strength of its national economy. Today, the three-tier healthcare providers, which are in charge of the delivery of medical services, are the MoH, other governmental care bodies and the private sector. Nonetheless, the management of the delivery of medical services in Saudi Arabia today is of real concern. This is because Saudi Arabia spans a large geographical area and has, as a result, a fragmented healthcare system where the quality of care varies considerably between its diverse and scattered regions. In this regard, there is a growing recognition on the part of the government and health authorities that a robust HIT infrastructure implemented by healthcare providers could significantly contribute to solving the current problems regarding the delivery of medical services. However, recent studies have shown that Saudi Arabia is deficient in many of the fundamental attributes that will be required over time if it is to be ready for the advanced application of clinical information systems. Thus, a clear national strategic plan must be established in this regard, together with an adequate budget to bridge this digital divide. The national strategic plan must also stress on the role of insurance companies in the development of sustainable national HIT infrastructure as they will be the key driver for the medical data exchange between healthcare providers in Saudi Arabia.

Chapter Three: Health Data Standards

3.1 Introduction

The intention of this chapter is to review the literature surrounding health data standards. In doing so, the chapter begins by giving an overview of the importance of such standards and then explains and illustrates some types and classifications in this regard. Next, it presents in detail the organisations involved in the development of health data standards and concludes with a summary highlighting the main issues that have been discussed.

3.2 The Importance of Health Data Standards

Rapid growth in terms of investment and increased adoption of HIT applications in healthcare organisations worldwide can be seen today. However, such systems must be interoperable one with another in order for healthcare organisations to obtain the benefits that may be gained by such applications, such as increased patient safety, reductions in medical errors, improvements in efficiency and lower medical costs (Park & Hardiker 2009). This can be achieved by the implementation of consensus standards (Zhang *et al.* 2007). The use of such standards is based on the idea of developing agreed specifications or standards for data exchange; these will not depend on any proprietary IT applications but must be universally understood and accepted for data-exchange (Thomas 2006). In this way, the health data standards' industry has the potential to increase quality whilst, at the same time, lowering costs and the risks involved with developing, purchasing and managing HIT applications (Zhang *et al.* 2007). For example, the use of data standards has the benefit of eliminating the high maintenance costs of the direct translation approach while allowing systems to be added, upgraded or removed with little or no impact on the remaining systems (Thomas 2006).

Luic and Striber-Devaja (2006) and Spyrou *et al.* (2002) stated that health data standards are essential in the healthcare environment in order to set out the conditions for data access and usage, as well as to make the sharing of medical data technically feasible. Spooner and Classen (2009), Jenders (2007) and Hammond (2005) emphasised that health data standards are the critical foundation for creating and aggregating a patient-centric EHR system, building national health information networks, interchanging data among independent sites, creating a population database for health surveillance and for defence against bioterrorism,

promoting clinical research, and facilitating clinical-decision support (CDS). Walker *et al.* (2005) developed a comprehensive financial model that showed substantial improvements in the economic efficiency of medical services through the exchange of patients' information between healthcare providers and related groups. According to this model, greater benefits can be gained from so-called "Level Four" interoperability, where EHR information is seamlessly shared and used by different applications throughout the care chain. Luic and Striber-Devaja (2006) claimed that standardising health data and business processes is the critical step in enabling the large number of primary, secondary and referred medical service organisations (e.g. pharmacies, laboratories and radiology providers) to be integrated.

Furthermore, an intensive study of the benefits of health data standards, carried out by Spooner and Classen (2009), demonstrated these benefits based on six main attributes: namely, safety, efficiency, timeliness, effectiveness, equity and patient-centeredness. The safety aspect refers to the prevention of medical errors by adhering to guidelines and the cultural shift among providers towards an expectation of safety-oriented support. The efficiency factor describes the possibility of integrating fragmented systems so that they can function independently for their designed purposes while sharing data in such a way that the re-entry of data is unnecessary. Timeliness refers to acts that must occur according to a schedule or at a point in the process of a disease where waiting would result in a poorer outcome. Health data standards promote consistency in the application of guidelines that, in turn, promote the effectiveness of healthcare systems and also affect the equity of such systems by ensuring that information systems provide the same levels of service to the whole population (via functional standards); they will also make possible regional health data interchange networks (via messaging and terminology standards). Standardised EHR systems and HIT applications could promote patient-centred care, with physicians and clinicians being able to retrieve a patients' record at any place, regionally, nationally and even internationally, in which the patient is being treated.

3.3 Types of Health Data Standard

According to Kim (2005), the creation of an interoperable healthcare system depends upon two important concepts: syntax and semantics. Syntax interoperability refers to the structure of the message content, which is the equivalent of the rules for spelling and grammar; these must be agreed and standardised in both the sending and receiving sites. In contrast, semantic

interoperability conveys the meaning of the sent message, the equivalent of a dictionary and thesaurus. Kim (2005) highlighted that, without semantic interoperability, data can be exchanged but there is no assurance that it can be processed in a meaningful way at its destination. Nevertheless, the available health data standards today address both types of interoperability. For example, Park and Hardiker (2009) stated that current attempts to standardise the capture, representation and communication of medical data in such a way as to represent their meaning, rely upon three layers of artefacts. These are generic reference models for representing medical data (e.g. HL7 CDA and the EHR Reference Model), agreed definitions regarding the structure of clinical data (e.g. penEHR archetypes and HL7 templates) and clinical terminology systems (e.g. LOINC and SNOMED-CT). However, the literature has shown that there is no agreement among previous studies on a unified category of health data standards that enables interoperability. Many studies have come with different categorisations. Table 3.1 demonstrates six different studies concerning health data standards and their types. However, the intention is not to review all the possible studies in this regards but instead is to show how different studies have come with different categorisations. In addition, Table 3.2 shows the different types of health data standards and their meaning described by those studies presented in Table 3.1.

In view of that, this research found that the classification offered by Kim (2005, pp.5-6) is the most appropriate and accurate since it matches the name of a category to a description of the standards along with specific supporting examples. In this regards, Kim (2005, pp.5-6) identified six types of health data standards including messaging, terminology, document, conceptual, application and architecture standards. Messaging standards specify the message format, data elements and structure to allow transactions to flow consistently between different systems. Terminology standards provide specific codes and terms for clinical concepts such as diagnosis and diseases. Document standards specify the types of information that are included in a clinical note and how it can be located. Conceptual standards allow information to be transported through the systems without losing meaning and/or context. Application standards determine the way medical procedures are processed and how systems interact. Architecture standards define how medical data are stored and distributed. Table 3.3 shows the key health data standards and development organisations in accordance with some modifications to Kim (2005, pp.5-6). In addition, Appendix B also offers some examples of some of the health data standards presented in Table 3.3.

Abdullah Ibrahim Alkraiji 2011

Table 3.1: Some studies concerning health data standards and their types.

No	Author(s)	Study's Title	Study's Purpose
1	Spooner & Classen (2009)	Data standards and improvement of quality and safety in child health care	This study discussed: 1. how health data standards can improve quality in child health; 2. what kinds of health data standards hold the most promise for quality improvement in child health; and 3. how child health professionals can engage in the work of developing health data standards
2	Luic & Striber-Devaja (2006)	The significance of information standards for development of integrated health information system	This study described the role of health data standards in the development and enhancement the success of health information systems in healthcare sector which is highly dependent on information used in both the delivery of care and the management of this sector.
3	Hammond (2005)	The making and adoption of health data standards	This study discussed: 1. Why health data standards are required; 2. The process of and the groups involved in creating health data standards; 3. Issues and barriers affecting the progress and acceptance of standards; and 4. Some recommendation for dealing with those barriers.
4	Kim (2005)	Clinical data standards in health care: Five case studies.	This study gave some information regarding health data standards such as their importance, purposes and types and presented case examples from a variety of healthcare sector in US that demonstrate ways organisations are making progress toward interoperability.
5	Spyrou et al. (2002)	Healthcare information standards: comparison of the approaches	This study discussed: 1. The different types of health data standards that can be used to provide interoperability in healthcare information systems; 2. A short comparison between HL7, HL7's CCOW and CEN/TC25 architecture; and 3. Solution that is being developed to achieve integration of health data using such standards.
6	Feldbaum & Dick (1997, pp.59-77)	Electronic patient records, smart cards and confidentiality.	This book dedicated a chapter to discuss the importance of health data standards and their role to support medical information exchange and the different types of standards and standards development organisations.

Table 3.2: Summary of some health data standard categorisations from previous studies.

Studies	Category
Spooner & Classen (2009, pp. 576-577)	1. **Terminology Standards** ensure consistent definitions of terms by users. 2. **Messaging Standards** specify the communications between EHR and registry systems. 3. **Functional Standards** specify the rules to support decision making that is correctly timed and properly administered.
Luic & Striber-Devaja (2006, p. 65)	1. **Data Standards** refers to the definitions of data elements, including data domains and coding, terminologies and classifications. 2. **Privacy Standards** include the legislation and policies that aim adequately to protect the privacy of consumers and healthcare providers. 3. **Patient Identification Standards** deal with the way in which patients are distinguished from one another and the authentication required to use online services. 4. **ICT and Technical Standards** are instrumental for the operation of healthcare organisations, the planning and management of the health sector, for electronic business transactions and also for the development of a national system of EHR.
Hammond (2005, p. 1206)	1. **General Standards** are instruments for broad use. 2. **Data Components Standards** refer to data elements, data types, terminologies, clinical statements and clinical document architecture. 3. **Data Interchange Standards** establish a structured format for free-form documents and images, and the sequence of the data during transmission. 4. **Knowledge Representation Standards** provide guidelines, protocol and decision support algorithms. 5. **EHR Standards** establish common definitions of functional requirements, EHR models, Continuity of Care Records (CCR), patient summary records and personal health records. 6. **Application-Level Support Standards** establish identifiers, resource registries, diseases registries, tool sets, conformance requirements and an implementation manual.

Kim (2005, pp. 5-6)	1. **Messaging Standards** allow transactions to flow consistently between systems by specifying format, data elements and structure.
	2. **Terminology Standards** provide specific codes for clinical concepts such as diseases.
	3. **Document Standards** indicate what type of information is included in a document and where it can be found.
	4. **Conceptual Standards** allow data to be transported across systems without losing meaning and context.
	5. **Application Standards** determine the way business rules are implemented and software systems interact.
	6. **Architecture Standards** define the processes involved in data storage and distribution.
Spyrou *et al.* (2002, pp. 14-15)	1. **Vocabulary Standards** intend to establish common definitions for medical terms to encourage consistent descriptions among practitioners.
	2. **Structure and Content Standards** give a clear description of the data elements by identifying data fields and standardising the field length, data type and content of each data field.
	3. **Messaging Standards** establish a format and sequence for data during transmission.
	4. **Visual Integration Standards** ensure that applications automatically synchronise based on their common context, according to the user's selection of application.
Feldbaum & Dick (1997, pp.59-77)	1. **Vocabulary Standards** establish common definitions of medical terms and determine their representation in medical records.
	2. **Structure and Content Standards** provide a definitive description of the data elements to be included in the EHR.
	3. **Messaging Standards** provide for the uniform and predictable electronic exchange of data by establishing the order and sequence of the data during transmission.
	4. **Security Standards** ensure patient data remain confidential and protected from unauthorised users.

Table 3.3: Key health data standards and development organisations (Kim 2005, pp.5-6).

Type	Description Name	Acronym	Function	Developer
Messaging	Health Level Seven Messaging Standards Version 2 and Version 3	HL7 v2.x and v3	Electronic message formats for clinical, financial and administrative data.	Health Level Seven (HL7)
	Digital Imaging and Communications in Medicine Committee	DICOM	Format for communicating radiology images and data.	National Electronic Manufacture Association
	National Council for Prescription Drug Programs	NCPDP	Structure for transmitting prescription requests and fulfilment.	National Council for Prescription Drug Programs
	Institute of Electric and Electronic Engineers Standard 1073	IEEE 1073	Message for medical device communications.	Institute of Electric and Electronic Engineers Standards Association
Terminologies	International Classification of Diseases	ICD-9 and ICD-10	Diagnosis and disease codes in billing and claims. Version 9 is often used in the US while version 10 is most used in the EU.	World Health Organisation
	Logical Observation Identifier Names and Codes	LOINC	Concept-based terminology for lab orders and results.	Regenstrief Institute for Healthcare
	Systemised Nomenclature of Medicine	SNOMED	Mapping of clinical concepts with standard descriptive terms.	College of American Pathologists
	Current Procedural Terminology	CPT	Codes for medical, surgical and diagnostic services for administrative, financial and analytical purposes.	American Medical Association
	Read Clinical Classification	Read	Read is clinical terminology system used by the NHS in the primary and secondary care in the United Kingdom since 1985. It has been used to support electronic communication of patient records, reporting and research.	UK Department of Health

Document	Continuity of Care Record	CCR	Document format that gives a snapshot of patient core data and recent encounters (allergies, meds, treatment, care plan) and makes it available to the next giver.	ASTM International E31 Committee on Health Informatics
	Clinical Document Architecture	CDA	Standards exchange model for clinical documents such as discharge summaries and progress notes. Formally known as Patient Record Architecture.	Health Level Seven (HL7)
Conceptual	Electronic Health Record	HL7 V3 RIM	A shared, generic model that facilitates interoperability. It standardises all data models to a norm rather than each model to every other model.	Health Level Seven (HL7)
	Electronic Health Record	OPENEHR	OpenEHR is a leading-edge architecture and comprehensive reference model, offering support for archetypes, coherent design philosophy and plans for a Shared EHR solution fully compliant with ISO Technical Specification ISO TS 18308.	OPENEHR
	Electronic Health Record	EHRcom	EHRcom is a five-part standard including the reference model, archetype interchange specification, reference archetypes and term lists, security features and exchange models.	CEN/TC 251 AND ENV/EN 13606
Application	Clinical Context Object Working Group	CCOW	Standards for providing comprehensive view and single sign-on capability across systems without integrating a database.	Health Level Seven (HL7)
Architecture	Public Health Information Network	PHIN	Components of an electronic surveillance and management system for integrated bioterrorism and public health preparedness.	Center for Disease Control and Prevention

Abdullah Ibrahim Alkraiji 2011

3.4 Standards' Development Organisations (SDO)

Many health and related professional groups, as well as public and private organisations, have established different types of standard, each serving a particular medical information purpose. From an institutional perspective, four types of standard may be distinguished (Hammond & Cimino 2006, pp. 265-311). Official standards are made obligatory by government regulations, for example, by law. Voluntary standards are developed by SDOs, normally on request from interested parties such as an industry, but are not made mandatory by governments. For example, the European Committee for Standardisation (CEN) has the objective to develop voluntary technical standards. Industry standards are defined by one single company or group of companies and initially they are always proprietary, therefore their specifications are not disclosed. Open standards are characterised by that everyone can participate in their development without being a member of a specific group or institution. Hammond (2005) summarised the steps required to make a standard. According to his study, standards begin with an awareness of both the need for a standard and a reengineering of the business process to enable information exchange. Next, a critical mass of technical expertise, most likely from vendors rather than users, must be gathered to produce the standard. However, an open acceptance process is usually required to achieve widespread acceptance and use. Finally, the standards are marketed for adoption and implementation. This section describes in some detail several of the best standards development organisations (SDOs) that have gained the most international attention. Furthermore, most of these organisations are in accordance with Kim's (2005, pp.5-6) categorisation, which was found by this study to be the most appropriate and accurate.

3.4.1 International Organisational for Standardisation (ISO)

Founded in 1947, ISO is the world's largest developer and publisher of international standards. ISO is a network of the national standards institutes from 161 countries (with one member per country). It has a Central Secretariat in Geneva, Switzerland, that coordinates the system. ISO is a non-governmental organisation with the mission to promote the standardisation of goods and services in order to facilitate international exchange. It also acts as a coordinator between the private and public sectors to enable a consensus to be reached on solutions meeting both the requirements of business and the broader needs of society. Furthermore, it attempts to develop co-operation in the spheres of intellectual, scientific,

31

technical and economic activity. Therefore, ISO does not really focus on healthcare standards specifically, rather, it focuses on a broad spectrum of standards for virtually every other industry (Hammond & Cimino 2006, pp. 265-311).

In late 1999, the ISO formed a technical committee known as ISO/TC 215 to support the development of compatibility and interoperability among the different systems in the healthcare environment (Kalra 2006). According to Begoyan (2007), ISO/TC 215 has already published 37 standards relating to different aspects in the field of health informatics across 22 countries. Begoyan (2007) noted that the three main standards produced by ISO/TC 215 included ISO/TR 20514, ISO/TR 18308 and ISO/TR 18307. ISO/TR 20514 defines the content of the EHR, its structure and the context in which it is used, together with its terminologies. ISO/TR 18308 defines the requirements for the EHR reference architecture (but not the EHR architecture specification) to support the sharing and exchange of EHR information across different countries, different healthcare sectors and different models of healthcare delivery. The main users of these standards are the developers of EHR architectures, such as CEN.   ISO/TR 18307 describes the requirements needed to achieve interoperability and compatibility between systems and applications in a trusted medical data exchange environment. Accordingly, the focus of ISO is most likely to be on efforts to develop standards for coordination and harmonisation, rather to establish new standards.

3.4.2 World Health Organisation (WHO)

The WHO developed the International Classification of Diseases (ICD), which is one of the best-known terminologies used throughout the world. This was published in 1960, since when it has been revised at roughly 10-yearly intervals. For example, the Ninth Edition (ICD-9) was published and used in 1979 while the Tenth Edition (ICD-10) came out in 1989. For many years, all countries used the ICD-9 version but, since the introduction of ICD-10, there seems to have been a major split, with the US retaining version 9 and European countries moving towards version 10. The codes in the classification are primarily for the names of diagnoses and close to 10,000 diseases have numerical representations. In addition, the WHO produced an international classification of drugs in the World Health Organisation Drug Dictionary in order to provide the proprietary drug names used in different countries, their chemical properties, active ingredients and supplies (Feldbaum & Dick 1997, pp.59-77).

3.4.3 European Committee for Standardisation (CEN)

CEN was established in 1999 by the Commission's Health Telematics Group. It is a voluntary technical committee (TC) acting for the rapidly evolving field of healthcare informatics and telematics. The committee is known as CEN/TC 215 and it aims to coordinate and follow up the development of standards in healthcare informatics at a European level. It has seven working groups engaged in developing multi-disciplinary standards with regard to healthcare systems and their interoperability (Begoyan 2007; Feldbaum & Dick 1997, pp.59-77). According to Begoyan (2007), CEN/TC 215 has produced the only comprehensive EHR interoperability standards in the world; these are known as CEN 13606.

3.4.4 American Society for Testing and Materials (ASTM)

ASTM was founded in 1898 and chartered in 1902 as a scientific and technical organisation for the development of standards regarding the characteristics and performance of materials. It is the largest non-government source of standards in the US. ASTM has over 30,000 members from 90 different countries and dominates the area of healthcare data standards. ASTM's Committee E31 has established sub-committees to focus on and be responsible for the development of health data standards (Feldbaum & Dick 1997, pp.59-77). Since its inception in 1970, E31, with representation from 17 countries, has been working on developing consensus standards for the architecture, content, storage and communication of healthcare information. This includes patient-specific information and medical knowledge but is also concerned with the integrity and confidentiality of data. E31 has produced a specification and standards for a Continuity of Care Record (CCR), a document format that gives a snapshot of a patient's core data and recent encounters (e.g. allergies, treatment and care plan). This record makes the information available to the next caregiver while maintaining information security (Hammond & Cimino 2006, pp. 265-311). In addition, ASTM E31 collaborates with other organisations in the use of PDFs (Portable Document Format-Healthcare) to capture, exchange, preserve and protect healthcare information (Smith 2009).

3.4.5 Institute of Electrical and Electronic Engineers (IEEE)

The IEEE is an international organisation that has played an important role in developing computer, telecommunications and medical device standards (Hammond & Cimino 2006, pp. 265-311; Feldbaum & Dick 1997, pp.59-77). IEEE launched a committee, known as the Institute of Electrical and Electronics Engineers (IEEE) Engineering in Medicine and Biology Society (EMBS), to establish data interchange standards with regard to medical devices. In 1984, the P1073 Committee of EMBS started to develop the Medical Information Bus (MIB) standard which mainly allows data from medical instrumentation (e.g. monitoring devices and hospital information systems) to be exchanged (Hammond & Cimino 2006, pp. 265-311). In November 1987, the P1157 Working Group of the IEEE EMBS started to develop the Medical Data Interchange (MEDIX) standard in order to create a healthcare delivery system and data model on which data interchange standards could be based (Alsafadi *et al.* 1994). More recently, IEEE EMBS has worked jointly with ISO to charter a committee known as the ISO/IEEE 11073 Standards for Medical Device Communication. ISO/IEEE 11073 aims to provide real-time, plug-and-play interoperability for patient-connected medical devices and to facilitate the efficient exchange of vital signs and medical device data, acquired at the point-of-care, in all healthcare environments (Yao & Warren 2005; Cooper 2002).

3.4.6 Health Level Seven (HL7)

HL7, founded in 1987, is an ANSI-accredited, voluntary, non-profit-making organisation whose purpose is to provide standards for the exchange of medical data and the delivery of medical services (Hammond & Cimino 2006, pp. 265-311; Spyrou *et al.* 2002; Feldbaum & Dick 1997, pp.59-77). According to Feldbaum and Dick (1997, pp.59-77), HL7 follows the procedures laid down by ANSI for reviewing and balloting in order to be certain that any standard represents a consensus view among users and producers of healthcare information systems. HL7 acts primarily as a messaging standard. It focuses on the interface specifications required by an organisation's HIT infrastructure when communicating medical data within or outside its healthcare systems (Spyrou *et al.* 2002). HL7 achieves interoperability through messages that are syntactically and semantically standardised; its protocol defines message and message exchange formats. The interchange of data is performed between communication applications with messages that are initiated by the source application and then sent to the recipient applications (Spyrou *et al.* 2002). According

to Begoyan (2007), HL7 messaging standards are seen today as the most successful, advanced and widely used messaging standards in the healthcare industry. The following sections describe some of the most widespread and internationally recognised standards affiliated to HL7.

3.4.6.1 HL7 Version 2 (HL7 v2.x)

HL7 v2.x Messaging Standard is currently the most widely adopted standard for medical data exchange between different systems within the HIT infrastructures of healthcare organisations. Although HL7 v2.x provides great flexibility for the exchange of medical data between different systems, it does not necessarily ensure successful and direct interoperability between HIT applications because it lacks a precisely defined, underlying information model structure. Thus, detailed bilateral agreements between the healthcare systems are necessary in order to achieve interoperability (Begoyan 2007; Eichelberg *et al.* 2005).

3.4.6.2 HL7 Version 3 (HL7 v3)

HL7 v3 is an extension, upgraded form of HL 2.x, being more focused on specific contexts, terminology, models and conceptual definitions and relationships. HL7 v3 addresses the issues of interoperability in HL7 v2.x by using a well-defined methodology. HL7 v3 is based on the concept of employing an object-oriented data model and Reference Information Model (RIM) to create a message (Begoyan 2007; Eichelberg *et al.* 2005). The RIM evolved by accommodating various commercial and academic medical data models and the data elements defined in HL7 v2.x (Hammond & Cimino 2006, pp. 265-311). However, the scope of the HL7 v3 standard is limited to the exchange of messages between different HIT applications. Thus, the Clinical Document Architecture (CDA) is proposed as an HL7 document that can be exchanged in HL7 messages or via other transport solutions (Begoyan 2007; Eichelberg *et al.* 2005).

3.4.6.3 HL7 Clinical Document Architecture (CDA)

HL7 CDA defines the structure and semantics of medical documents for the purpose of exchanging data amongst healthcare systems. CDA is a Markup Language (XML) document that derives its meaning from HL7 RIM and its data type. CDA documents are structured

through the use of three levels; each level iteratively adds more mark-ups to the document. Level one is an unconstrained specification of contexts, such as parties, roles, dates and times, places and uses, in a structured organisation of headings. In level two, it is possible to constrain both the structure and content of a document using a template; this increases interoperability since the receiver knows what to expect. The third level constrains and structures the CDA document in such a way that each item of information is specified by a unique code. Hence, obtaining a completely semantic CDA document is only possible with level three which provides for machine processing (Begoyan 2007; Iakovidis *et al.* 2007; Eichelberg *et al.* 2005; Bott & Braunschweig 2004).

3.4.6.4 HL7's Clinical Context Object Workgroup (CCOW)

CCOW publishes an application standard to allow different HIT applications to share medical data at the point of care. This standard provides a comprehensive view and a single sign-on capability across systems using a technique called "context management"; it refers to the same patient, encounter or user without integrating a database. HL7's CCOW standard builds on the original functionality so that, when a physician signs on to one application within a group of distributed systems, the same sign-on is simultaneously executed on all other applications within the group. For example, when a physician selects a patient, all the related patient information in all the applications is retrieved. This results in a combined view of the entire patient's information on one screen (Spyrou *et al.* 2002; Kim 2005).

3.4.7 National Electrical Manufacturers' Association (NEMA)

NEMA, working jointly with American College of Radiology (ACR), recognised the need to communicate digital image information regardless of a device's manufacturer. This was in order to facilitate the development and expansion of Picture Archiving and Communication Systems (PACS), as well as to allow the creation of diagnostic information databases which could then be integrated into a wide variety of devices distributed geographically. Accordingly, this led to the development of the Digital Imaging and Communications in Medicine (DICOM) standard. Basically, DICOM focuses on the workflow of images by providing a reliable protocol for the exchange of image data between imaging and non-imaging modalities, devices and systems. DICOM is typically used in high-quality viewing and image processing departments, such as radiology, surgery and radiotherapy (Begoyan

2007; Indrajit & Verma 2007; Hammond & Cimino 2006, pp. 265-311; Eichelberg *et al.* 2005).

3.4.8 Regenstrief Institute for Healthcare

The Regenstrief Institute is an internationally recognised informatics and healthcare research organisation working to enhance the quality and cost-effectiveness of healthcare. Its efforts resulted in the development of the Logical Observations, Identifiers, Names and Codes (LOINC) standard that was initiated in 1994 as a response to the demand for electronic clinical data exchange between the laboratories that produced the data and hospitals, physician's offices and those who used the data for clinical care and management purposes. Currently, the LOINC database includes over 50,000 observation terms for clinical care and management. The purpose of LOINC's database codes, as universal identifiers for laboratory and non-laboratory observations, is to facilitate and enhance the exchange and pooling of results for the purposes of clinical care, outcome management, and research (Hammond & Cimino 2006, pp. 265-311).

3.4.9 College of American Pathologists (CAP)

For more than 40 years, CAP has invested in research and in the development of health data standards and the science of computing. This resulted in the development of Systematised Nomenclature of Medicine - Clinical Terms (SNOMED-CT) in 1995, following the introduction of the Systematized Nomenclature of Pathology (SNOP) in 1964 (Hammond & Cimino 2006, pp. 265-311). SONMED-CT is a terminology standard which provides a common language, offering a consistent way of capturing, sharing and aggregating medical data across healthcare sectors (Hammond & Cimino 2006, pp. 265-311). Although SNOMED-CT is itself a comprehensive dictionary, it can be mapped into other medical terminology standards such as ICD in order to facilitate enhanced health reporting, billing and statistical analysis, whilst avoiding duplicate data capture. SNOMED-CT is a large dictionary database of medical concepts and covers all domains of medicine, such as clinical findings, observable entities, procedures, substances, pharmaceutical products, organisms and body structures. There are over 350,000 concepts in SNOMED-CT and each one is linked to one or more descriptions which are regarded as 'synonymous' with the concept. Concepts are arranged in hierarchies to help identify the relationships between them (Hammond & Cimino

2006, pp. 265-311). Elkin *et al.* (2006) justified the importance and use of SNOMED-CT. For example, SNOMED-CT makes data available to the systems for the purposes of clinical-decision support, improved patient safety and knowledge-based access to health information in support of clinical practice. In addition, SNOMED-CT provides a more detailed coding system for medical data than pre-coordinated terminologies such as ICD-9. Moreover, SNOMED CT is a useful method for encoding clinical problems; this would be an important step towards creating an interoperable EHR and clinical-decision support.

3.4.10 National Council for Prescription Drug Program (NCPDP)

NCPDP is an ANSI-accredited and non-profit-making standards development organisation. It has over 1,500 chain and independent members who represent a broad spectrum of parties interested in data exchange within the pharmacy services' sector of the healthcare industry. Through such forums and support, NCPDP creates and promotes the transfer of data related to medications, supplies and services within the healthcare system through the development of standards and industry guidance (Hammond & Cimino 2006, pp. 265-311). Claims, eligibility and remittance advice are examples of electronic NCPDP transaction standards for real-time processing that are used by the pharmacy services industry. In addition, NCPDP developed NCPDP SCRIPT standards that have been used for the electronic data interchange of prescription transactions (e.g., new prescriptions, refills, change requests, etc.) to communicate between e-prescribing devices and retail pharmacies (Amatayakul & Lazarus 2005, pp. 223-238).

3.4.11 Integrating the Healthcare Enterprise (IHE)

IHE, founded in 1998, aims to bridge the gap between established standards in order to promote interoperability between systems within specialist departments, such as radiology and conventional hospital systems (Carr & Moore 2003). IHE activities are not limited to the USA but have spread to, for example, Canada, Europe and Japan. IHE works closely with standards organisations that have gained the most international attention, such as CEN and HL7 (Kalra 2006). In spite of this, IHE is not strictly a standards development organisation; rather, it is involved with the clarification of how existing standards can be used to promote systems integration. Therefore, IHE works in ways complementary to SDOs, driving their

adoption in commercial products and providing a feedback loop for their further development and refinement (Carr & Moore 2003).

Four separate committees were organised to guide the IHE processes. The first is a review committee which defines the rules of participation for vendors and also intervenes in issues and conflicts involving the competitive interests of participating vendors. Secondly, the planning committee determines the general scope of the technical tasks to be completed each year by prioritising them based on inputs such as 'less expensive' and 'more convenient'. The third committee is the technical committee which produces the detailed documentation defined by the planning committee to specify the standards-based transactions required to achieve these goals. The last committee is the testing team which is responsible for the development and organisation of software testing tools, the supervision of face-to-face testing events, and the management of vendor demonstrations (Carr & Moore 2003). Each year IHE organises "Connectathon" events in Asia, Europe and North America. "Connectathon" events are the largest interoperability-testing events within the healthcare information technology industry in terms of vendor-to-vendor contact. The results of this open invitation are recorded, published and then are available online (Indrajit & Verma 2007).

3.5 Electronic Health Record (EHR) Standards

According to ISO/TR 20514 (2005), the basic-generic EHR definition should cover, among other things, two essential characteristics: the ability of authorised users to share medical information concerning patients, and support for continuing, efficient and quality integrated medical services. Kalra (2006) identified the basic requirements which must be supported by the EHR architecture in order for the EHR system to achieve its essential characteristics. The EHR architecture must maintain the meaning of the context of the patient record entry as intended by the author of that record. It must also provide professionals and enterprises with certain tools to analyse and interpret EHR on an individual or population basis. In addition, it must incorporate essential medico-legal constructs to support the safe and relevant communication of EHR entries among different working groups whilst maintaining the confidentiality and privacy of patients' information. Therefore, the challenge for the EHR architecture was to develop a generalised approach in order to represent every conceivable element of health record data in a consistent way. Accordingly, the dual-model approach was proposed. This approach distinguishes the RIM (e.g. HL7 RIM, EN13606 EHRcom and

39

openEHR), which is used to represent the generic properties of health record information, from a composition or constraint method (e.g. HL7 templates and archetypes in EN13606, EHRcom and openEHR), which allows for more detailed definitions of the content, values, relationships, code sets and clinical concepts of particular EHR components (Kalra 2006). Today, three examples of EHR architecture are considered to be the most important ones in which the dual Reference and Archetype Model approach is adopted (Blobel & Pharow 2008; Kalra 2006; Eichelberg *et al.* 2005). These are explained in the following sections.

3.5.1 GEHR/openEHR

In 1992-1994, the European Union launched a project to facilitate the creation and sharing of health records by consumers and clinicians. The project name was later changed to the Good Electronic Health Record (GEHR) with strong participation from Australia. The GEHR initiative aimed to establish an open-source implementation to take forward harmonisation in the field, from both a patient and a clinical perspective. Accordingly, the GEHR was maintained under the name openEHR. The openEHR Foundation is an independent, non-profit-making organisation which was founded in 2000 by University College, London, and Ocean Informatics (Eichelberg *et al.* 2005; Kalra 2006; Bott & Braunschweig 2004). Kalra (2006) highlighted five aims for the openEHR Foundation. The first is to promote and publish the formal specifications, based on implementation experience and evolving over time as medical knowledge develops, required to represent and communicate EHR information. The second aim is to promote and publish those EHR information architectures, models and data dictionaries which meet the required specifications and which have been tested in implementations. The third aim is to validate the EHR architectures through comprehensive implementations and evaluations while the fourth aim is to maintain open-source implementations in order to enhance the pool of tools available for supporting the applications of clinical systems. The final aim is to coordinate and collaborate with other related working groups to stimulate the development of high-quality health data standards. Beale (2002) stated that the archetype concept is the most noteworthy concept introduced by GEHR/openEHR. According to Beale's (2002) study, this approach uses a two-level methodology to model the EHR architecture. Eichelberg *et al.* (2005) described and explained the two-level methodology of EHR architecture thus: the first level, which must be stable over time, specifies a generic reference information model of the healthcare domain and contains only a few classes (e.g. role, act, entity, participation); the second level models

40

health concepts such as blood pressure and lab results as archetypes. This process is carried out using constraint rules that specialise the generic data structures that can be implemented using the reference model.

3.5.2 CEN/TC 251 AND ENV/EN 13606 EHRcom

In 2001, the CEN/TC 251 launched an initiative known as EHRcom to review and revise its 1999, four-part, pre-standard ENV/EN 13606 relating to EHR Communications in order to produce a definitive European standard. The EHRcom project aims to produce a rigorous and durable EHR information architecture to support the interoperability of the different clinical systems and components that need to interact with EHR services (Iakovidis *et al.* 2007; Kalra 2006; Eichelberg *et al.* 2005; Bott & Braunschweig 2004). The EHRcom architecture is based on EHR exchange messages and adopts the archetype method of openEHR (Eichelberg *et al.* 2005). EHRcom is a five-part standard and includes the reference model, the archetype interchange specification, reference archetypes and term lists, security features, and exchange models (Iakovidis *et al.* 2007; Kalra 2006; Eichelberg *et al.* 2005; Bott & Braunschweig 2004). According to Eichelberg *et al.* (2005), CEN/TC 251 is looking to introduce EHRcom into ISO/TC 215 as the basis for an international EHR standard. However, only the first part, which is the reference model, is stable, while parts two to five inclusive are still working drafts. The EHRcom reference model has five components which describe the aspects required for communicating the EHR extracts among different information systems. These components are: packages, extract, demographics, access control and message. The EHR uses HL7 version 3 messages for communicating EHR extracts (Iakovidis *et al.* 2007; Kalra 2006; Eichelberg *et al.* 2005; Bott & Braunschweig 2004).

3.5.3 HL7 v3 RIM and Clinical Document Architecture (CDA)

The HL7 v3 RIM-based standards provide a means of modelling medical information across the health sector, then deriving consistent messages from the resulting models. According to NEHTA (2006) and NEHTA (2007), the HL7 v3 RIM-based standard is, among others, considered one of the most appropriate EHR architecture solutions since it provides many major benefits. For example, the core elements of HL7 v3 are standards formally accredited by ANSI; some have been submitted to ISO as potential international standards. In addition, the HL7 v3 RIM-based standard has won growing international support. For example,

41

Canada, Australia, the UK and the Netherlands have chosen this model to be the cornerstone of their e-health strategies. However, NEHTA (2006) and NEHTA (2007) highlighted some drawbacks with regard to HL7 v3 RIM-based standards, such as the significant cost and the unknown implications of large-scale implementation.

3.6 Summary

One of the major characteristics of a sustainable healthcare system is to promote patient-centred care. In doing so, the HIT infrastructure should be designed and delivered around the needs of patients rather than those of the NHS institutions. However, this requires a level of interoperability between HIT applications based on consensus health data standards. In this regard, this chapter has demonstrated some potential benefits that could be introduced into healthcare organisations by the adoption of HIT related standards. In addition, it has discussed the different types of health data standard and presented some categorisations from the literature, as shown in Tables 3.1 and 3.2. Moreover, the chapter has explained in detail the key originations involved in the development of health data standards and has concluded with a discussion related to the three EHR architectures that are available today although they are still in development (Kalra 2006; Eichelberg *et al.* 2005).

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Chapter Four: Literature Review

4.1 Introduction

The intention of this chapter is to review the literature by assessing innovation adoption theories in depth. In doing so, the chapter commences by discussing the studies on IT related standards carried out thus far and reveals, from this examination, the need for conducting other empirical studies concerning the adoption of HIT related standards due to the limited number of scholarly papers. Then, this chapter discusses the traditional adoption models and points out their limitations in explaining the adoption process in a complex scenario such as at an organisational level. Next, this chapter discusses the growing body of literature concerning innovation adoption in an organisation as a sequence of stages that is always influenced by the characteristics of the innovation itself, the organisation acquiring the innovation, and the external environment in which the organisation operates. Thereafter, to investigate the adoption of IT related standards, this chapter discusses in detail the main theories concerning IT related standards' adoption that have been examined by previous studies. This chapter concludes with a summary highlighting the main points discussed thus far.

4.2 Studies on IT Related Standards

According to West (2004), research into IT related standards lies in four main areas. The first area is the technical content paradigm which concerns the details of specific new standards. The second area is the creation of the standards which involves the development of standards in organisations and the process of such standardisation. The third area is the selection of standards which relates to the adoption of the standards and the competition between them. The final area is the impact of the standards, assessed by measuring their economic value which, and according to West (2004), has rarely or never been measured. West (2004) continues his argument by stating that while the technical content of IT related standards is covered well from both an engineering and computer science perspective, little is still known with regard to the remaining three areas.

This assertion was also confirmed by other studies, such as those of King and Lyytinen (2003), Markus *et al.* (2003) and Byrne and Golder (2002), who explicitly stated that the

43

literature surrounding the subject of the adoption of IT related standards is limited to a small number of empirical studies. In addition, Thomas *et al.* (2008) claimed that the literature is lacking studies concerning the adoption process of data exchange standards. Moreover, the Journal of Biomedical Informatics (Call for Papers 2011) pointed out the need for detailed, experience-based discussions pertaining to the adoption of various and different types of health data standards, and this could be said to validate the importance of this research. The researcher has found only a few studies with regard to the adoption process of health data standards. These studies were not built based on a specific theory or model. Instead, they were designed to map the landscape of standardisation for health data in such countries as China (Zhang *et al.* 2007) and America (Hammond 2005) or to focus on specific standard (Lin *et al.* 2010). This offered a limited, holistic adoption view of health data standards. Empirical studies into the adoption of HIT related standards are needed to contribute to the body of knowledge in the field of IS since academics and practitioners, who are dedicated to the on-going use of health data standards, still lack a significant body of evidence with regard to the adoption of HIT related standards.

4.3 Traditional Adoption Models and their Limitations

The previous studies of IT innovation adoption were based on a core set of adoption theories which attempted to explain the attitudes and innovation-related behaviour of individuals (Gallivan 2001). The core set of innovation adoption theories, as shown in Table 4.1, were also identified by other previous studies, such as those of Kamal (2006) and Jeyaraj *et al.* (2006). The traditional innovation adoption theories are well-grounded in theory and have proven their value in the IS literature, such as in explaining personal behavioural intentions to adopt an innovation technology (Gallivan 2001). However, a review of eighteen studies applying the traditional innovation theories to IT innovation adoption, carried out by Fichman (1992), found that the outcomes of these studies were sensitive to the fit between the assumptions underlying these models and the specific features of the adoption context and the technology in question. This study noted that these theories were successful when applied to a narrow range of adoption scenarios. For example, if the adoption was at an individual level and the technology did not require extensive specialised knowledge before the adoption. This assertion was also confirmed by Karahanna *et al.* (1999) who claimed that the adoption of technology innovation, in view of the diverse aspects of any organisation, was a major concern.

44

In addition, Gallivan (2001) pointed out that the application of traditional theories to complex adoption situations produced serious deviations in the findings compared to the expected results. This was because of the complexity of, for example, the adoption decision-making that is made at an organisational level, and the adoption of the technology itself which involves a variety of activities and requires high levels of knowledge with regard to the innovation and coordination across multiple adopters. Moreover, Fichman and Kemerer (1997) stated that most traditional models neglected the realities of the adoption of innovation scenarios within organisations where individual adoption decisions are made at divisional or workgroup levels, rather than at the level of the individual. Furthermore, Zmud (1982) concluded that much prior research failed to explain the correlation between the significance of the attributes of innovation and the characteristics of the organisational context. This led Fichman (1992) to argue that researchers should either abandon such traditional theories or integrate them with new approaches in order to develop theories that would fit these complex scenarios. Gallivan (2001) and Kamal (2006) were found also to support this assertion when they argued that studying the adoption process of technology innovation might require, either modifications to the traditional models, or the creation of entirely new ones to explain non-voluntary innovation adoption processes at an organisational level.

Table 4.1: Traditional theories of innovation adoption.

References	Theory Description	Theory Characteristics	Theory Process
Unified Theory of Acceptance and Use of Technology UTAUT (Venkatesh *et al.* 2003)	UTAUT was a result of a review and consolidation of eight theories that earlier studies had employed to explain technology usage behaviour. Its main aim was to explain users' intentions to use a technology and their subsequent behaviour.	UTAUT posits two main factors including dependent constructs (which are behavioural intention and usage behaviour) and independent constructs (which are performance expectancy, effort expectancy, social influence, facilitating conditions, gender, age, experience and voluntariness of use).	The theory proposes that four key constructs, including performance expectancy, effort expectancy, social influence and facilitating conditions, are direct determinants of usage intention and behaviour. The other factors are posited to moderate the impact of the four key constructs.
Technology Acceptance Model TAM2 (Venkatesh & Davis 2000)	TAM2 is an extension of TAM which looked to explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes where the innovation was applied in both voluntary and mandatory settings.	Seven factors (experience, subjective norm, image, job relevance, output quality, result demonstrability and perceived ease of use) directly influence perceived usefulness which, in turn, influences the intention to use. This is also determined by subjective norm which, in turn, is determined by the image construct.	The actual use of the system is directly influenced by behavioural intention to use; this, in turn, is directly influenced by perceived useful and perceived ease of use.
IT Innovation Adoption Research Model (Agarwal & Prasad 1998)	This theory added a new construct to TAM. The new construct is the personal innovativeness in the domain of information technology (PIIT) which can help to identify, in the organisation, individuals who are likely to adopt technology innovations earlier than others.	In an effort to identify upstream antecedents of the technology acceptance beliefs, the PIIT was added to the two other factors of perceived usefulness and perceived ease of use.	The actual IT use is directly influenced by the relationships between PIIT and other technology acceptance constructs.
Diffusion of Innovations (Rogers 1995)	Diffusion is the process for assimilating an innovation by the members of a social system over time and through certain communication channels.	The individual's decision adoption is influenced by five characteristics of innovation, including: relative advantage, compatibility, complexity, trialability and observability.	Diffusion of an innovation occurs through a five-stage process including: Knowledge, Persuasion, Decision, Implementation and Confirmation.

46

Perceived Characteristics of Innovating (PCI) (Moor & Benbasat 1991)	PCI extended and refined the DOI to include eight perceived characteristics of using an innovation, together with the perception of voluntariness.	The individual's adoption decision is influenced by eight characteristics: relative advantage, compatibility, ease of use, result demonstrability, image, visibility, trialability, and voluntariness.	The actual use of the system is directly influenced by behavioural intention to use; this, in turn, is directly influenced by the eight factors.
The Technology Acceptance Model TAM (Davis 1989)	TAM is an IT theory that explains how people come to accept and use a technology. TAM is an adaptation of the Theory of TRA.	TAM posits two factors that determine an individual's intention to use an innovation technology; these are Perceived Useful and Perceived Ease of Use.	A personal behavioural intention to use a technology is directly influenced by perceived usefulness and perceived ease of use.
Social Cognitive Theory (Bandura 1986)	The social cognitive theory explains how a person acquires and maintains certain behavioural patterns whilst providing the basis for intervention strategies.	Three elements determine how certain behavioural patterns are acquired by a person; these are behavioural, environmental and personal.	Social cognitive theory is the interaction processes between three elements: behavioural, environmental and personal.
Theory of Planned Behaviour (Ajzen 1985)	Theory of Planned Behaviour (TPB) was developed based on the TRA; however, TRA was related to voluntary behaviour which appears not to be 100% voluntary in certain circumstances. This resulted in the addition of another construct which is perceived behavioural control.	Perceived behavioural control is the individual's perception with regard to how easy or difficult a particular behaviour is to be performed.	The intention of an individual to perform the behaviour is determined by attitudes, subjective norms and perceived behavioural control.
Theory of Reasoned Action (Ajzen & Fishbein 1980)	The Theory of Reasoned Action (TRA) is a social psychology theory which attempts to explain an individual's behaviour in acquiring such an innovation.	TRA defines the links between the beliefs, attitudes, norms, intentions and behaviours of individuals.	An individual's behaviour is determined by his/her behavioural intention, which is itself determined by his/her attitudes and subjective norms towards the behaviour.

4.4 Adoption Process at an Organisational Level

The limitations of the traditional theories in explaining the innovation adoption process at an organisational level has resulted in a growing stream of literature which focuses on the adoption process as sequence of stages that should consider different contexts, including the innovation itself, and organisational and environmental factors (Gallivan 2001). Markus and Robey (1988) defined the stage models as sub-types of process research models. According to Shaw and Jarvenpaa (1997) and Soh and Markus (1995), the stage models were found to be valuable when attempting to describe how the adoption processes unfold, with a focus on the time-ordering of events and the conditions required for certain outcomes to occur. However, the intention of this chapter is not to examine all possible models, but rather to give a snapshot of some of them in order to stress the importance of looking at the adoption process at an organisational level as a sequence of stages, each of which must be carefully studied while different additional contexts are considered. In this regards, Table 4.2 lists some stages models presented in the literature and Table 4.3 describes with some details those models.

For example, Lewin (1952) stressed that any process of social change follows a sequence of three stages. The unfreezing stage sets up the system for change. The moving stage, the group or unit learns new required behaviour patterns to carry out the change. In the refreezing stage, the group or unit will make these patterns of behaviour a permanent part of the system. Pierce and Delbecq (1977) identified the organisational innovation process as a sequence of three stages; the initiation stage involves the pressure to change and the gathering of sufficient information regarding the targeted innovation; the adoption stage involves the decision to allocate the required resources to the innovation; the implementation stage refers to the development of such activities to ensure that the expected benefits of innovation are realised. Becker and Whisler (1967) defined four stages that are required in the organisation for the adoption process of an innovation. These are, the stimulus stage which is mediated by an individual action where the organisation takes the lead regarding the usage of the new idea; the conception stage refers to a plan of action carried out by some members and that the organisation should pursue; in the proposal stage, a formal proposal is made for the approval of others in the organisation; and, in the fourth and final stage, a decision is made whether to adopt or reject the innovation. Darmawan (2001) drew up a four-phase conceptual model of

48

the innovation adoption process. These phases are initiation, adoption, implementation and evaluation. According to Darmawan (2001), two levels of adoption are considered at an organisational level, the organisational level and the individual level. The organisational level begins when an organisation realises the need to incorporate technology innovation for the reason of strategic change while the individual level of adoption begins when the technology is implemented in the organisation; it finishes when the technology is fully utilised.

However, Kamal (2006) contended that the previous studies discuss a broad spectrum and diverse perspectives of the processes of innovation adoption. This was also asserted by West (1999) who argued that prior research has rarely examined the adoption decision stage directly, thus treating it as a "black box" yielding aggregate-level outcomes. West (1999) continued his discussion by commenting that examining the current standards in an organisation, which naturally include more general issues of power and authority, is necessary to understand the antecedents to any product-purchase decisions. Hu *et al.* (2000) broadly defined the adoption decision stage as that in which an organisation makes the decision to acquire a specific technology and makes it available to the target users for the performance of their appointed tasks. Frambach and Schillewaert (2002), Darmawan (2001), Agarwal and Prasad (1998), Pierce and Delbecq (1977), and Becker and Whisler (1967) described the adoption decision stage as the actual stage where organisations take the decision to adopt or reject a specific technology.

In addition to the stages of the adoption innovation process at an organisational level, another stream of research focuses on different contexts of factors alongside the innovation attributes. For example, Fichman (1992) argued that classical innovation attributes, in the traditional innovation theories, alone are not likely to be strong predictors in examining the adoption of technology in an organisation. Similarly, Hu *et al.* (2002) suggested that the technological attributes, although important, may not explain sufficiently the adoption decision-making regarding a technology in an organisation; therefore several other contexts must be considered. In addition, Gallivan (2001) suggested that researchers should not choose a model which ignores the temporal aspects of implementation, or which neglects such important aspects (e.g. technology, people and the organisation). Gallivan (2001) continued his argument by stating that the theoretical adoption model should capture longitudinal data on all three aspects of the technology and the organisation alongside the people, as there is

always an assumption that amendments in people's innovative behaviour are due to the interactions of the first two aspects.

Darmawan (2001) identified and captured a variety of factors that might influence the adoption of technology in organisations; these included technological, institutional, personal, social and economic factors. Bretschneider (1990) compared the implementation of management information systems in public and private organisations and pointed out the importance of organisational attributes. Cooper and Zmud (1990) investigated technology adoption in organisations and emphasised that organisational and task considerations were both essential. Kimberly and Evanisko (1981) examined the adoption of technological and administrative innovations in hospital settings. They then singled out the importance of individual, organisational and contextual variables. Tornatzky and Fleischer (1990, pp. 152-154) studied innovation adoption processes in various organisations and proposed that an organisation's technology adoption decision can be jointly explained by a fairly comprehensive framework of three dimensions, the organisational, technological and environmental contexts. The technological context is essentially described by depicting the important attributes of the technology. The organisational context is depicted by descriptive measures concerning the organisation (e.g. scope, size and managerial structure). The environmental context refers to the different attributes of the external world in which an organisation operates. The Technology-Organisation-Environment (TOE) framework of Tornatzky and Fleischer (1990, pp. 152-154) is largely consistent with many previous studies such as those of Chang *et al.* (2006), Hu *et al.* (2002), Hu *et al.* (2000), Fichman (1992), Brancheau and Wetherbe (1990), Bretschneider (1990), Copper and Zmud (1990), Zmud (1982), and Kimberly and Evanisko (1981).

Table 4.2: Stages models described in the literature.

No	Reference	Stages
1	IT Innovation Adoption Process (Kamal 2006)	Two stages were used in this study including pre-adoption and post-adoption stages.
2	Four-Phase Innovation Adoption Process (Darmawan 2001)	Four stages were adopted in this study such as initiation, adoption, implementation and evaluation.
3	Framework of Organisational Assimilation of Complex Technological Innovation (Gallivan 2001)	Two stages were used in this study including primary and secondary adoption stages.
4	IT Adoption Model (Dixon 1999)	Three steps were described in this study such as innovation requirements assessments, analysing fit of technology and the decision making either to adopt or reject the innovation.
5	A Technological Diffusion Approach (Cooper & Zmud 1990)	Two steps for the innovation adoption were described in this study including adoption and infusion.
6	Organisational Innovation Model (Pierce & Delbecq 1977)	This study described three steps for the innovation adoption such as initiation, adoption and implementation.
7	Two-Stage Innovation Adoption Model (Zaltman et al. 1973, pp. 51-103)	Two stages were used in this study including initiation and implementation stages.
8	Stages of Innovation Adoption (Becker & Whisler 1967)	Four stages were adopted in this study such as stimulus, conception, proposal and adoption.
9	Change Model (Lewin 1952)	Three steps were described by this study such unfreezing, moving and refreezing.

Table 4.3: IT adoption models at the organisational level.

Reference	Description	Stages			
IT Innovation Adoption Process (Kamal 2006)	This study proposed that the decision-making in organisation leading to the adoption of an innovation may be conceptualised as a temporal sequence of stages which must be managed carefully by the organisation and its intended users.	(1) Pre-adoption stages (Motivation, Conception, Proposal and Adoption Decision)		(2) post-adoption (Implementation, Confirmation, User Acceptance and Actual Use)	
Four-Phase Innovation Adoption Process (Darmawan 2001)	This model was built through a review of different factors ranging from technological and institutional to personal, social and economic aspects. This model starts when an organisation begins to realise the need for strategic change and ends when the technology is utilised.	(1) Initiation	(2) Adoption	(3) Implementation	(4) Evaluation
Framework of Organisational Assimilation of Complex Technological Innovation (Gallivan 2001)	This study proposed a hybrid framework combining both the literature and the process research on the adoption of an innovation implementation in organisations. It suggested that there are some limitations with the traditional models regarding the context of the organisational level and there is a need to describe various scenarios where new constructs are needed to complement those traditional theories.	(1) Primary Authority Adoption Decision		(2) Secondary Adoption and Organisational Assimilation Processes	
IT Adoption Model (Dixon 1999)	This study defined the process of innovation at an organisational level as a triangle of three ribs intertwined at all stages of the innovation process. These are the end-user, the innovation and the organisation itself. So, good design should incorporate these into the implementation strategies.	(1) Analysing requirements and assessing capabilities	(2) Analysing fit of technology	(3) Adoption or Rejection	
A Technological Diffusion Approach (Cooper & Zmud 1990)	This study defined technology implementation as an organisational effort undertaken by the management for solving the critical issues raised throughout the implementation process. It hypothesised that task-technology compatibility and complexity are the main critical factors.	(1) Adoption reflects very rational behaviours		(2) Infusion reflects social learning and political behaviours	

52

		(1)	(2)	(3)
Organisational Innovation Model (Pierce & Delbecq 1977)	This study reviewed innovation in terms of organisational context and structure, and member attitudes. According to this study, organisations which are more organic in structure will apparently have the momentum to initiate innovation. In addition, adoption requires some formalisation and centralisation to decrease conflict during the process of the adoption.	Initiation begins when the pressure to change occurs, and so, information regarding the innovation is gathered	Adoption begins when the decision-making is undertaken and the required resources are allocated	Implementation refers to the development of such activities to ensure the realisation of the expected benefits
Two-Stage Innovation Adoption Model (Zaltman *et al.* 1973, pp. 51-103)	This study explained the relationship between the innovation attributes and the decision stages at the level of the organisational decision makers. It discussed the characteristics of an organisation; for example, a more centralised authority structure might smooth the progress of the adoption process by reducing conflict and ambiguity. It also discussed resistance to innovation and how this relates to stages in the process.	(1) Initiation		(2) Implementation
Stages of Innovation Adoption (Becker & Whisler 1967)	An organisational innovation process is one that follows invention but can be separated from it in terms of time and location. The innovation appears to be not a single variable but an attenuated and complex process in which a number of critical variables are likely to operate.	(1) Stimulus, (2) Conception, (3) Proposal, (4) Adoption		
Change Model (Lewin 1952)	This study suggested that for any type of social change management, it is important that levels of quasi-stationary equilibrium can be amended in either of two ways: by adding forces in the desired direction or by diminishing opposing forces.	(1) Unfreezing, (2) Moving, (3) Refreezing		

53

4.5 Theories for the Adoption of IT Related Standards

Thomas (2006) stated that the study of the adoption of IT related standards has been carried out from a variety of perspectives. However, Thomas (2006) emphasised that the application area to which a business enterprise relates is the area that is relevant to the research of the adoption process of the IT related standards. In this regard, two main streams of theory have been employed by previous researches, the adoption theory and the perspectives of the economics of standards. Hovav *et al.* (2004), in their study "A Model of Internet Standards Adoption: The Case of IPv6", stated that, while the adoption of an innovation theory perspective focuses on the general characteristics of the innovation and the adopters, the economic perspective examines switching costs and community effects, thus making both perspectives more constructive in providing a rich set of influencing factors. Thomas *et al.* (2008) and West (2004) asserted that the adoption of innovation theory, and the theory that is often termed the economics of standards, are the most predominant theories used by previous researchers to study the phenomenon of the adoption of IT related standards at an organisational level. In relation to adoption theory, Thomas (2006) argued that only two of these theories are relevant to the adoption process of IT related standards from a business perspective, namely Rogers's Diffusion of Innovations (DOI) and the Technology-Driven Model. However, the Technology-Driven Model focuses on users' attitudes towards technology and changes, and does not deal specifically with decision makers' attitudes and perceptions towards IT related standards, DOI is the most appropriate theory when looking at the adoption of IT related standards at the decision-making stage from a business perspective (Thomas 2006). This was also consistent with the findings of other previous studies, such as those of Thomas *et al.* (2008), Hovav *et al.* (2004) and West (2004).

4.5.1 Diffusion of Innovation (DOI) Theory

Most adoption studies build on Rogers' (1995) sociology model for the adoption of technology innovations. The primary concern of subsequent researchers in DOI is how individual adopters learn about innovations and then make their decisions either to adopt or reject the innovation. Rogers (1995, p. 5) defined the term diffusion as: "the process by which an innovation is communicated through certain channels over time among the members of a social system." DOI theory consists of four interrelated aspects. The innovation's

54

characteristics, the diffusion or communication channels through a social system, time, and the consequences. With regard to the innovation's characteristics, DOI theory identifies five generic innovation characteristics that are considered to influence the adoption process:

1. **Relative Advantage:** the degree to which potential adopters perceive the innovation as superior to existing substitutes.
2. **Compatibility:** the degree to which potential adopters feel the innovation is consistent with their present needs, values and practices.
3. **Complexity:** the degree to which the innovation is easy to understand or use.
4. **Trialability:** the degree to which the innovation is experimented with on a limited basis.
5. **Observability:** The degree, to which the innovation's benefits or attributes can be observed, imagined or described to the potential adopters.

According to Mustonen-Ollila (1999), any study into the diffusion of innovation has either adopted or built upon these five general attributes. In most cases, any additional attributes can be easily mapped to one of these attributes. In relation to communication channels, these are the means by which messages get through from one individual or other unit of adoption to another. The communication channels, which can be either internal or external to the adopting community and can be transmitted either through formal or informal messages, are important to the adopters or other units of adoption in learning about the existence and substance of an innovation. The social system is a set of interrelated units (e.g. an individual, group, organisation and decision-maker) and the roles of opinion leaders and change agents (such as champions) that are involved in solving problems in order to attain common objectives. The innovation adoption time is the length of time required for the innovation to pass through the innovation-decision process.

4.5.2 The Economics Perspective

The concept of the economic perspectives of standards focuses mainly on an innovation's inherent economic value for the potential unit of adopters (Thomas 2006; Wapakabulo *et al.* 2005; Hovav *et al.* 2004). Two essential theories have been used within the economic perspective of standards. The first theory is the network effect. This theory is based on the theory of network externalities (sometimes known as network effects) which describes a positive correlation between the number of users of an innovation (e.g. a fax machine) and the utility of the innovation (Katz and Shapiro 1986). The network externalities are

predicated on the belief that the benefits of adopting an artefact are correlated to growth in the size of the community of adopters (Hovav *et al.* 2004). This was also confirmed by others, such Katz and Shapiro (1986) and Farrell and Saloner (1985), who argued that the likelihood of an artefact being adopted is a function of the number of current adopters in the social network. In addition, Hovav *et al.* (2004) identified various methods that could improve the attractiveness of an innovation for adoption by a community of potential adopters. These, for example, include a decrease in cost, an increase in usage experience, and an increase of compatible products. The second theory of the economics perspective of standards concerns switching costs. This theory refers to a standard-specific investment that makes organisations hesitant to change to the required standard although the standard is seen to be superior on the basis of objective criteria (Hovav *et al.* 2004). Hovav *et al.* (2004) listed several reasons behind this issue, such as transient incompatibility cost, risk, and sunk cost. For example, an adopter may be unwilling to bear the transient incompatibility, the risk of being locked into an artefact before it reaches a critical mass, or the sunk costs resulting from the presence of a large installed base of existing technology. Nonetheless, the literature has discussed several ways which might increase the adoption rate of an innovation by the potential community adopters from an economic perspective. These include: the communication channels (Nilakanta & Scamell 1990); general industry knowledge of the new technology (Arthur 1988, pp. 590-607); the environment and the availability and allocation of relevant resources (Kwon & Zmud, 1987, pp. 227-251); and the existence of sponsorship or financial incentives (Katz & Shapiro 1986). According to Hovav *et al.* (2004), the presence of sponsorship may help in decreasing the risk of adoption by, for example, promoting the technology, setting and mandating standards, and subsidising early adopters.

4.6 Summary

This chapter began with a background of studies on IT related standards and explained that one of the research areas within the field concerns the adoption of the standards in organisations. The previous studies revealed a lack of empirical research with regard to the adoption of IT related standards in organisations and highlighted that more empirical studies are needed since researchers and practitioners who are devoted to the on-going use of standards still lack a significant body of evidence in terms of the applications, roles, and both enabling and hindering factors, regarding the adoption of such standards in organisations. In addition, the researcher found only one study, which was research carried out by Lin et al.

(2010), concerning the adoption of health data standards. This study focused solely on the adoption of HL7 in Taiwanese hospitals. It was based only on Rogers' paradigm to explain (by using a quantitative survey methodology), broad, general factors that would predict the adoption process of HL7 in Taiwanese hospitals and thus offered a limited, holistic view of the adoption of health data standards. Therefore, in addressing this gap in knowledge, the researcher first considered existing adoption theories in order to build a theoretical background to the research. The literature explained that applying only traditional adoption theories to a complex adoption scenario, where the decision-making is made at an organisational level and the innovation itself also requires high levels of knowledge and coordination across multiple adopters, produced only serious deviations in the findings compared to the expected results. This resulted in a growing stream of literature focusing on the adoption of an innovation at an organisational level as sequence of stages which should be considered in parallel with different contexts, including the innovation itself, the organisation acquiring the innovation, and the environment in which the organisation operates. The adoption stages are most often classified into two main clusters including the pre-adoption and post-adoption stages. The pre-adoption stage starts when the organisation begins to be interested in the innovation and finishes when the decision regarding the acquisition of an innovation is made while the post-adoption stage starts when the innovation is implemented in the organisations and finishes when its target users accept its use for the benefit of the organisation. Although several theories can be applied to study the adoption of IT related standards, the previous studies explained that the predominant theories are Rogers' paradigm, which focuses on the general characteristics of the innovation and the adopters, and the economic perspective of standards which examines switching costs and community effects. An in-depth review of the literature explained that an innovation adoption model at an organisational level should not ignore or neglect, when being developed, three essential constructs: the adoption stages, the TOE framework and the IT related standards' theories.

Abdullah Ibrahim Alkraiji 2011

Chapter Five: Research Methodology

5.1 Introduction

This chapter explains how the framework of the qualitative research options was constructed, shown in Figure 5.1. The chapter also describes how this framework was used to define the philosophical outline for addressing the aim and the objectives of this research. The reason behind the decision to construct and then use the framework was to ensure that all relevant research options were considered as a series of top-down stages, including the research's philosophy, approach and methodology, together with the data collection and data analysis methods. Once the framework was constructed, the research questions were compared and linked to the relevant research options in each successive stage. The philosophical outline starts with the philosophy of the research's methodological stance and the research paradigm options. Next, options for the research approaches are worked through. Then the methodology options are examined and the data collection and the data analysis options are examined and selected. Since no options are considered to be mutually exclusive, the combinations of research options are considered to be valid as long as they can be justified. Therefore multiple options might be chosen from each stage of the framework.

Furthermore, this chapter explains how the empirical research design strategy, as shown in Figure 5.2, is built as a set of procedures that are open-ended and rigorous and, at the same time, are important to the qualitative research design. The reason for developing and then using this design strategy was to consider adequately the complexity of the social setting under investigation. This strategy consists of three parts including the research design, the case study data collection, and the data analysis.
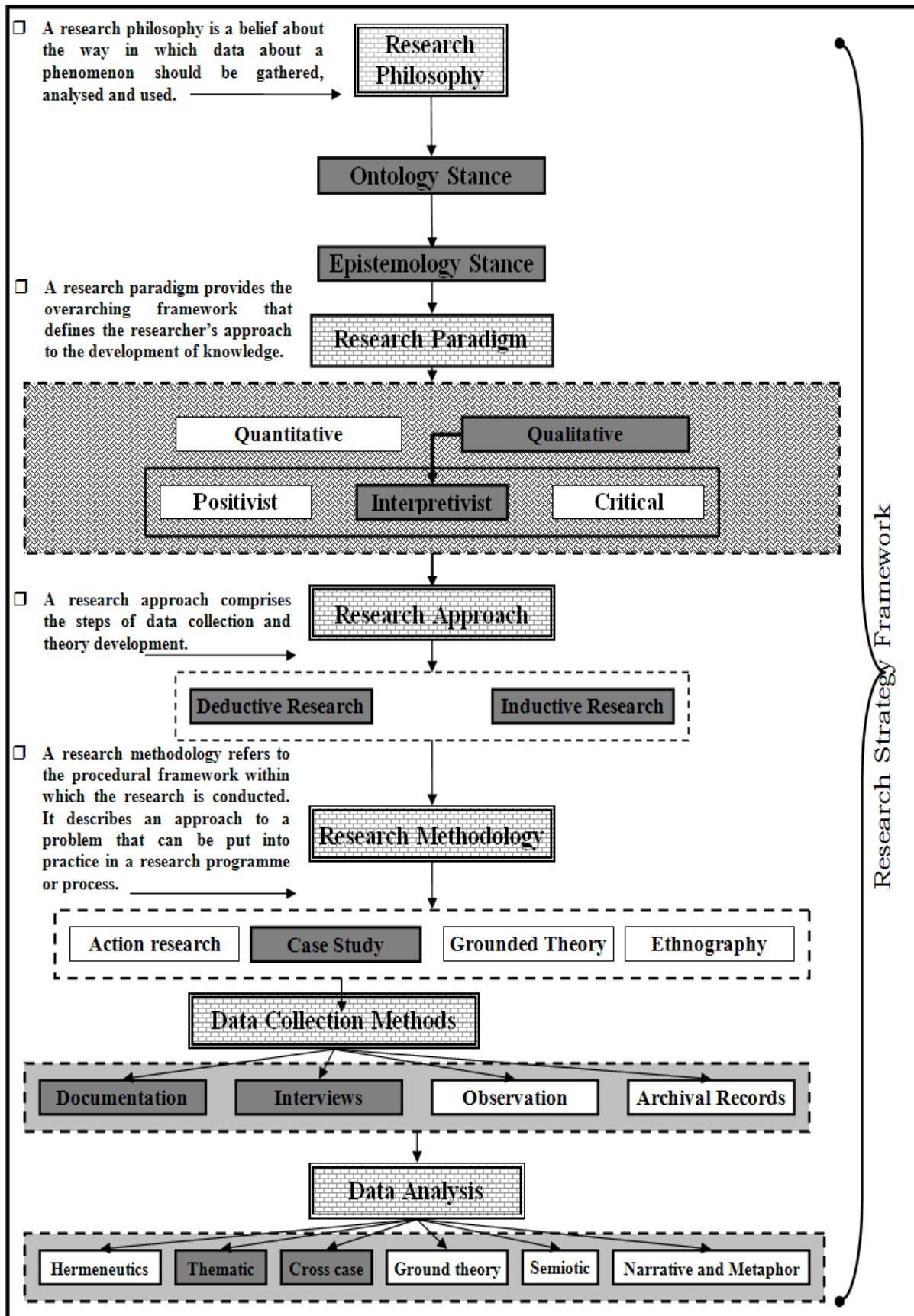
Figure 5.1: Theoretical research strategy framework and the selected options.

5.2 Research Philosophy

Among others, Jackson (2001) reported that a research philosophy is perceived as a belief regarding the approaches in which data about a phenomenon under investigation should be gathered and studied. Myers (1997) stressed that all the research, whether quantitative or qualitative, must be rooted in some underlying assumptions with regards to what constitutes valid research and which research methods are appropriate. Galliers (1992, pp. 144-162) claimed that there is no particular framework that encompasses all the domains of knowledge needed for the study of IS. In addition, Orlikowski and Baroudi (1991), among others, argued that an IS subject is not based on a single domain perspective. Instead, there are various different philosophical assumptions regarding the underlying nature of a phenomenon under investigation. For the purposes of this research, the most pertinent philosophical assumptions are those which relate to the underlying twin concepts of ontology and epistemology as the purpose of science is to transform things believed into things known (Galliers 1992, pp. 144-162). Ontology refers to the constitution of underlying assumptions that are made about the reality of the phenomenon under investigation (Cornford & Smithson 2006, p. 61).

According to Remenyi *et al.* (2005, p. 31), a large amount of academic research carried out today is based on empirical data because of the philosophical assumption that evidence (as opposed to thought or discourse) is required for making a satisfactory claim to have contributed to the body of knowledge. However, every empirical study presupposes an understanding of the material under investigation and hence, some kind of theoretical position is required in order to conduct such research (Remenyi *et al.*, 2005, p. 31).On the other hand, the term epistemology refers to the constitution of valid knowledge which is acquired through the investigation of a phenomenon (Cornford & Smithson 2006, p. 61). In other words, epistemology focuses on examining knowledge in real settings and is concerned with developing new models or theories which are extensions of the existing ones, owing to that knowledge, and the approaches of discovering it, is not static, but forever changing (Grix 2002). In this regard, Irani (1998) stated that the question behind the research philosophy is to investigate the nature of knowledge as being hard, real and capable of being transmitted in a tangible form, rather than experiencing the nature of knowledge as being of a unique and essentially personal nature. Accordingly, epistemology ranges from a position that sees general explanations based on regularity and causal relationships (positivism) to one that only

gives validity to the viewpoint of the participant within a given activity (anti-positivism) (Burrel & Morgan 1979).

5.3 Research Paradigm

Nogeste (2007) declared that the research paradigm provides a holistic framework that can be used to define the researcher's approach to the development of knowledge. However, Nogeste (2007) reported that the literature lacks common agreement with regard to the types or numbers of the key research paradigms reported therein. This assertion was also confirmed by Myers (1997) who claimed that there is significant disagreement in the literature as to whether those research paradigms or underlying epistemologies are essentially opposed or can be accommodated within the one study. In this regard, Remenyi *et al.* (2005, pp. 22-38) advocated that any empirical study can be, in nature, either positivist or phenomenological. This is sometimes described as an anti-positivist, descriptive or interpretative approach. However, Themistocleous (2002) claimed that the positivist approach has been the dominant underlying epistemology in IS research. In addition, Chua (1986, cited in Myers 1997) identified three categories of underlying research epistemology within the IS context, positivist, interpretive and critical. This was also confirmed by Themistocleous (2002) who stated that other philosophical approaches, such as critical and interpretivist stances, alongside the positivism paradigm, were also conducted in the IS literature. In this regard, the author looked carefully at each paradigm and chose carefully the most appropriate one, as discussed in the following sections.

5.3.1 Positivism

The philosophy of the positivistic paradigm sees the researcher, in regard to the phenomenon under investigation, from two angles, as an objective analyst and as an interpreter of a tangible social reality. The assumption of the underlying positivistic paradigm is that the researcher is an autonomous entity who neither affects nor is affected by the circumstances of the research subject. This paradigm assumes that there are independent causes that lead to the observed results, that evidence and parsimony are critical and important, and that it should be possible to generalise or to model the observed findings (Remenyi *et al.* 2005, pp. 22-38). According to Galliers (1992, pp. 144-162), the positivistic paradigm derives from the physical and natural world fields; therefore, it is characterised by repeatability, reductionism

61

and refutability. However, Remenyi *et al.* (2005, pp. 22-38) claimed that the positivistic stance does not yield interesting or profound insights into complex problems, especially in the social sciences. This was also noted by Jackson (2001) who claimed that there has been much debate about whether or not positivism is entirely suitable for the study of social science phenomena. This lead to many authors calling for a more pluralistic approach. With regard to the IS discipline, the positivistic paradigm has been used in IS research since the late 1970s (Jackson 2001). According to Orlikowski and Baroudi (1991), 96.8% of IS research in the leading American IS journals has conformed to this approach. However, Orlikowski and Baroudi (1991) argued that IS studies could only be classified as positivist if there was evidence of a formal proposition, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample of a stated population.

5.3.2 Interpretivism

According to Remenyi *et al.* (2005, pp. 22-38) and Myers (1997), the philosophical basis of interpretivistic research is rooted in the phenomenological approach. The research underlying phenomenological assumptions, as opposed to the positivist paradigm, does not consider the world to consist of an objective reality, but rather focuses on the primacy of subjective consciousness. Thus, each situation is considered as distinctive and its meaning is a function of the circumstances and the individuals involved. In addition, the phenomenologist is not independent of the subject of the research but is an intrinsic part of it. Therefore, the phenomenologist has to look beyond the details of the situation to understand the reality behind them and then constructs a meaning in terms of the situation being studied. In addition, the phenomenologist understands that the world does not consist of multiple realities, but rather, each reality is an artefact in its own right (Remenyi *et al.* 2005, pp. 22-38). Unlike positivist studies, phenomenological research is not readily conducive to generalisation, other than stating that the phenomenon has been shown to exist or occur at least, and therefore, for the phenomenologist, the world is socially constructed (Remenyi *et al.*, 2005, pp. 22-38).

For interpretivist researchers, the underlying philosophical assumption is that access to reality is only through social constructions (e.g. language, consciousness and shared meanings), since interpretive studies attempt to investigate the subject under study through the meanings

that people assign to them (Myers 1997). According to Kaplan and Maxwell (1994, pp. 30-55), the interpretivistic paradigm does not attempt to predefine dependent and independent variables; rather, it focuses on the full complex picture of human sense-making as the situation emerges. This was also confirmed by Galliers (1992, pp. 144-162) who, among others, reported that the underlying interpretivistic paradigm tends to allow concepts (constructs) to emerge from field data rather than entering the field with pre-conceived theories. In relation to the adoption of standards, Thomas (2006) argued that IT related standards are not implemented as an independent object, but are adopted and used as part of an information system (IS) project. According to Themistocleous (2002), Walsham (1993, pp. 3-23) and Orlikowski and Baroudi (1991), the term IS encompasses the social and organisational structure, culture, intellect and philosophy related to the distribution of information through the organisation. In this regard, Galliers (1992, pp. 144-162) argued that positivism is not the only relevant approach; an alternative interpretivistic paradigm was significant in IS studies at least until the term IS shifted from a technical view to considering human, social and organisational aspects. Walsham (1993, pp. 4-5) explained that the interpretive approach in IS research aims at "producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context."

5.3.3 Critical Research

Critical epistemology refers to the assumption that the social reality of the phenomenon under investigation is historically constituted and that it is produced and reproduced by people (Myers 1997). The critical approach is concerned with historical data. The ideology and contradictory nature of existing social practices are the criteria adopted in such studies which are approached by using a critical paradigm. Therefore, critical research focuses on the oppositions, conflicts and contradictions in contemporary society and seeks to be an emancipator in order to help eliminate the causes of alienation and domination (Myers 1997). In other words, critical researchers aim to provide a social critique whereby the restrictive and alienating conditions of the current situation under investigation should be brought to light. Meanwhile, researchers using the critical approach conduct mainly long-term historical and ethnographic studies of the processes that make up an organisation's structure. Jackson (2001) confirmed this assertion by stating that research studies using the critical method

63

should be selected with an awareness of their social consequences to maximise the potential of all those involved.

5.3.4 Rationale for the Choice of the Interpretivist Paradigm

Although using a critical paradigm in IS studies will enhance an understanding of communication deficits, particularly in the design, use and implementation of IT applications, the critical paradigm has had limited support for its application to social theory (Kvasny & Richardson 2006). Kvasny and Richardson (2006) contend that the use of critical research in the IS field still remains largely indeterminate, regardless of the theoretical orientation informing the analysis. Kvasny and Richardson (2006) listed various reasons for this limitation, such as the lack of clarity of the aims of critical research, the lack of a clear or agreed theoretical basis for critical research, and the dissonance between critical theory and practice. In addition, Brooke (2002) highlighted that the most common limitations of critical research cited in the literature are the lack of social theory (specifically concerning the nature of emancipation) and an inadequate conceptualisation of power which led writers to allude to epistemological and methodological weaknesses in the critical approach. This assertion was also confirmed by Trauth and Howcroft (2006, pp. 141-145) who noted that there is a dearth of critical research applied to the IS field since very few papers on critical research have appeared. Given the reasons above, the critical research paradigm was not chosen for the purpose of this research.

The choice between the positivist and interpretivist approaches has an impact on the empirical research strategy of IS studies, since the positivist paradigm assumes that the researcher takes the role of observer, whilst the interpretivist approach dictates that the researcher gains knowledge only by participating socially in the subject under study (Irani *et al.* 1999). With respect to the positivist paradigm, the interpretivist philosophy was chosen for the purpose of this research. The review and analysis of previous studies indicated that there are many political, cultural, managerial, social and technical issues related to the adoption of HIT related standards. These issues appear to be multiple, complex and interrelated so they cannot be separated from their organisational and cultural contexts. Therefore, the researcher would only gain the necessary knowledge by participating in the subject being studied. In addition, the aim of this research is to allow concepts to emerge from the field data using some sort of documentation and interviews. These also require the

researcher to participate in the subject of the study, and this is opposed to the positivist approach but is well-suited to the interpretivist paradigm.

5.3.5 Reasoning behind the Selection of Qualitative Research

According to Thomas (2006), many different research approaches can be used as a framework when undertaking planned research. However, one of the most common distinctions is between qualitative and quantitative approaches (Thomas 2006; Myers 1997). Whilst the quantitative approach was originally developed in the natural sciences to study natural phenomena, qualitative approaches were developed in the social sciences to enable researchers to study social and cultural phenomena (Myers 1997). Cornford and Smithson (2006, pp. 62-64), among others, reported that the purpose of quantitative research is to develop matrices (numbers) through the use of some sort of statistical analysis techniques which then are used for describing the phenomena (objects and relationships) under investigation. However, Themistocleous (2002) argued that the selected framework must be able to take account of confidential and subjective issues. It must acknowledge that many management decisions are idiosyncratic and guided by circumstances which pertain to the organisation. Therefore, rich empirical data are required to provide more understanding regarding the adoption process of integration technologies. According to Cornford and Smithson (2006, pp. 62-64), qualitative research is naturally strongly associated with the epistemological assumptions of interpretivism since it is less certain as to the possibility of the pursuit of value-free, time-and-place-independent.

This was also confirmed by Irani (1998) who reported that, since events that form a phenomenon are conditioned by interacting variables such as time and culture, no two situations are identical. In addition, Thomas (2006) emphasised that research concerning the adoption of data-exchange standards must acknowledge the reality of the complex social situation; therefore, the researcher should focus on both the context and standards, making the qualitative approach more appropriate. Moreover, Dedrick and West (2003) suggested that a richer framework for understanding organisations' decisions regarding the adoption of standards can be achieved through undertaking a qualitative study of a specific case of standards' adoption. Furthermore, Benbasat *et al.* (1987) reported that a qualitative research approach enables the researcher to study a new topic in the IS field in a natural setting, to learn about the state of the art, and to generate theories and practice. Indeed, the last decade

65

has seen a strong movement for qualitative research developing across the whole field of the social sciences, including the IS discipline (Walsham 1995). Cornford and Smithson (2006, pp. 62-64) loosely defined qualitative researchers as those who "eschew metrication and seek other means of capturing and analysing (understanding) data."

Given the aforementioned explanation, and given the objectives of this study and that the issues under investigation are confidential and subjective, the qualitative approach is clearly an appropriate framework for undertaking this research. However, the qualitative approach presents a number of disadvantages that should be taken into consideration when adopting such a research approach (Themistocleous 2002). For example, qualitative data are usually predominantly textual, with a richness that can be lost when aggregation or summarisation occurs. In addition, the data can be fairly unstructured and unbounded as they concern people's behaviour when attempting to understand their perceptions of a particular situation. However, this can be minimised by following exactly the interview agenda (see Appendix C) and asking probing and follow-up questions only if the interviewee's answer needs more explanation. Moreover, such data are often longitudinal, to a greater or lesser extent, as the observations may continue for an extended period of time. Furthermore, Cornford and Smithson (2006, p. 145) found that there are potentially several drawbacks to qualitative research compared to the quantitative approach. First, it is very hard to generalise to a wide range of situations since the research is specific to, at best, a small number of cases. Second, its richness and complexity imply that the data are often open to a number of very different interpretations; as a result, researcher bias is a constant danger. Third, researchers are involved in dynamic cases where the situation is changing frequently, thus, they have to face inherent problems in trying to make controlled observations, controlled deductions and predictions. Thus, validity and variability are constant concerns for researchers.

5.4 Research Approach

A research approach comprises of the process of data collection and theory development (Nogeste 2007). There are mainly two research approaches, namely inductive and deductive reasoning. While the deductive approach can be considered to be theory-driven, the inductive approach is data-driven. Deductive reasoning is a theory-testing process which begins with a well-established theory or generalisation, and then seeks to examine the application of this theory to specific instances (Hyde 2000). Therefore, the deductive approach is well-suited to

topics with rich literature as it can be used for defining theoretical propositions (Saunders *et al.* 2003, pp. 117-122). On other hand, the inductive approach, usually called a 'bottom-to-up' approach (Gorman and Clayton 1997, p.5), starts with little existing literature and observation, and then the theory is developed through the collected data (Saunders *et al.* 2003, pp. 117-122). Robson (1993, p. 61) contended that the inductive approach is preferred over the deductive one since it enables a full description to be made of the phenomenon under study and brings out interactions between the enquirer and the respondents. However, Patton (1991, p. 194) argued that both inductive and deductive processes can be adopted by the qualitative researcher. This is because, according to Hyde (2000), the researcher begins to identify the literature and develop theoretical concepts which are then investigated in the real setting using the deductive reasoning approach. However, there might be a chance for the researcher to analyse the collected data using the inductive approach for other concepts that have emerged. Given that the intention of this research is to develop, through the literature, a conceptual model of critical factors influencing the adoption of HIT related standards from different related disciplines, and then to examine the conceptual model to see to what extent this model is pragmatic in real settings and what other factors emerge, both deductive and inductive reasoning was applied in this research.

5.5 Justifying the Use of the Case Study Methodology

A research methodology refers to the procedural framework used by the researcher for solving a specific problem in real practical settings (Remenyi *et al.*, 2005, p. 28). Galliers (1992, pp. 144-162) suggested that the research methodology of one study is an on-going process taking on a particular style and utilising different research methods to collect empirical data. In terms of IS research, Myers (1997) described the research methodology as a strategy of inquiry which commences from the underlying philosophical assumptions of the research questions and then moves to identify the most appropriate research method for collecting the enquiry's evidence. However, just as there are various philosophical assumptions which can inform qualitative research, there are also various qualitative research methodologies which can be used to collect evidence from real settings (Myers 1997). Irani (1998), among others, reported that the decision to select a particular research methodology is a complex task, which should only be decided after considering a number of factors. This is because each methodology can influence the way in which the researcher looks at the subject under investigation and collects the data (Myers 1997). Yin (2003, pp. 1-18) explained that

the selection of a suitable research methodology depends on three different criteria: the research questions, the researcher's control over behavioural events, and the contemporary events.

Nonetheless, Myers (1997) explained that the most common methodologies used by IS researchers are action research, grounded theory, ethnography and case study research. However, with respect to the first three methodologies, for the purpose of this research, the case study methodology was seen by the author as a suitable approach. This is because, for example, the action research methodology requires the researcher to be part of the phenomenon under investigation; he/she should be involved in the procedures undertaken to solve the problems. This is not the case in this research where the intention is to examine the proposed model, as described in Chapter Six, and, based on this, to offer some general recommendations. In addition, grounded theory was rejected since the researcher developed the proposed model through the literature review which contradicts the philosophical assumptions behind grounded theory research. Moreover, the ethnographic methodology was abandoned because of its cost, its time-consuming nature, and the restricted accessibility to the real settings.

The case study methodology allows valid and reliable information to be gathered within the IS research community. It adds to the accumulation of knowledge about processes within a unit of analysis (Klein & Myers 1999). Yin (2003, p. 13) defined the case study as "an empirical enquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used." Yin (2003, p. 13) explained that the case study methodology allows the investigator to cover contextual conditions believing that they might be highly pertinent to the phenomenon being studied. Therefore, a case study aims to achieve in-depth understanding and represents a way of systematising the observation of the context of a phenomenon. This was also asserted by Yin (2003, pp. 1-18) who claimed that a case study is an intensive examination of the phenomenon under investigation in its natural setting; it involves multiple data collection methods to gather information from one or more entities (e.g. people, groups).

In addition, Yin (2003, pp. 1-18) emphasised that the case study is particularly appropriate for certain types of situation where the research and theory are at an early formative stage.

This is similar to the case of this research as its purpose is to examine to what extent the formative conceptual model meets reality. Moreover, Benbasat *et al.* (1987) summarised where and when the case study is seen to be a suitable research methodology. For example, when the focus is on contemporary events; when no experimental controls or manipulations are involved; where the investigator does not specify the set of variables in advance; where the research hypothesis development is at an initial stage in the knowledge-building process; and where the research questions are 'why' and 'how'. Furthermore, Myers (1997) and Benbasat *et al.* (1987) pointed out that the case study methodology is particularly well-suited to IS research since the interest of studying the IS discipline in organisations has shifted to organisational rather than technical issues. This was also supported by Orlikowski and Baroudi (1991) and Alavi and Carlson (1992) who reported that case study research is the most common qualitative method used in the IS discipline. Although a case study methodology was chosen, there are a number of variants that this approach can take. The taxonomy of these variants was based upon Cavaye's work (1996, cited in Irani 1998). These variants are as follows.

5.5.1 Case Study Objectives

There are several research variants concerning the objectives for choosing a case study methodology. For instance, it can be considered a suitable methodology to investigate a phenomenon, to build theory and test theoretical concepts and relationships, or it can be used for all three variants. In addition, case studies have a strong tradition of description and theory-building, with major proponents, such as Remenyi (1991), advocating this objective because of the methodology's deductive and inductive characteristics. However, the research variant of this study is to investigate a phenomenon in order to test theoretical concepts. This is because the researcher developed a conceptual model, as described in Chapter Six, and then looked to test it and to discover other concepts that might emerge.

5.5.2 Case Study Types

Yin (2003, pp. 3-5) contended that case studies are far from being only an exploratory strategy, asserting that some of the best and most famous case studies have been both explanatory and descriptive. This depends on whether they are used to answer 'what', 'how' and 'why' research questions respectively. However, the case study followed in this study can be classified as exploratory. The reason behind this selection is that this study focuses

69

more on questions of the "what" type (e.g. what are the factors that influence the adoption of HIT related standards at the decision-making stage in healthcare organisations?). According to Themistocleous (2002), exploratory case studies are useful for discovery and theory-building as they are valuable in developing and refining concepts for further study.

5.5.3 Case Study Approach

An integral part of developing a suitable research design is the decision whether to investigate a single or a multiple set of cases since a research design is a logical sequence of events. A single case enables a researcher to undertake an in-depth examination and get close to the phenomenon under investigation (Yin 2003, pp. 53-55). It allows for a rich description and the identification of deep structures. It also enables the full and rich analysis of a phenomenon, which may, in turn, contribute by adding to the body of knowledge through the development of theories and concepts (Irani 1998). However, Jackson (2001) asserted that the key feature of using the case study methodology is the numbers of case studies that can be included in a study. Therefore, the outcomes drawn from multiple case studies are more compelling than those obtained from single-case approaches. Although the study of multiple cases may not allow the same degree of rich description as those investigations based around a single case, the overall study is regarded as more robust (Irani 1998). According to Jackson (2001), a multiple-case study is seen as appropriate when the aim of the study is to develop theory which permits cross-case analysis, a necessary feature if the developed theory is to allow widespread generalisation. Since the purpose of this research is to examine certain theoretical concepts in order to develop a pragmatic model of factors influencing the adoption of HIT related standards in healthcare organisations, a multiple-case study methodology was selected. Regarding the number of cases required for the researcher to carry out the research enquiry, the literature is still limited in terms of suggesting the number of cases, and so this is usually determined intuitively (Irani 1998). For example, Dyer and Wilkins (1991) explained that the number of cases depends on how much is known about the phenomenon itself and what new information is likely to emerge from studying further cases. In addition, Eisenhardt (1989) suggested that a multiple-case approach requires the study of at least four, but no more than ten cases. On the other hand, Gable (1994) advocated that a multiple enquiry should include up to five organisations. However, for the purpose of this study, six healthcare organisations were chosen based on various justifications, as described in Chapter One.

5.6 Data Collection Methods

Themistocleous (2002) asserted that the use of multiple methods for data collection in a case study will lend greater support to the researcher's conclusions. In addition, Yin (2003, pp. 83-106) identified several sources of evidence that can be used in case studies, such as documentation, archival records, interviews, observation and physical artefacts. Myers (1997), however, emphasised that a case study researcher typically conducts interviews and examines documentary materials first without using other methods such as participant observation. Nevertheless, this researcher decided to use any evidence for data collection as long as it was available but, since documentation and interviews were the only sources of enquiry available to the researcher, others methods were abandoned. Nonetheless, the following sections describe each method.

5.6.1 Documentation

Documentation plays a major role in any data collection which uses the case study methodology. It is primarily used to corroborate and augment evidence from other sources. Yin (2003, pp. 83-106) lists three reasons for seeking corroboration and augmentation from other sources: verifying the spelling and titles of organisations; providing specific details that can support the verbal accounts of informants; and, finally, setting the context for interviews or discussions within the organisation being studied. According to Yin (2003, pp. 83-106), this type of evidence can take many forms, such as letters, reports of events, administrative records and newspaper clippings; therefore, documentation should be the object of explicit data collection plans. For the purpose of this research, varied documentation was collected as long as the sources were available to the researcher. These included, for example, some RFP projects, IT strategic plans, information strategic plans, and the big picture of HIT infrastructures for some organisations. In addition, all the organisations' web sites were carefully examined as a main source of documentary material.

5.6.2 Interviews

Interviews are a guided conversation rather than structured queries, and open-ended interviews are one of the most frequently used sources of evidence in case studies (Myers 1997). According to Yin (2003, pp. 83-106), the researcher has two tasks throughout the interview process. The first task is to follow the line of the research inquiry, as reflected by

71

the case study protocol. The second task is to ask the actual research questions in an unbiased manner. The literature explained that there are three major forms of interview in existence: structured, semi-structured and unstructured (Cornford and Smithson 2006, pp. 120-121). A structured interview implies that the researcher follows only the interview agenda in a pre-planned sequence without divergence and with a minimum of explanation. In an unstructured interview, the researcher simply provides the topic and the conversation proceeds without any planning. A semi-structured interview implies that the interviewer prepares an outline for the interview in advance, including the number of questions, to act as guide, though without the intention of following it rigorously.

Cornford and Smithson (2006, pp. 120-121) emphasised that, by using the semi-structured interview, the researcher ensures that the same topics are covered in each interview while the emphasis can be shifted as appropriate. In contrast, Cornford and Smithson (2006, pp. 120-121) pointed out that both the extremes of structured and unstructured interviews have their dangers in terms of a lack of completeness or a failure to reap the benefits of the personal interview. However, unstructured interviews are helpful when the researcher needs to gain the full picture of an organisation's management structures and the workflow of business processes. Such information might be made available to the researcher through some employees during their breaks or lunch times, or through unofficial meetings, seminars and workshops (Themistocleous 2002). Therefore, both unstructured and semi-structured interview approaches were chosen to serve the purpose of this research work.

In addition, interviews can also be undertaken in various forms, such as personal interviews, face-to-face or group interviews, and telephone surveys (Themistocleous 2002). However, this research involves a set of predetermined issues that need to be addressed to help in collecting in-depth data and therefore the face-to-face interview was selected as the dominant form. A video-conferencing online form was also used in the second stage when the researcher had to return to some interviewees to validate the research findings and the proposed model in order to draw up some recommendations owing to time limitations and the limited research budget. The duration of an interview is not specific; hence, it might take place in a five-minute conversation or over lengthy, multiple sessions (Frey & Fontana 1991). The estimated time for the semi-structured interview agenda, as shown in Appendix C, was about one hour. However, this depended on the time allocated by the informants to the researcher. The researcher sought to conduct interviews of approximately one hour but he

72

also appreciated that the interviewees were decision makers who were most probably managers and seniors. Therefore, the allocated time was sometimes less than one hour. Nonetheless, the researcher acknowledged the benefits of using semi-structured interviews when he had the opportunity to discuss the research questions with some interviewees for a longer period of time, sometimes more than two hours, because some senior managers were happy to allow this and showed enthusiasm for the subject of the research, as shown in Table 5.1.

Table 5.1: The entire interview sample of the research.

No	Name of Healthcare Organisation	Interview and interviewees' details				
		Coded Name	Interviewee's Position	Interview Date	Duration Time	Recorded ?
1	NGHA	Participant 1	Executive Director of Information Systems & Informatics	2-6-2010	1 h	Yes
		Participant 2	Associate Executive Director of Enterprise Applications	10-5-2010	55 min	Yes
		Participant 3	Director of Corporate Medical Imaging Informatics	9-6-2010	2 h	Yes
		Participant 4	Manager of Radiology Information System Interface	9-6-2010	2 h	Yes
		Participant 5	Project Manager	10-5-2010	1 h & 16 min	Yes
		Participant 6	Manager of Medical Applications	30-4-2010	1 h & 48 min	Yes
		Participant 7	Lab Information System Team Leader	10-5-2010	1 hour	No
		Participant 8	Cardiac Research Team Leader	12-5-2010	1 h & 15 min	No
2	KFSH&RC	Participant 9	Medical Informatics Specialist	11-5-2010	43 min	Yes
		Participant 10	Head of Clinical Systems	19-5-2010	1 h	Yes
		Participant 11	Director of Medical and Clinical Informatics	18-5-2010	1 h	Yes
		Participant 12	Senior Programme Analyst	22-5-2010	28 min	Yes
		Participant 13	Senior Information System Architect and Manager of Data Warehouse	23-5-2010	24 min	Yes
		Participant 14	Chief of Clinical Auditor and General Consultancy Services	23-5-2010	22 min	Yes
		Participant 15	Chief of Information Technology Affairs	26-5-2010	50 min	Yes
3	KFMC	Participant 16	Manager of Integration Unit	17-5-2010	1 h & 6 min	Yes
		Participant 17	Manager of Process Automation Division	22-5-2010	1 h & 40 min	Yes
		Participant 18	Director of ICT Department	19-5-2010	22 min	Yes
		Participant 19	Director of Health Information Management	1-6-2010	1 hour	Yes
4	SFH	Participant 20	Director of IT Department	5-5-2010	42 min	Yes
		Participant 21	Development Team Leader	5-5-2010	2 h & 9 min	Yes
		Participant 22	Development Team Leader	5-5-2010	1 h & 28 min	Yes
		Participant 23	Research and Development Manager	8-5-2010	1 h & 50 min	Yes
5	RUHs	Participant 24	Director of Computer and Information Department	2-5-2010	1 hour	Yes
		Participant 25	Software Engineer	2-5-2010	1 h & 14 min	Yes
		Participant 26	Software Engineer	2-5-2010	1 h & 14 min	Yes
		Participant 27	Supervisor of Clinical Applications Projects Management Unit	2-5-2010	1 h	Yes
		Participant 28	Manager of Clinical Applications	2-5-2010	38 min	Yes
		Participant 29	Manager of Data Centre	15-6-2010	1 h	Yes
6	RAFH	Participant 30	Director of IT Department	31-5-2010	1 h	Yes
		Participant 31	Manager of Data Centre	2-6-2010	1 h 15 min	Yes
		Participant 32	Manager of Lab Information System	7-6-2010	1 h	Yes
		Participant 33	Director of Medical Records	7-6-2010	1 h	Yes

74

5.7 Data Analysis

Once the evidence has been gathered by the qualitative researcher, it is necessary to analyse it. Just as there are different types of data collection methods, there are also various data analysis approaches with different techniques for interpreting qualitative data. However, the common thread is that all qualitative methods of analysis are concerned primarily with textual analysis, whether in terms of verbal or written materials (Myers 1997). The key challenge is that the researcher in qualitative research independently collects rich textual materials and these may make him/her feel swamped by their volume (Remenyi *et al.* 2005, pp. 112-114). As a result, clarity, in terms of the process and practice of qualitative analysis, is vital as if readers do not know how the study has analysed the data or are ignorant of what assumptions have informed its analysis, it is difficult for them to evaluate, synthesise or compare the study with others on the same topic (Braun & Clarke 2006). This might result in impeding other people from carrying out related research studies in the future (Attride-Stirling 2001). However, all qualitative analysis methods are grounded in thematic analysis approaches as they use the same traditional ways of analysing the qualitative data; these include thematising meanings (Holloway & Todres 2003, p. 347) and using thematic coding (Ryan & Bernard 2000, pp. 769-802).

This has led some authors, such as Braun and Clarke (2006), to argue that analysis methods are in essence thematic, but they are either claimed as being something else or are not identified as any particular method at all. Therefore, thematic analysis should be seen as a foundational approach for qualitative analysis and can be defined as an approach that is used for identifying, extracting, analysing and reporting patterns (themes) within the collected textual materials and then organising and describing those themes in detail (Braun & Clarke 2006). According to Braun and Clarke (2006), one of the main benefits of thematic analysis, compared to other forms of qualitative analysis, is its flexibility. While some qualitative data analysis methods are tied to, or stem from, a particular theoretical or epistemological approach, thematic analysis, in contrast, is an independent method which can be applied across a range of theoretical and epistemological approaches. This in turn offers a flexible and useful research instrument which can be used by qualitative researchers potentially to provide a rich and detailed, yet complex, account of data, thus offering theoretical or epistemological freedom (Braun & Clarke 2006). As previously mentioned, Jackson (2001) claimed that a multiple-case study is preferable since it permits cross-case analysis which is a

75

necessary feature for the widespread generalisation of theories. This is because cross-case analysis allows similarities and differences between the cases to be identified and so a chain of evidence for the relationships between the cases can be studied further (Altameem 2007). Accordingly, for the purpose of this research, a hybrid approach for analysing qualitative data, which included thematic analysis and cross-case analysis, was used to analyse the collected textual materials.

5.8 Research Validity and Reliability

Yin (2003, pp. 33-39) explained that construct validity is the way to establish correct operational measures for the subject under investigation and proposed various approaches for the researcher to increase construct validity when carrying out case studies. For example, one approach is that the researchers should specify carefully and exactly the scope of the phenomenon under investigation. Then, they should determine precisely the sources from which the evidence required for studying the research phenomenon will be generated. The researcher explained the scope of this research in Chapter One and, in addition, developed the conceptual model, as presented in Chapter Six. This model was based on the innovation adoption theory and theories related to the economics of standards perspective. The proposed model was examined through six healthcare organisations. As mentioned in Chapter One, these healthcare organisations were chosen because they are the major healthcare providers in Saudi Arabia, they have a more advanced HIT infrastructure with the highest IT budgets, they have and recruit well-qualified people with regard to both IT and health informatics, and they are considered to be the main supporters of e-health initiatives (Altuwaijri 2008). They are also involved in the pilot project run by the Council of Health Services concerning the exchange of health information. The sampling interview was also based on systemic methods, as explained in Section 5.9.2.2. The second approach mentioned by Yin (2003, pp. 33-39) is the use of multiple sources of evidence in a manner which encourages convergent lines of inquiry. The term that is usually related to the use of multiple sources is triangulation. Through triangulation procedures, the researcher overcomes bias in the research findings, which is considered to be a danger in qualitative research (Ryan & Bernard 2000).

According to Yin (2003, pp. 33-39), there are four types of triangulation, data triangulation, investigator triangulation, theory triangulation and methodological triangulation. In addition, Remenyi et al. (2005, p. 115) explained that the researcher can triangulate the study results in

76

such a way as to use multiple data collection methods, as well as multiple informants and cases. In this research, the author triangulated the research findings through three approaches. First, the research's conceptual model was constructed based on two main theories, the innovation adoption theory and theories related to the economics of standards perspective. Secondly, a chain of evidence was conducted in six healthcare organisations in Saudi Arabia in order to collect evidence for the research's line of inquiry. Thirdly, two data collection methods were used for gathering the required data, documentation review and interviews with senior informants in a range of different positions. In addition, the findings of this research were triangulated thorough the literature since the interview agenda (see Appendix C) were developed based on the researcher experience and the literature as the intention of the researcher is to also confirm inferences made from the findings of several research methods and approaches in the literature.

The third approach for improving construct validity in research, according to Yin (2003, pp. 33-39), is the use of the analytic tactic of pattern matching. This was achieved through the use of a hybrid approach, which included thematic analysis and cross-case analysis methods, for analysing the qualitative data, as described in Section 5.8.3. A fourth approach for enhancing the validity of the research results is to have the draft case study report reviewed by key informants. The researcher, after completing the analysis, reported back the research findings to the majority of the interview sample for them to be reassessed and for further modifications to be suggested. In this part, the intention of the researcher was, not only to review the findings, but to evaluate further the constructed model and to provide some recommendations for enhancing the adoption of HIT related standards in healthcare organisations. Five key informants agreed to participate in the evaluation process. Due to time and budget constraints, an online video-conferencing (Skype) form, as agreed by the participants, was used to discuss the research results. The participants were happy and agreed with the findings and so provided the researcher with some recommendations on how to promote the adoption of HIT related standards in healthcare organisations, as explained in Chapter Nine.

Concerning reliability, Yin (2003, pp. 33-39) described this as making sure that any new investigator should arrive at the same conclusions or findings as an earlier one by following the same procedures described by the earlier researcher. The objective of construct reliability is to minimise, as far as possible, the errors and biases of a study. Yin (2003, pp. 33-39)

suggested the use of a study protocol and the development of a case study database as specific tactics to overcome the documentation problem. The study protocol was developed as an action plan for collecting, analysing and reporting the evidence of the research's line of inquiry, as described in Table 5.2. In addition, the researcher used a folder management system for organising and saving all the research data in an appropriate way.

5.9 Empirical Research Strategy

Due to the complexity of the social setting under investigation, the researcher used of a set of procedures that were open-ended and rigorous in order to carry out the qualitative research design. Janesick (2000, pp. 379-399) and Irani (1998) proposed that a qualitative research strategy might follow three stages: research design, data collection and data analysis. This research followed these stages and, in doing so, an empirical research strategy was developed, as shown in Figure 5.2. This strategy guided the researcher in examining the constructed model, described in Chapter Six, and in collecting and analysing the empirical qualitative data derived from multiple sources in real settings.
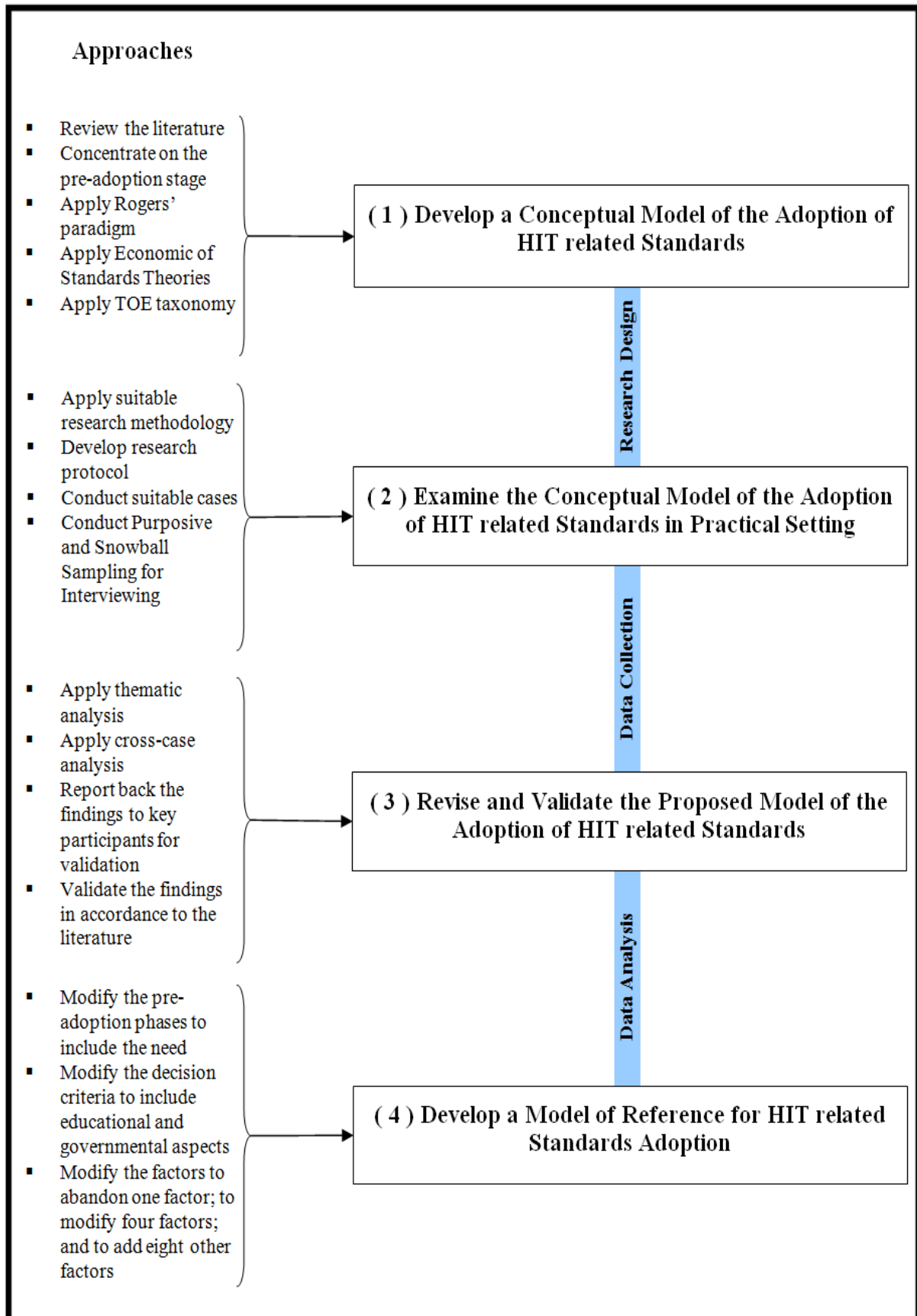
Figure 5.2: Empirical research strategy framework.

5.9.1 Research Design

According to Themistocleous (2002), the research design is the first independent part of the empirical research strategy where the researcher needs to investigate the literature to identify the research needs and issues, and then uses the most appropriate research methodology to carry out the research's line of enquiry in real settings. The literature was carefully reviewed in order for the researcher to gain a deep understanding of the research subject. This in turn, led the researcher to identify the research needs, questions and issues. Based on a critical review of the literature, a proposed model, as described in Chapter Six, was developed. However, a research methodology had to be determined in order for the researcher to examine the proposed model in a practical setting. Therefore, a multiple-case study was chosen as an appropriate methodology to carry out the research.

Next, the research design should be processed, as suggested by Yin (2003, pp.67-77), into a protocol that will serve as a mechanism to generate appropriate data. According to Yin (2003, pp.67-77), a research protocol is an instrument that acts as an action plan for an empirical line of enquiry. A case study protocol helped the researcher to set out the proposed rules and procedures that should be followed while carrying out the fieldwork research. The research protocol was also an important way of increasing the reliability of the case study research (Yin 2003, pp.67-77). Since this research is based on a multiple-case study methodology, developing a protocol to guide the researcher in carrying out the data collection process was also seen as another reason for developing the research protocol.

Themistocleous (2002) listed five reasons for the development of a research protocol. These are, controlling the task of data collection in a manageable format; ensuring that the required data are gathered; ensuring that the research follows the research time schedule; tracking the path of the developed knowledge; and finally acting as a map for other researchers to follow in order to achieve similar conclusions. In addition, Themistocleous (2002) asserted that a research protocol is needed when the issues under investigation are subjective and where the research depends on a framework which uses a qualitative approach. Similarly, Yin (2003, pp.67-77) explained certain benefits of having a research protocol for case study researchers. For example, it keeps the research targeted on its objectives and, in addition, it allows the researcher to anticipate in advance many associated problems, helping to resolve these at an early stage. Furthermore, Yin (2003, pp.67-77) explained that a case study protocol should

consist of four steps. The first step is the overview of the case study project. This should cover the background of the issues being investigated and include relevant reading about them. The second step covers field procedures which should emphasise the major tasks involved in collecting data. These include gaining access to the organisations, having sufficient resources, making a clear schedule of the data collection activities, and providing for unanticipated events. The third step involves the case study questions which are at the heart of the protocol. This is a set of substantive questions reflecting the research's actual line of inquiry. The fourth step is a guide for the case study report that helps in facilitating the gathering of relevant data in an appropriate format. It also reduces the need to gather further information from the sites. Table 5.2 shows these different steps and how they are linked to the research outline and activities.

Table 5.2: Protocol steps and their links to the research outline and activities.

Protocol Steps	Research Outline
Overview of the case study project	▪ Chapters 1, 2,3,4 & 6
Field procedures	▪ Pilot study in January 2010 ▪ Selecting the appropriate healthcare organisations ▪ Getting access permission on April 2010 ▪ Identifying the appropriate sampling ▪ Scheduling the site visit and interview times from the 12th April 2010 to the 12th July 2010 ▪ Using a tape recorder to record the interviews ▪ Collecting all the necessary and available documentation from the sites ▪ Developing a method for managing, storing and retrieving all the textual material
Case study questions	▪ Interview agenda, as presented in Appendix C ▪ Transcribing all the recorded interviews into MS Word 7 documents ▪ Using a Computer Assisted Qualitative Data Analysis Software (CAQDAS) application for analysing the collected fieldwork data
Guide for the case study report	▪ Chapter 7 ▪ Chapter 8

81

5.9.2 Data Collection

Interviews and a review of documentation were carried out to collect the required evidence from the selected healthcare organisations. Apart from semi-structured interviews, the interview agenda focused on collecting data based on the conceptual model presented in Chapter Six (see Appendix C). The following sections describe in more detail the main activities that were carried out during the data collection stage.

5.9.2.1 Selecting Healthcare Organisations and Piloting the Interview Instrument

The data collection stage ran from 12 April 2010 to 12 July 2010. Of the Saudi healthcare organisations, six hospitals located in Riyadh were contacted and involved in this research. In addition, before being finalised, the interview instrument was piloted in January 2010. The purpose of the pilot study was to identify any problems, such as the wording of questions, the length of the interview, and whether the research instrument was compiled in a logical fashion. In addition, the pilot was intended to test the ability of the interviewer to administer the research instrument and indicate whether further training was required. Three academicians who used to work in the IT departments in some of these healthcare organisations were interviewed to test the suitability of the interview instrument. The academicians advised making some minor corrections and offered some suggestions. For example, the interview questions were felt to be rather long and therefore some questions needed to be merged since most of the interviewees were senior personnel and managers and the interviews had to be restricted to the allocated time. The researcher also benefited from attending the Saudi e-Health conference on 2-4 May 2010 in Riyadh. This offered the researcher the opportunity to meet some key stakeholders and decision makers related to HIT adoption in the case hospitals. It also gave him the chance to introduce himself and his research and to receive their business cards in order to contact them for the purpose of scheduling a meeting. It afforded the further opportunity to chat or carry out an unstructured interview with regard to the adoption process of HIT related standards.

A number of researchers have explained the difficulties involved in collecting data for the purpose of research in Saudi Arabian society (Altameem 2007). Therefore, in order to overcome this barrier, the researcher used two techniques. First, he used his personal contacts and networking to schedule meetings with organisations and individuals involved in the research, and to obtain some documentation. This also created an appropriate rapport with the

82

respondents which could result in them providing more information for the research. Personal relationships and trust-building contacts with the subjects of the research were considered important elements in the collection of data. Secondly, the researcher obtained official letters from his sponsor on behalf of the General Director of King Fahad Security College, from his supervisors, and from Loughborough University's Research Office. The candidate hospitals were given these official letters in order to enable the researcher to access the sites and interview the selected sample of people. The researcher faced some 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.

5.9.2.2 Sampling Procedures and Conducting Interviews

IT departments were the main stakeholders responsible for the adoption process of HIT related standards in the cases studied in this research. However, the IT departments reported that some other departments had partial responsibility in terms of the adoption of health data standards. These included Medical and Clinical Informatics departments, Lab departments and Medical Records' departments. Therefore, the researcher intended to focus on the target stakeholders whilst interviewing whoever was available as long as the person met the necessary research criteria as informants. So, the purposive sampling method was used to identify the participants. A purposive sample was derived to identify all those people who were in charge in terms of the adoption of HIT related standards. The IT departments of the selected healthcare organisations were contacted in order to identify the targeted informants. In addition, the chain referral or snowball sampling method was also used to identify other informants. This is because that there are other people who are or used to be in charge in the decision-making of HIT application adoption and they are not affiliated to the IT department. A snowball sample was obtained by asking participants to suggest someone else who was appropriate for the study. For example, when the Head of Information Technology Affairs in KFSH&RC was asked to suggest other people who could potentially participate in or contribute to the study, he recommended that the researcher contacted the Director of Medical and Clinical Informatics who then recommended the researcher interviewed the chief of the Clinical Auditor and General Consultancy Services. However, through the snowball sampling process, some people and interviews were neglected based on the researcher's knowledge and judgment as those people were found to be not appropriate for

this study. Thus, the number of participants totalled 33 persons, all of whom were managers or senior officials. Table 5.1 shows in detail the entire interview sample for this research.

All the interviews were conducted in person to ensure that an appropriate expert had the opportunity to participate in the research, give feedback and tell his/her unique story. Interview times ranged from 22 minutes to 2 hours, depending on the interviewee's schedule and availability. The intention of the interview was not to confirm the critical factors in the literature but rather to find which, if any, critical factors were evident in the organisations regarding the adoption and implementation of HIT related standards, as well as to discover other factors not proposed in the researcher's conceptual model. Furthermore, the objective of the semi-structured interviews was not merely to receive yes or no answers to questions but rather to obtain a full picture and description of an episode, together with detailed explanations of activities and actions. The open-ended, semi-structured interview enabled the researcher to ask probing and follow-up questions, depending also on each interviewee's schedule and availability.

The researcher started the interview by introducing himself and giving a brief overview of the research being undertaken and its purpose. Then, respondents were free to express themselves on any question asked. After each question the researcher confirmed to the respondents his understanding of the answer and asked if this was what the respondents meant. This contributed to and increased the validity of the research results. Most of the interviews were tape recorded and transcribed in a Word document as soon as possible after each individual interview. This was because taking notes during the interviews might cause the researcher to lose the focus required for asking probing and follow-up questions. In addition, taking notes during the interviews required more time which was impossible in some instances. Furthermore, this helped to increase the accuracy of the data and prevented data being lost during transcription. The researcher ensured that each interviewee felt perfectly free to talk openly when being recorded and gave their full consent without pressure to be recorded on tape. In addition, the researcher took into consideration ethical issues when conducting the interviews. These included gaining informed consent and making assurances of confidentiality and anonymity. Therefore, the candidate interviewees were given enough information about the research and its purpose in order to make a decision about whether or not to participate in the study. Participants were also assured that whatever information they

provided to the researcher will be kept securely, treated as highly confidential and not be divulged to anyone outside of the research team.

5.8.3 Data Analysis

The thematic analysis approach applied in this research was based on the guidelines devised by Braun and Clarke (2006). These guidelines, as shown in Table 5.3, involve six steps which are required for analysing qualitative data and are, familiarising oneself with the collected data; generating initial codes; searching for themes; reviewing themes; defining and naming themes; and producing the report. In terms of familiarisation with the collected data, the researcher immersed himself in the data in several ways. For example, the data were collected by the researcher using interactive means and so the analysis of the data started with some prior knowledge, initial analytic interests and thoughts. The transcription process was also an excellent way for the researcher to begin the process of familiarising himself with the interview data and creating meanings from them. According to Bird (2005, p. 227), transcription is "a key phase of data analysis within an interpretative qualitative methodology." The majority of the tape-recorded interviews were first translated from Arabic into English and then transcribed into MS Word 7 documents. Therefore, during this stage, the researcher had the opportunity to immerse himself in the collected data to the extent that he was familiar with the depth and breadth of the content.

The step of generating the initial codes started when the researcher had become familiar with the data through the generation of an initial list of ideas about what was in the data and what was interesting about them. For producing these codes, different Computer Assisted Qualitative Data Analysis Software (CAQDAS) applications can be used. However, the final choice of software is often based on a combination of practical considerations and personal preference, which are based on subjective ease-of-use considerations (Thomas 2006). As a result, the QSR NVivo 8 was employed to carry out the second step of the data analysis. This was done by tagging and naming selections of text within each data item. As suggested by Braun and Clarke (2006), the researcher coded as many potential themes and patterns as possible as it is never possible to know what might become of interest later on. The result of this step was a long list of the different codes that the researcher had identified across the data.

In searching for themes, there was a need to re-focus the analysis at a broader level than had been undertaken with the codes. This required sorting and collating all the different relevant codes into potential themes. In doing so, visual representations using MindGenius Education software were used to help the researcher to sort the codes into themes. This step ended when a collection of possible themes and sub-themes was produced, together with related codes. The thematic map was then refined to consider whether the collated codes for each theme appeared to form a coherent pattern, whether the individual theme was valid in relation to the entire data set, and if the thematic map accurately reflected the meanings evident in the data set as a whole (Braun & Clarke 2006). After the step of searching for themes, the researcher came up with a set of candidate themes. These themes were refined once again via two levels. At the first level, the reviewing was carried out at the level of the codes. The researcher needed to read all the collated codes for each theme and then examine whether they appeared to form a coherent pattern. Sometimes, the theme itself was problematic or the code did not fit within the theme. This required a new theme to be created for those codes or for them to be discarded from the analysis. At the second level, the reviewing was undertaken at the level of the themes where the validity of each theme was examined in relation to the data set and thereafter whether the thematic map reflected the meanings evident in the data set as a whole. At the end of these steps, all the themes were seen to have a coherent meaning related to the purpose of the research and to be linked together to reflect the overall story of the collected data.

The outcome of reviewing the themes was the production of a satisfactory thematic map. Once it was developed, each theme was then refined and defined. This process was carried out to identify two things, the essence of what each theme was about and what aspect of the data each theme captured (as described by Braun and Clarke 2006). This required going back to the theme codes and organising them into a coherent and internally consistent account with an accompanying narrative. Each individual theme had its own story that fitted into the broader overall story that the research was considering in relation to the research questions. It was important that, by the end of this phase, the scope and content of each theme were clearly defined and described in a small volume of text. It was also important to start thinking about the names that would be given to reflect what each theme was about. The production of the report began when fully thought through themes were clearly defined and their scope described in order to tell the complex story in a way which would be easy for the readers to assure the validity of the analysis. This complex story was also supported by sufficient

evidence of the themes within the data (i.e. code extracts) to demonstrate the prevalence of the themes.

Table 5.3: A thematic analysis: six-step guideline for analysing qualitative data (Braun & Clarke 2006).

Activities	Description
Familiarising yourself with your data	- transcribing data - reading and re-reading the data - noting down initial ideas
Generating initial codes	- coding interesting features of the data in a systematic fashion across the entire data set - collating data relevant to each code
Searching for themes	- collating codes into potential themes - gathering all data relevant to each potential theme
Reviewing themes	- checking that the themes work in relation to the coded extracts the entire data set - generating a thematic map of the analysis
Defining and naming themes	- on-going analysis to refine the specifics of each theme and the overall story the analysis tells - generating clear definitions and names for each theme
Producing the report	- the final opportunity for analysis - selection of vivid, compelling extracts or examples - final analysis of selected extracts - relating back the analysis to the research questions and the literature - producing a scholarly report of the analysis

5.10 Summary

This chapter described the philosophy of the methodological stance that was adopted by this study to address the research questions highlighted in Chapter One. For this, the researcher developed a theoretical research strategy framework, as shown in Figure 5.1. The reasoning behind this is that the sequences of the parts of the research methodology are still debatable and so there is a need to develop such a framework in order to ensure that all relevant

research options are considered as a series of top-down stages. In this regard, this framework starts with the research philosophy which is based on the philosophical assumptions related to the underlying ontology and epistemology. Then, the interpretivist approach was chosen as a suitable research paradigm. The reason for this choice was because there are many political, cultural, managerial, social and technical issues concerned with the adoption of HIT related standards and therefore the researcher must participate in the subject of the study in order to gain knowledge. Next, this chapter justified the selection of qualitative research which is naturally strongly associated with the interpretivist paradigm. Regarding the use of qualitative research, both deductive and inductive approaches were adopted to enable the researcher to examine to what extent the proposed model, described in Chapter Six, was valid in real settings. Thereafter, the case study methodology was selected to enable the researcher to collect the empirical qualitative data required. In this regard, multiple data collection methods, namely documentation and interviews, were seen as sufficient and the most appropriate to lend greater support to the researcher's conclusions, as well as to triangulate the research findings in such a way to reduce the bias that is considered to be a danger in qualitative research. In addition, a hybrid approach, comprising thematic analysis and cross-case analysis, was adopted to analyse the collected empirical data. Moving from the theoretical to the empirical stage, an empirical research strategy framework was also developed, as shown in Figure 5.2, because of the complexity of the social setting under investigation. This consisted of three stages: the research design, the data collection and the data analysis. The research design was the first part of the empirical research strategy and developed an understanding of the research area under investigation. This led to a specific research area and ultimately identified the research needs, issues and an appropriate methodology. The research design was processed into a protocol, an instrument that acts as an action plan for an empirical line of inquiry. The data analysis stage, which followed the six-step guidelines developed by Braun and Clarke (2006), systematically tells the complex story that emerged from the qualitative data.

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Chapter Six: Conceptual Model of the Research

6.1 Introduction

The chapter aims to identify and analyse, throughout the related literature, those critical factors, which can be mapped into the proposed model, influencing the adoption of HIT related standards at the decision-making stage in healthcare organisations. In doing so, the chapter begins with a discussion related to the lifecycle stages of the adoption process in organisations. This is to give an understanding of the stages of the adoption process and to define and describe the sequences of phases in the pre-adoption stage of which decision making is a part. Then, the chapter reviews the adoption process in an organisational context, highlighting the main issues that can be jointly explained by the three dimensions, innovation, and the organisational and environmental contexts. This leads to the development of the researchers' conceptual model of the adoption process of HIT related standards at the decision-making stage in healthcare organisations. Based on this model, an in-depth review of the literature is then carried out to analyse the critical factors in order to identify and link them to the corresponding dimensions of the TOE framework. However, given the lack of literature surrounding HIT related standards, the literature review focuses on two main subjects. The IT related standards and the area that is related to the adoption of medical technology for integration purposes since both subjects have a similar background to the adoption of HIT related standards. The chapter concludes with a summary which gives an overview of the main issues discussed in this chapter.

6.2 Lifecycle Stages of the Adoption Process at an Organisational Level

Rogers (1995) explained that the decision-making process is a temporal sequence of phases. It begins when the initial knowledge of an innovation is formed, moves to the development of certain attitudes towards the innovation, then to a decision either to adopt or reject the innovation, starting to use the innovation, and eventually seeking reinforcement of the adoption decision. Gallivan (2001) ascertained that an organisational adoption process is divided into two main phases: the primary and secondary adoption and assimilation stages. According to Gallivan (2001), and as shown in Figure 6.1, the primary IT adoption phase refers to the decision-making to adopt or reject the innovation technology; this might occur at

different levels in an organisation, such as at the corporate, divisional or departmental level. The secondary IT adoption and assimilation phase refers to specific decision-making on the part of individuals or departments with regard to the adoption of the innovation technology that has been agreed to be adopted by the organisation. However, in this phase, the concern is not whether an individual adopts the innovation but rather when and how he/she adopts it, through what experiences, what barriers are encountered, and how these issues impact on organisational assimilation and outcomes. Therefore, while secondary adoption refers to events at an individual level, the assimilation stage describes how deeply the innovation penetrates the adopting unit as a whole (e.g., the company, division or workgroup). According to Gallivan (2001), when the organisation's authorities make the decision to adopt an innovation technology which fits in with their objective to change some aspect of their business, they may proceed by three different paths to ensure secondary adoption. First, they can mandate the innovation throughout the organisation at once. Secondly, they might allow individuals to diffuse the innovation voluntarily whilst providing them with the necessary resources and support. Thirdly, they might launch a pilot project in order to observe the processes and outcomes that unfold in order to decide when they implement the innovation more broadly.

Similarly, Kamal (2006) defined two main phases in the adoption process of IT innovation in organisations, the pre-adoption and the post-adoption phases. According to Kamal (2006), the pre-adoption phase is the actual decision-making stage in an organisation in which it decides to adopt a specific technology. The post-adoption phase deals with the activities and events following the adoption decision, and its target concern is the continuous usage of the innovation. Kamal (2006), as shown in Figure 6.2, describes the pre-adoption stage as a sequence of four phases. The motivation phase refers to the organisation's awareness of the adoption of a specific innovation. This leads the organisation to acquire some information and knowledge about the innovation in order to motivate the organisation in ascertaining an attitude towards its adoption. The conception phase describes a plan of actions that need to be undertaken by the organisation to pursue the adoption of the innovation. This leads a number of organisational members to create an attitude towards the innovation adoption. The proposal phase describes the formal proposition that is made to the rest of the organisation regarding the adoption of the innovation. The formal proposition is considered to be crucial in making the innovation adoption decision and therefore, substantiated reasons for approval from the organisation at this stage should be provided to the rest of the organisation. In

90

addition, the decision makers need to analyse and assess the organisational requirements and capabilities for acquiring a specific technology. The last phase of the pre-adoption stage is the adoption decision, which is the actual stage where organisations take the decision to adopt a specific technology. In the light of the post-adoption stage, Kamal (2006) proposed four essential steps. These are the confirmation of the innovation idea, users' acceptance of the technology, the actual use of the innovative technology within the organisation, and integrating innovative technology within the IT infrastructure in an organisation.

However, since most of the adoption models of innovation in an organisational setting describe mainly two stages in the adoption process, namely the pre-adoption (primary adoption) stage and the post-adoption (secondary adoption) stage, the researcher considers these stages to be applicable to the investigation of the adoption process of HIT related standards in healthcare organisations. In the context of this research, the pre-adoption stage is the actual decision taken by those in authority in healthcare organisations to adopt or reject HIT related standards. The post-adoption stage refers to the decision-making of individuals or departments regarding the application of the innovation that their organisation has decided to adopt, and the target behaviour is the continuous usage of this system for the benefit of the organisation. Given that the actual focus of this research is on the pre-adoption and decision-making stage of the adoption process of HIT related standards, and the need to simplify the pre-adoption stage by dividing it into a sequence of phases, the taxonomy of the IT innovation adoption process devised by Kamal (2006) is therefore applied in this research. The taxonomy of Kamal (2006) seems to be applicable since it was built after an extensive review of related studies. Therefore, the pre-adoption stage is further divided into four phases, motivation, conception, proposal and decision making, as discussed earlier.
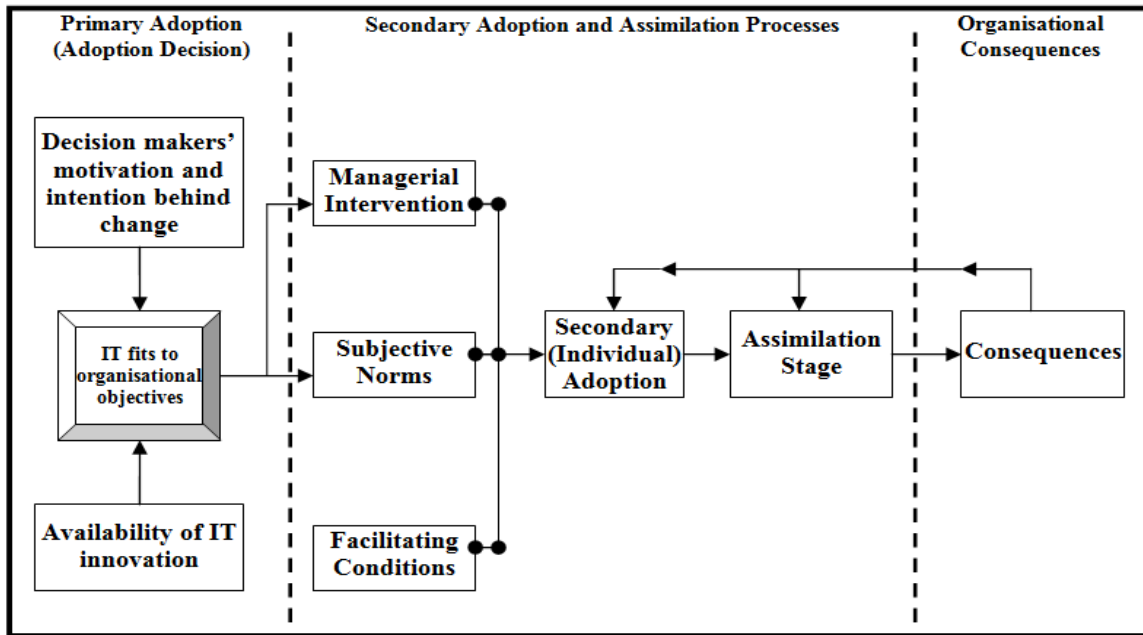
Figure 6.1: Innovation adoption stages at the organisational level (Gallivan 2001, p. 60).
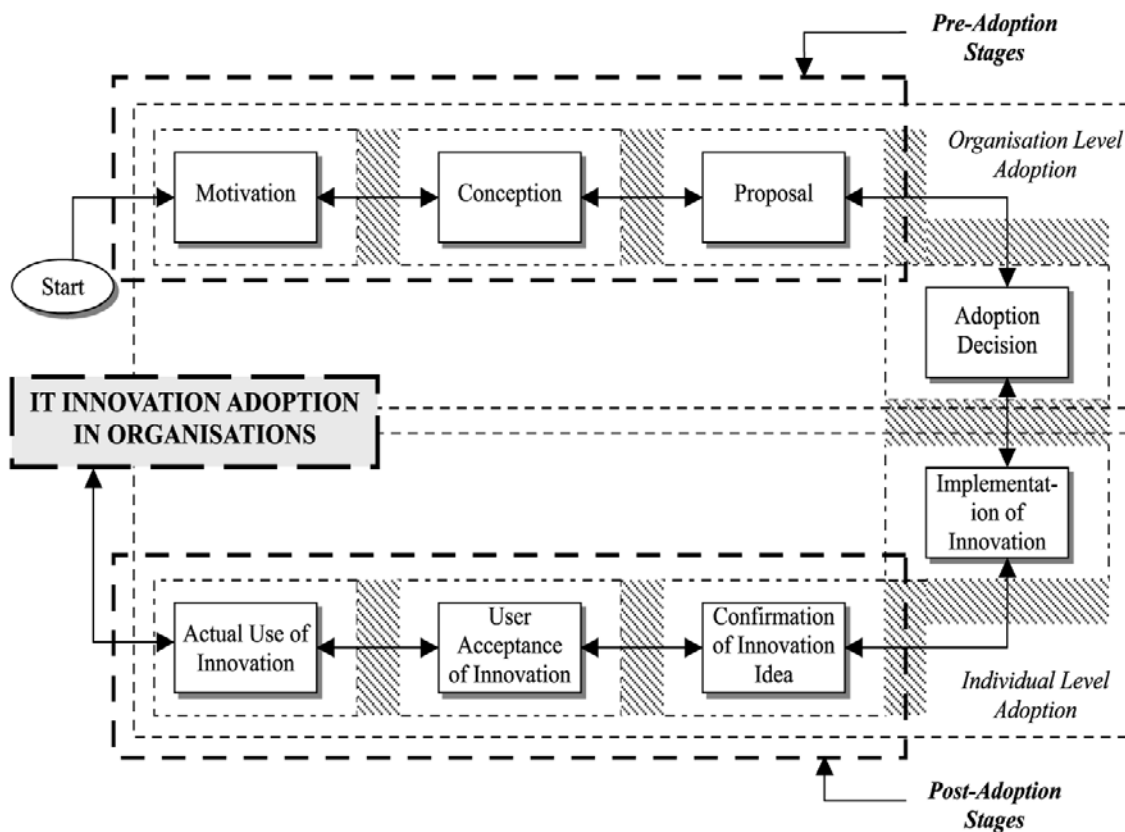
Figure 6.2: Taxonomy of the IT innovation adoption process (Kamal 2006, p. 200).

6.3 The Adoption Process in an Organisational Context

West (1999), in his study, "Organisational Decisions for IT Standards Adoption: Antecedents and Consequences", explained that previous studies concerning innovation adoption focused on a single innovation and who adopts that innovation; this is termed an "innovation-centric" approach. West (1999) argued that this approach tends to have a pro-adoption bias with late adopters. However, this bias was seen to be weaker concerning the adoption of innovation technology at an organisational level due to that organisations demonstrate a bias towards the ability to adopt any innovation rather than any particular innovation (West 1999). In order, thus, to reduce the expected level of bias, a balanced analysis of the factors affecting the adoption process of innovation should be undertaken through the application of another approach termed "adopter-centric". This approach focuses on a single adopter (e.g. usually at a corporate, divisional or department level) and the innovations it adopts (Thomas 2006). In other words, the innovation-centric approach focuses on the adoption of HIT related standards from general perspectives (e.g. the characteristics of the innovation and the general characteristics of the organisation) while the adopter-centric approach examines the adoption within organisations from, in particular, a decision-making perspective.

However, West (2004) argued it is difficult for the adoption process of IT related standards in an organisation to be grasped by a single person's cognitive power or within the discretionary authority. Chen (2003), when looking at the adoption of XML and Web services, developed a model, as shown in Figure 6.3, which encompasses three factors affecting the decision-making process. These factors are stakeholders, organisational factors and the characteristics of the IT standards. However, West (2004) went on to contend that a more robust and influential framework for understanding technology adoption in an organisational context was developed by DePietro *et al.* (1990, pp. 151-175). They defined a context for change model that consists of three factors namely, the technology, the organisation and the environment. Thus, according to West (2004), these dimensions should be considered during the investigation of the primary adoption decision. In addition, West (2004) posited that the three factors interact with each other and influence the technology adoption decisions.
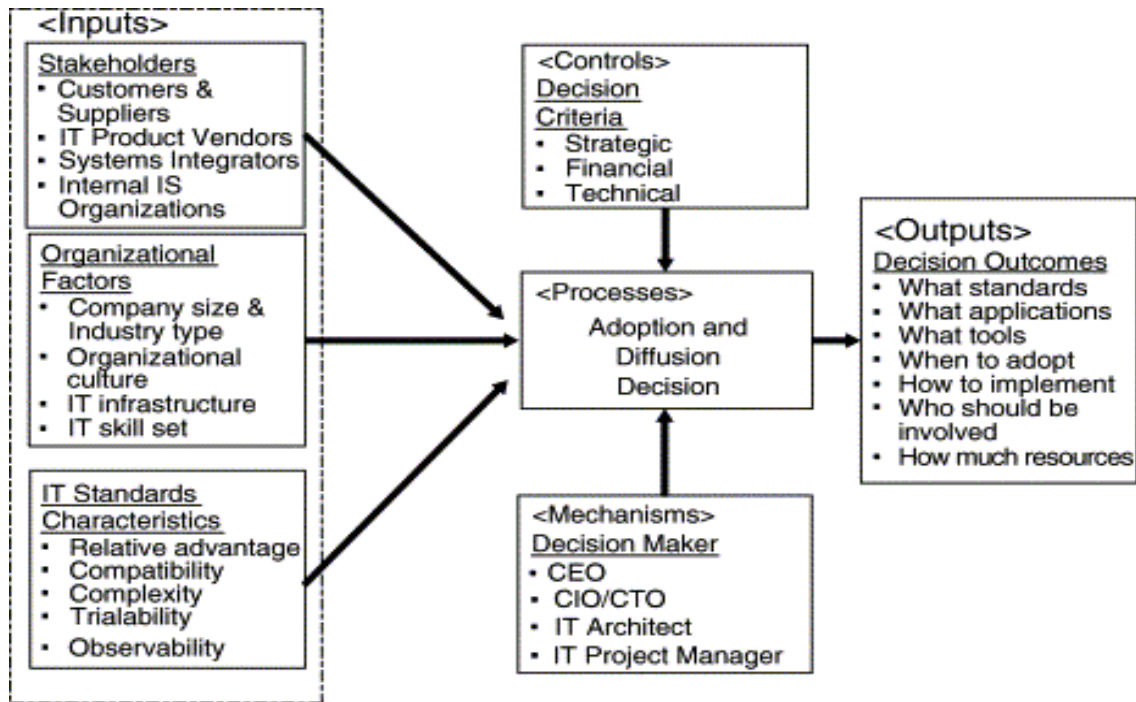
Figure 6.3: XML and web services adoption and diffusion model (Chen 2003, p. 270).

In addition, Nelson and Shaw (2003), in their study of 21 models for the adoption of inter-organisational standards, confirmed the assertion made by West (2004). They highlighted that the most common set of constructs utilised in the study of inter-organisational standards' adoption is the 'organisational – technology – environmental' set, often referred to as 'TOE'. This assertion by West (2004), and Nelson and Shaw (2003), was also consistent with the model created by Tornatzky and Fleischer (1990, pp. 152-154) who described three factors influencing the adoption of an innovation technology namely, the technological context, the organisational context and the external environment. Thomas (2006) developed a new IT related standards' adoption process model, as shown in Figure 6.4, which is based on Chen's model (2003). This new model integrated the TOE framework into Chen's model (2003) and abandoned the 'stakeholder' input variable whilst the control and mechanism aspects remained.
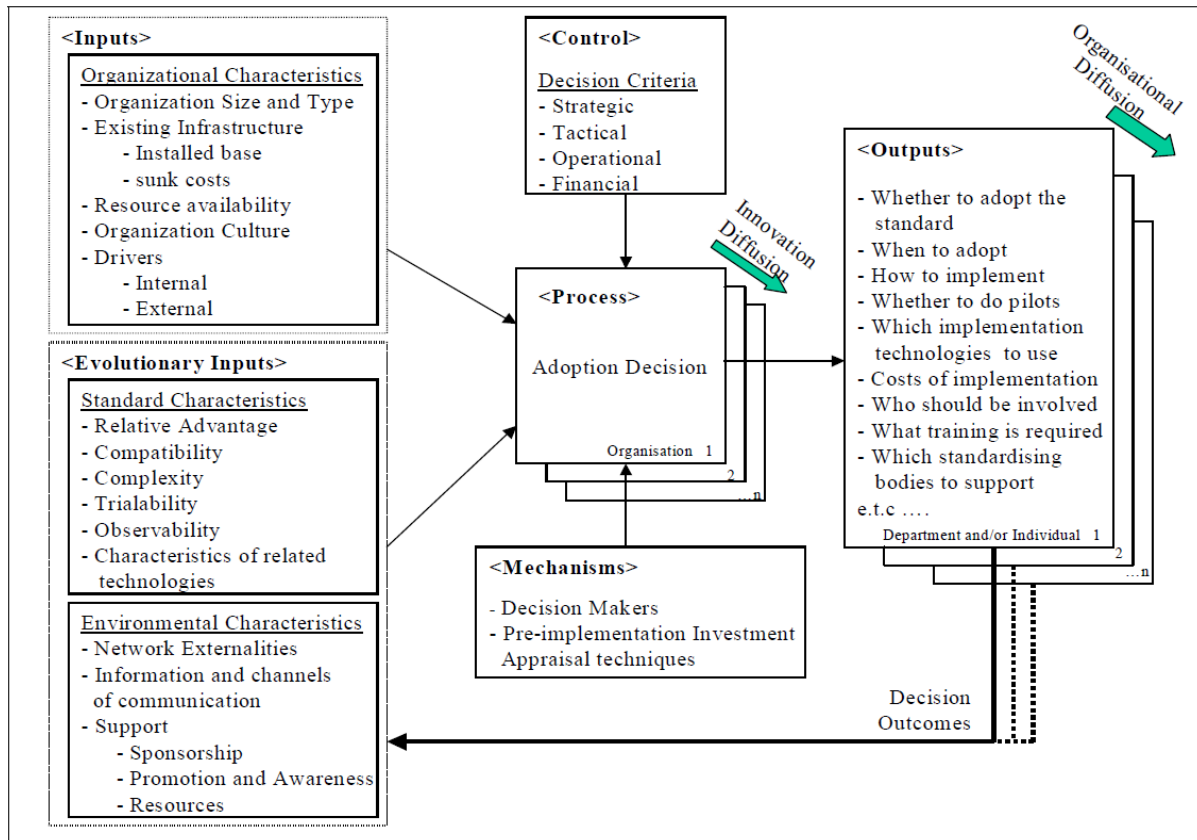
Figure 6.4: IT related standards' adoption process model at the organisational level (Thomas 2006, p. 54)

Decision control refers to the constraints or controls on the adoption activities, while the mechanisms describe the ways that those activities are carried out in an organisation (Whitman *et al.* 1997). Decision control is based on criteria that vary among organisations. For example, Irani *et al.* (1997) argued that an organisation will make a decision based on strategic, tactical, financial or operational criteria. Themistocleous (2004), and Shang and Seddon (2002) asserted that an organisation makes a decision to adopt an innovation based on promising benefits that are categorised into five major areas. These are operational, technical, strategic, managerial and organisational. Nevertheless, the adoption of particular standards in some cases is mandated and therefore an organisation has no option but to adopt those standards; this reduces the importance of the different decision criteria (Thomas 2006). Thus, the decision criteria construct applied in Chen's model (2003) and Thomas's model (2006) can be defined as the problems faced by the healthcare organisations and the thinking that led the authorities (e.g. senior, IT and information managers) to adopt such health data standards because their benefits would contribute to resolving these problems.

6.4 Conceptual Model of the Research

Fichman and Kemerer (1994) argued that it seems that no single, strongly predictive theory of innovation adoption is likely to emerge since the variety of potential scenarios for the adoption of innovation is so great. The researcher studying the adoption of an innovation technology should, rather than focusing on a single theory, focus on the innovation itself and the context in which the innovation is applied. This study has followed this strategy and the context which the researcher chose to focus on is the decision-making stage of the adoption process of HIT related standards by healthcare organisations. In addition, Arthur (1988, pp. 590-607) explained that IT related standards compete for adopters in a way similar to other innovations and technologies, and so the same basic factors that influence the adoption of innovations can also be used to study standards. The researcher developed a model, as presented in Figure 6.5, to act as the basis of this study. Since the focus of this research is on the pre-adoption process, the sequence of phases in the pre-adoption stage in Kamal's taxonomy (2006) was used as explained in section 6.2. These phases are motivation towards the innovation, gaining a specific conception about the innovation, making a formal proposal to the rest of the organisation about the adoption of the innovation, and the actual adoption decision stage.

Moreover, the factors influencing the adoption process of HIT related standards at the decision-making stage in healthcare organisations were studied and then identified based on the three dimensions, the innovation's context, the organisational context and the external environment, as explained in section 6.3. The innovation context essentially describes the existing health data standards and can be depicted, in part, by its important attributes such those described by Rogers (1995). The organisational context refers to descriptive measures (e.g. scope, size and structure) concerning the organisation which is adopting the health data standards and general organisational issues related to health data standards facing the decision makers in an organisation. However, the adoption decision taken by the organisation's authorities will generally be based on criteria categorised into operational, technical, strategic, managerial and organisational aspects as explained in section 6.3. The environmental context defines the external world in which an organisation operates and how the external environment facilitates or impedes the adoption of health data standards in healthcare organisations. Furthermore, the conceptual model is based on the predominant

96

theories in the study of IT related standards, mainly the DOI theory and the theory surrounding the economics of standards, as discussed earlier in Chapter Four.

Pre-Adoption Stages

Motivation Stage → Conception Stage → Proposal Stage → Decision Stage

Adopt OR Reject

These are the pre-adoption stages described by Kamal (2006) and explained in Section 6.2.

Organisational Characteristics

Control
Decision Criteria
Operational
Technical
Strategic
Managerial
Organisational

Mechanisms
Decision Makers
Seniors
IT Managers
Info Managers

Diffusion of Innovation (DOI)
&
Economics of Standards

Predominate IT related standards theories explained in Chapter Four.

Standards Characteristics

Environmental Characteristics

- The rectangle's angles reflect the TOE framework developed by Tornatzky and Fleischer (1990, pp. 152-154) and explained in Section 6.3.
- Decision control refers to the constraints or controls on the adoption activities which are based on five criteria, as explained in Section 6.3.
- Mechanisms describe the ways that the adoption activities are carried out by such mangers and seniors in an organisation

Figure 6.5: The Adoption Process Model of HIT related Standards at the Decision-Making Stage in Healthcare Organisations, developed by the researcher.

6.5 Analysing the Factors Influencing the Adoption of HIT related Standards based on the Conceptual Model

Due to the limitation of the literature concerning studies on the adoption of HIT related standards, the author investigated the literature related to the adoption of IT related standards and areas that are related to the adoption of medical technology for integration purposes since both subjects have a similar background to the adoption of HIT related standards. Thus, the literature was carefully reviewed and the final factors influencing the adoption of HIT related standards at the decision-making stage in healthcare organisations were then chronicled. The researcher attempted to examine more closely their importance in influencing the adoption process at the decision-making stage in the healthcare organisations and has tried to link those factors to the corresponding category.

6.5.1 Technological Factors

The technological factors are based on the five generic innovation attributes recognised by Rogers's model (1995), switching cost theory, which is related to the economics perspective of the standards, and other factors which were found to be supported by a large number of related studies.

6.5.1.1 Relative Advantages

The relative advantage factor is defined in this research as the degree to which HIT related standards have clear benefits over others in meeting the existing functionality requirements. Many benefits will result from the integration of an HIT infrastructure, for example, the satisfaction of stakeholders, such as patients and physicians, will increase since the availability of patient information at any place or time brings improvements in the interactions between physicians and patients. However, Khoumbati *et al.* (2006), using the modification made to the model by Shang and Seddon (2002), classified the benefits of the enterprise integration application adopted by healthcare organisations and grouped these benefits into five categories, operational (e.g. it reduces costs); technical (e.g. it results in flexible infrastructures); strategic (e.g. it increases stakeholder satisfaction); managerial (e.g. it increases performance); and organisational (e.g. it allows organisations to do business more effectively).

6.5.1.2 Compatibility

This factor refers to the degree to which HIT related standards are consistent with the experiences, resources, practices, values, skills and the IT infrastructure of potential adopters. The compatibility of the new standards with the existing organisational technical infrastructure and culture is an important factor in accelerating the acquisition of standards amongst healthcare organisations (Fichman 2004). For example, the studies by Wu (2004) and Chen (2003) found the lack of compatibility of web service technologies with the existing IT infrastructure to be one of the main barriers to adoption. Premkumar and Ramamurthy (1995) explained that the incompatibility of new systems with the existing work culture and procedures might increase the likelihood of the new system being rejected.

6.5.1.3 Complexity

Within this research, complexity is described as the ease with which HIT related standards are understood, implemented and used. Previous studies have explained that the complexity of the standardisation process concerning health data has resulted in, not only the slow development of health data standards, but has also led users and vendors not to implement certain standards whilst waiting for the situation to resolve itself (Jenders 2007). For instance, clinical information itself is a wide ranging, complex area and the SNOMED Clinical Terms Coding System alone describes more than 350,000 clinical concepts; moreover, there are many other different coding systems (Eichelberg *et al.* 2005).

6.5.1.4 Trialability

This factor describes the degree to which HIT related standards are experimented with by healthcare organisations on a limited basis. According to Thomas *et al.* (2008), there is a positive correlation between the adoption and the evaluation processes of the new IT related standards. The more pilots, demonstrations and seminars that were undertaken by an organisation with regard to the new system, the more chance there was that the new system would be adopted. This is also because there appears to be confusion in the market concerning health data standards and so, using a range of different evaluation methods enables the organisation to explore, before the adoption, the benefits that could be achieved from using such standards. This finding was also confirmed by Mykkanen and Tuomainen (2008) who argued that an evaluation of interoperability standards is necessary when there is

100

a need to demonstrate the usefulness of existing models or to find an open solution with regard to the development of applications and integration projects. In addition, Byrne and Golder (2002) ascertained that standards' development organisations should have an example installation which can be used to guide possible users and vendors, thus helping to circulate the standards amongst a potential community of adopters.

6.5.1.5 Observability

This factor correlates to the degree to which the benefits or attributes of HIT related standards can be observed, imagined or described by the community of potential adopters. According to Nilakanta and Scamell (1990), and Arthur (1988, pp. 590-607), effective communication channels and general industry knowledge can encourage the adoption of an innovation. Thomas *et al.* (2008) indicated that the lack of related information with regard to new standards might hinder the diffusion of the standards amongst potential adopters. A general flow of information is necessary for creating positive expectations (Thomas *et al.* 2008).

6.5.1.6 Switching Cost

Organisations are usually hesitant to adopt new standards owing to the likelihood that the cost of converting will be greater than the perceived benefits (Hovav *et al.* 2004). Therefore, many organisations conduct a cost–benefit analysis, covering both development and implementation costs, before adopting an innovation technology (Themistocleous 2004). This is because, for example, the new standard might create a high degree of drag, because of unfamiliarity in terms of the existing resources and skills in an organisation with the new standard. According to Hovav *et al.* (2004), high drag cost may require a high investment; this could be expected to limit the attractiveness of the new standard to the community of potential adopters. Another factor which can lead to a lower level of proliferation of the new standard is the perception of there being a high sunk cost since organisations have invested in their current infrastructure and so will be very reluctant to discard an amount of capital and equipment as a result of the requirements of adopting the new standard (Hovav *et al.* 2004).

6.5.1.7 Language

Zhang *et al.* (2007), in their study investigating the standardisation of health data in China, indicated that the language of the standards was seen as problematic in terms of the

development of standardisation processes for health data. This is because Chinese is the official language of the medical community there.

6.5.1.8 Systems Integration

The aim of achieving standardisation in health data in every nation is to achieve a comprehensive and integrated national health information infrastructure (Zhang *et al.* 2007). Luic and Striber-Devaja (2006) and Spyrou *et al.* (2002) state that health data standards are essential in the healthcare environment to make the sharing of medical data among others technically feasible. Spooner and Classen (2009), Jenders (2007), and Hammond (2005) emphasise that health data standards are the critical foundation for creating and aggregating a patient-centric EHR system, building national health information networks, interchanging data among independent sites, and creating a population database for health surveillance.

6.5.1.9 Market Uncertainties

There appears to be market confusion surrounding HIT related standards today. This is, as discussed in Chapter 1, due to two main reasons. The first reason is the lack of serious international efforts to consolidate and harmonise the development of such standards. The second reason concerns the increasing proprietary interests amongst the vendors of HIT applications because of reasons to do with market competition (Hammond 2005). Consequently, a wide range of multiple, overlapping and conflicting health data standards are available today on both domain-specific and domain-neutral levels. This, in turn, hampers market transparency and leads to a confused situation amongst the potential adopters to know the standards to which they should pay attention, the ones they should embrace, and those which they should adopt (Chheda 2007; Jenders 2007; Hammond 2005).

6.5.2 Organisational Factors

The innovativeness of an organisation is defined as the degree to which an individual or organisation is relatively early in adopting new ideas compared to other members of a social system (Rogers 1995, pp. 22). The adopter category noted by Rogers (1995, pp. 267-297) explains a classification scheme that shows where a user stands in relation to other users in terms of time. This classification scheme involves five groups of adopters, innovators, early adopters, early majority adopters, late majority adopters, and the laggards. The innovators'

group is venturesome, educated and willing to tolerate initial risks to devise swift solutions for solving problems. The early adopters tend to be visionaries and are more willing to take a risk with the new innovation. The early majority adopters tend to avoid the risks but are willing to adopt a new innovation once the early adopters have demonstrated the innovation's benefits. Although the late majority adopters are seen to be more sceptical, they will be influenced once others have adopted the innovation. The laggards tend not to believe the benefits of the new innovation and are likely to block the adoption of it. The laggards tend to lack the resources or business insight to adopt the new innovation. They will adopt the new innovation when they have no choice. Therefore, a lack of attention to the extent to which a technology innovation will affect and be affected by the organisation lies at the core of many adoption failures (Pirnejad *et al.* 2008). Thus, the literature has exposed many factors surrounding the innovativeness of an organisation that might influence the adoption of HIT related standards.

6.5.2.1 Organisational Size

The size of an organisation may influence the adoption decision process of HIT related standards and there are several characteristics that might to be said to reflect the size of a healthcare organisation. According to Khoumbati *et al.* (2006), various measures are used to represent the size of a hospital, such as the number of beds, its total assets, and the number of personnel. However, Kimberly and Evanisko (1981) stated that the dominant measure being used in hospital research as the operational definition of the size of a hospital and the one that influences the adoption of technological innovations, is the number of beds. The organisation's size was seen by the majority of the previous related studies as an important factor. This is because large organisations are rich in terms of the essential resources (e.g. financial and/or human) required to invest in the implementation of an innovation (Fichman 2004; Thong & Yap 1995). In addition, large organisations have been seen as traditionally strong supporters of standardisation efforts because of the distributed nature of their organisational systems (Chen 2003).

6.5.2.2 Organisational Culture

Prior studies have shown that organisations with a culture of success in terms of technology innovation adoption are more likely to be innovators. This is because the outcomes of the decisions, over time, have a positive evolutionary impact on the attributes of the standard.

103

This outcome, of knowledge gathered from past adoption appraisal, might highlight the benefits of the next standards (Thomas, 2006). However, organisations which have extensive experience of failure regarding the adoption of beneficial innovations will become less well adapted and may become laggards to innovation (Fichman 2004). In addition, the attitude of top managers towards technology, especially when they have positive knowledge or experience and understand the advantages brought by such technology, will influence the adoption decision regarding an innovation technology (Thong & Yap 1995). For example, one benefit of HIT related standards is the ability of different authorised users to share patients' information; thus, the willingness of an organisation to exchange data with others depends on the willingness of an organisation's top management. Moreover, the staff's attitude (e.g. their opinions and beliefs) towards change and standards are the second issue relating to organisational culture. For example, the common attitudes and perceptions are that the adoption of standards will restrict users' privileges, change work processes and procedures, reduce work flexibility, and/or monitor the users' productivity when the systems are integrated (Thomas *et al.* 2008).

6.5.2.3 Organisational Structure

Davidson and Chismar (1999) argued that the degree of centralisation and formalisation within an organisational structure might have a direct impact on the development of information systems in hospitals. Kamal (2006) explained that the adoption process of an innovation technology requires some significant upheavals in the organisation's structure and these often meet with some resistance. Therefore, the successful adoption requires various changes to be made to the organisational structure, such as adjustments to reward schemes, changes in authority or responsibility patterns, or the shifting of power centres (Kamal 2006). Wapakabulo *et al.* (2005) argued that the delays in the adoption of an IT project that often occur are frequently because of the changes that have to be made to the organisation's structures so that they will fit in with the new system. In addition, Khoumbati *et al.* (2006) explained that there is always a need for adjustments to be made to the organisational structure to keep the close relationship between administrators and physicians in the healthcare industry because of the autonomous role of physicians. This was also confirmed by Pare and Trudelb (2007) who indicated that, within a hospital structure, physicians exercise a significant amount of control; this can have a negative impact on the allocation of resources to the new innovation technology. Therefore, conflict between administrators and

Abdullah Ibrahim Alkraiji 2011

physicians regarding their responsibilities during the implementation of an IT project may result in political barriers which will, in turn, reduce the likelihood of the new technology being a success. Good relationships between administrators and physicians are considered as most beneficial in achieving the long-term goals and objectives in a healthcare organisation's development (Khoumbati *et al.* 2006).

6.5.2.4 Organisational Support

Many organisational activities are needed during the adoption of an innovation technology. For example, prior research has shown that the support of top management is a key factor that can, positively or negatively, affect the adoption of IT projects (Karsh & Holden 2007, pp. 393-410; Pare & Trudelb 2007; Chang *et al.* 2006; Doebbeling *et al.* 2006; Li *et al.* 2005). This is because the success of the adoption of an innovation technology in an organisation depends on how strongly the strategy for innovative technology adoption is designed. This in turn, must be supported by the top management in order for it to be a success in carrying out the necessary activities and tasks (Thong & Yap 1995). Therefore, the interest, supportive attitude, knowledge and experience of the top management with regard to innovation technology are major concerns in every adoption of an innovation technology. The greater the support of top management, the easier it is for organisations to overcome the obstacles encountered in the adoption process (Li *et al.* 2005). Other forms of support, such as technical support and the training sessions available to users once the technology is in their hands, as well as the allocation of the required resources, are also important during the adoption process (Pare & Trudelb 2007). For example, training sessions provide stakeholders with the skills and confidence they need to address their concerns, which might result otherwise in an inadequate utilisation of the new system.

6.5.2.5 Organisational Change

The adoption of innovation technology not only requires significant resources and investment by the healthcare organisation, it also requires many levels of interaction among personnel, management and the system; this generally represents major organisational change because the efforts required for social engineering during the adoption represent the highest percentage of risk of the system failing compared to technical aspects (Doebbeling *et al.* 2006). A crucial step for the organisation in the adoption process is to assess its readiness for major organisational change (e.g. training, leadership, commitment, individual engagement

105

and trust, culture, politics, bureaucracy and professional ethics) (Stablein *et al.* 2003). Therefore, building organisational support for change is considered one of the main factors in enhancing the success of the adoption of an innovation technology in healthcare organisations.

6.5.2.6 HIT Infrastructure

HIT infrastructure refers to the part of the organisation's infrastructure which forms a platform for the IT applications (Khoumbati *et al.* 2006). Several studies have reported the IT infrastructure as an important factor in innovation technology adoption models. For example, Iacovou *et al.* (1995) referred to IT infrastructures when they described organisational readiness for the adoption of EDI technology. According to Khoumbati *et al.* (2006), organisational readiness refers to the level of sophistication of IT usage and IT management in the organisation. Thomas (2006) explained that an amount of capital and equipment already existing in the organisation may have to be abandoned as a requirement for the new standard, this can present an obstacle. Another issue is the compatibility and/or conflict of the new standards with the existing IT infrastructure, which may also be a significant hurdle that has to be overcome (Nelson & Shaw 2003). For example, Chen (2003) explained that a standardised IT infrastructure allows an organisation to adopt systems which are independent of any specific vendors and technologies.

6.5.2.7 Clinicians' Engagement

The successful implementation of HIT applications depends upon the utilisation of those applications by the key stakeholders (e.g. nurses, physicians, radiologists and pharmacists) in healthcare organisations (Doebbeling *et al.* 2006). According to Khoumbati *et al.* (2006), the low rate of adoption of these integration technologies in healthcare organisations is due to the lack of willingness and awareness amongst physicians of the benefits of medical data exchange. Therefore, education programmes are required to overcome this barrier. In addition, Thomas *et al.* (2008) concluded that it is crucial to engage the users of the standards in the development process if these standards are to be widely adopted. This was also confirmed by Hammond (2005) who asserted that the engagement of clinical expertise into the process of developing standards is vital in making continuous progress in the development of such standards. This is because clinical experts create scenarios for the

content of the standards, giving them actors, roles and interactions through which the required data structures and data exchanges are predefined and derived.

6.5.2.8 Professional Availability

Themistocleous (2004) explained that IT sophistication refers to the technical expertise and the level of understanding in addressing technical problems associated with the technologies in the organisations. Khoumbati *et al.* (2006) advocated that the availability of professionals, with regard to technical aspects, is an essential attribute to the success of the adoption of enterprise application integration in healthcare organisations. For example, Chwelos *et al.* (2001) concluded that organisations with sophisticated IT resources are more likely to be early adopters of EDI technology. In addition, Lorence and Churchill (2005) clarified that non-uniformity between hospitals, with regard to the adoption of information security, is the result of a lack of local expertise; this was also supported by Doebbeling *et al.* (2006) Moreover, Pare and Trudelb (2007) found that a lack of technical expertise in a hospital can pose serious problems in the adoption phases of a PACS system. Furthermore, Fichman (2004) found that the majority of the studies concerning innovation technology adoption concluded that organisations with the "Right Stuff" (i.e., greater innovation-related needs and abilities) exhibited a greater level of innovation (i.e., greater frequency, earliness, or extent of adoption).

6.5.3 Environmental Factors

The environmental conditions in which an organisation operates are considered as important factors to be taken into account whilst studying the adoption of IT related standards (Thomas *et al.* 2008). One of the most common theories in this regard concerns network externalities. However, the literature explained several other factors that were highlighted by previous studies; these can be grouped into environmental factors, as described in the sections below.

6.5.3.1 Government Policy and Strategic Planning

Hovav *et al.* (2004) argued that the standards development organisations can only develop, promote, maintain and recommend standards; they cannot mandate their adoption by vendors and users. Therefore, practical guidance is needed to help healthcare organisations make sense of the proliferation of health data standards and to choose wisely when evaluating or

purchasing HIT applications that incorporate these standards. As a result, there is a need for an agreed national strategic direction regarding health data standards and specifications in order for healthcare authorities to maximise interoperability across the health sector and to lessen the risks associated with the implementation of specific standards. The existence of a government policy and strategic plan is an important factor in supporting interoperability between HIT applications; it is also essential in facilitating the acquisition of HIT applications that incorporate such standards (Zhang *et al.* 2007; Halamka *et al.* 2005; Hammond 2005).

6.5.3.2 External Pressures

Khoumbati *et al.* (2006) explained that there are several stakeholders in the context of healthcare organisations, such as suppliers and government bodies, who collaborate with the healthcare providers for the adoption of technologies. Therefore, healthcare providers look for new practices in order to better coordinate cross-enterprise business processes, with stakeholders for example. Previous researchers have revealed that environmental pressure is a primary factor driving organisations to adopt EDI technology. For example, a study by Kuan and Chau (2001) explained that organisations in Hong Kong were under pressure from the government to adopt EDI technology in order to end the manual submission of paper declarations. In addition, Kimberly and Evanisko (1981) reported that organisations look to the adoption of innovative technology when facing intense competition from other industries. This was also supported by Kuan and Chau (2001) when they argued that although organisational considerations are characterised by the promotion of governments, they are also subject to pressure from within the industry.

6.5.3.3 Network Externalities

This is one of the main theories used within the stream of economics perspectives of standards and refers to the benefits created through the adoption of new standards by other organisations in the community (Hovav *et al.* 2004). According to Wapakabulo *et al.* (2005), the more people who adopt a particular standard, the value of that standard increases and therefore additional adopters are encouraged. The value of the standards is increased because of the reduction in the cost of the support (due to economies of scale) and the increase in potential synergies through the facilitation of interactions among adopters. Therefore, it is

often the case that the barriers to the adoption of the standards are lowered as more organisations adopt them (Hovav *et al.* 2004).

6.5.3.4 External Support

This describes the forms of promotion and awareness-raising; it is also related to vendor support, consultant support and government support. The need for external support has been justified for several reasons, such as the complexity of health data standards, the limited knowledge amongst healthcare organisations with regard to the adoption and implementation of such standards, and the lack of employees with relevant expertise. Therefore, healthcare organisations seek outside support or external consultants to overcome these problems. External support was recognised as an essential factor affecting the adoption process by several related previous studies such as those of Zhang *et al.* (2007), Hammond (2005) and Hu *et al.* (2000).

6.5.4 Final Picture of the Conceptual Model

After carrying out an in-depth review of the literature, the conceptual model was modified, as presented in Figure 6.5. This modification involved including the twenty one factors identified in Sections 6.5.1, 6.5.2 and 6.5.3 to the appropriate category of the TOE framework in the conceptual model. Figure 6.6 presents a holistic view of the conceptual model of the critical factors influencing the adoption process of HIT related standards at the decision-making stage in healthcare organisations.
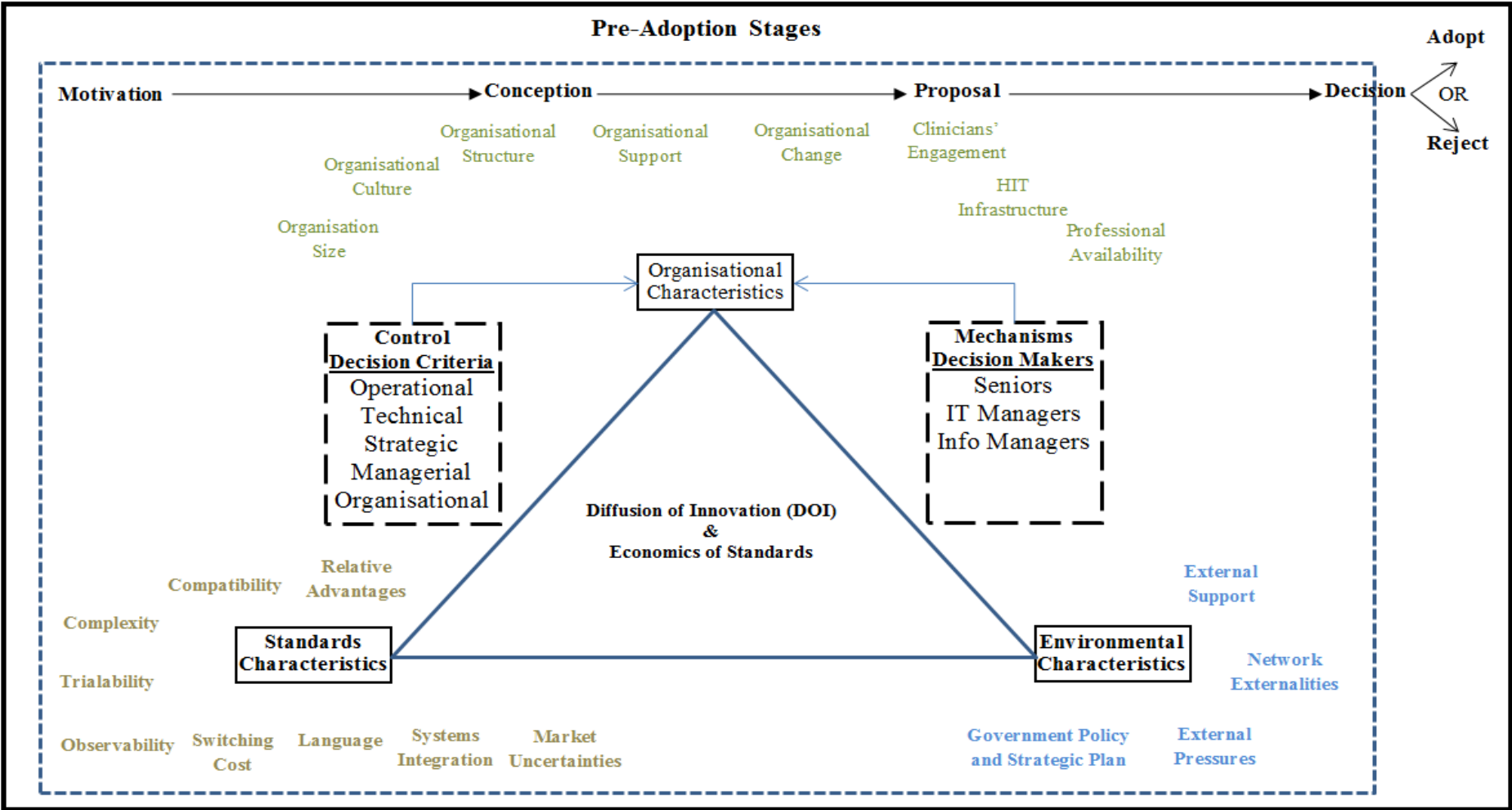
Figure 6.6: A Conceptual Model of Critical Factors Influencing the Adoption Process of HIT related Standards at the Decision-Making Stage in Healthcare Organisations, developed by the researcher.

6.6 Summary

The critical factors influencing the adoption of HIT related standards at the decision-making stage in healthcare organisations have been identified through an in-depth investigation of the literature surrounding two main subjects. The area that is related to the adoption of medical technology for integration purposes, and studies on IT related standards. The reason behind this was the lack of studies concerning the adoption processes for health data standards. As a result both disciplines were the starting points for this research. In order to identify these critical factors, the pre-adoption stage (a sequence of phases including motivation, conception, proposal and decision-making) has been carefully studied. In addition, the factors have been categorised according to the TOE framework, and analysed based on DOI theory and the theory surrounding the economics of standards. DOI theory is based on the five attributes of an innovation: relative advantage, compatibility, complexity, trialability and observability. In addition, two main theories have been used within the economic stream. The first related theory is the network effects theory which describes a positive correlation between the number of users of an innovation and the utility of the innovation. The second related theory is the switching cost and this refers to an innovation-specific investment that makes organisations hesitant to change to a supported innovation. Based on this discussion, a model of the adoption of HIT related standards at the decision-making stage in healthcare organisations has been developed, as presented in Figures 6.5 and 6.6, to direct and lead the discussion of the main issues surrounding the adoption of HIT related standards throughout the thesis. However, this model and the identified factors do not provide any guidance on the validity, relevance and priority of these factors. Therefore, further investigations are required to verify the model in order to understand its applicability.

Abdullah Ibrahim Alkraiji 2011

Chapter Seven: Data Analysis

7.1 Introduction

Chapter Four of this thesis identified the gap in the literature which requires further investigation regarding the adoption process of HIT related standards in healthcare organisations. In doing so, and based on an extensive review of previous literature, a conceptual model of the critical factors influencing the adoption process of HIT related standards at the decision-making stage in healthcare organisations was proposed in Chapter Six. The researcher examined the validity of the proposed conceptual model using an interpretative, exploratory multiple-case study approach, as justified in Chapter Five. Six healthcare organisations in Saudi Arabia were chosen to carry out this research. Multiple data collection methods, including unstructured interviews, semi-structured interviews and an analysis of the existing documentation, were employed by the researcher to collect the required data. The possibility of bias was reduced (an issue considered to be a danger in qualitative research) through data triangulation. The purpose of collecting these data was to examine the validity of the proposed model and this was achieved by evaluating the adoption process of HIT related standards in Saudi healthcare organisations. A hybrid approach of thematic and cross-case analysis was adopted to analyse the empirical data. This was because the researcher was seeking to identify perspectives in each case study that described human and organisational behaviour and perceptions during the adoption of HIT related standards, and then to discover what similarities and differences existed between the cases regarding such perspectives. For example, while some cases reported that they were not able to adopt ICD-10 AM because their HIS systems were very old and did not allow further modifications to be made, other cases explained that the HIS systems were bought from American vendors whose systems were still based on ICD-9 CM since this is the American national code for diseases and diagnoses. Accordingly, this enabled the researcher to identify three main themes, HIT infrastructure, standard compatibility, and support. Nonetheless, the analysis of the empirical data should not be seen as a comparison of the different cases. Instead, it allowed the findings to have a better grounding and also allowed the identification of other possible themes in developing a holistic and empirical model which might permit others to draw parallels to the research outcomes. This chapter commences by giving the background to each case. It then discusses the different types of health data standards being used by each healthcare organisation and the purposes for their adoption. Next, the chapter offers a detailed

112

presentation of those factors that enable or hinder the adoption of HIT related standards at the decision-making stage. The chapter concludes by presenting a summary of the main points raised.

7.2 Background to the Cases

The following sections present an overview and background to each case. This includes some general information and a brief description of the HIT infrastructures of each case. The background to each healthcare organisation had been formulated by the data from the interviewees, web sites and some other documentation.

7.2.1 Background to National Guard Health Affairs (NGHA)

NGHA aims at providing the highest quality healthcare to patients who include personnel of the Saudi Arabian National Guard (SANG), their dependants, and other eligible patients. In 2010, NGHA ran five hospitals and 60 clinics located in different regions of the Kingdom with a total number of 2650 beds, 2324 physicians and 4685 nurses. With regard to the hospitals, King Abdulaziz Medical City in Riyadh is the largest with approximately 900 beds. King Abdulaziz Medical City in Riyadh was opened in May 1983 and, since then, has been expanded in order to cover the rapidly growing patient population in all of its catchment areas. Today, King Abdulaziz Medical City in Riyadh is a centre of excellence and expertise; it has been internationally recognised as one of the leading healthcare centres due to its successful separation of conjoined twins. King Abdulaziz Medical City in Jeddah, which was founded in July 1982 with about 600 beds, is the second main and largest of NGHA's hospitals. While King Abdulaziz Medical City in Jeddah provides healthcare services for eligible patients and a population in the western region of the Kingdom, it also promotes an understanding of disease prevention amongst its population and is an important medical-based practice in the institutional, local, regional, national and international collegial community.

Imam Abdulrahman Al Faisal Hospital in Dammam was founded in 2002 with approximately 400 beds, while King Abdulaziz Hospital in Al Ahsa was founded in 2002 with about 400 beds. These are the leading hospitals in the eastern region of the Kingdom and they provide the SANG personnel and their eligible dependents in the eastern region of the Kingdom with the highest quality and continuity of primary, secondary and tertiary healthcare services. King

Abdullah Specialist Children's Hospital, founded in 2009, was the first specialised children's hospital in the Kingdom of Saudi Arabia. It is located in Riyadh and has a capacity of 350 beds which provide concentrated pediatric care. NGHA also provides excellent academic research and medical education while participating in industry and community service programmes in the health field. For example, King Abdulaziz Medical City in Riyadh has been the nucleus of Health Sciences for King Saud bin Abdulaziz University (KSAU-HS) and King Abdullah's International Medical Research Centre. KSAU-HS, founded in 2005, was the first university to specialise in health sciences in the Kingdom of Saudi Arabia and in the whole region. However, while KSAU-HS is a part of King Abdulaziz Medical City in Riyadh, it is supervised by the Ministry of Higher Education and governed by the regulations and statutes of the Higher Education Council. King Abdullah's International Medical Research Centre, founded in 2006, is a medical research centre which aims at providing a specialised scientific environment that supports clinical research; it offers excellent healthcare and promotes the continuous development of diagnostic approaches and methods of treatment, as well as the prevention of diseases. Due to the excellence and expertise of NGHA in terms of medical services, it has been accredited by several different types of regional and international institution as having an organisational commitment to improve the quality of medical services whilst ensuring a safe environment, and working continually to reduce risks to patients and staff while achieving the highest standards of care.

The IT department in NGHA is a corporate department which is responsible for all the IT departments in every hospital. The title of the IT department was changed so that it is now known as the Information Systems and Informatics Department; this reflects the interest of NGHA authorities in the subject of health informatics and also its positive impact on the quality of HIT applications in the hospitals. The Department was restructured to involve many people from different backgrounds, in particular medical people from a business background. The HIT infrastructure in NGHA has passed through different development eras. Before 2000, NGHA had no real system that spanned more than one department; each department had its own system which was developed in-house. Patient information, therefore, remained in a departmental stand-alone system that was never integrated with other systems; thus, information concerning patients was duplicated, scattered around numerous locations, and collected at different times by different people or information systems. At this time, therefore, the focus was on the information itself and on providing an integrated system. As a result, NGHA devised a new vision: to implement a completely integrated Hospital

114

Information System (HIS) in 2000. In 2001, action was taken to replace all the incompatible and heterogeneous applications with a complete integrated HIS system. So, a task force was established to evaluate all the possible HIS solutions available "off-the-shelf". Because the number of possible vendors was large, the competition among them fierce, and because the HIS system itself was very complicated with tens of different modules and functions, the task force decided to evaluate only those systems that were considered to be "best of breed" systems; the team was also supported by an adequate project budget. Through a rigorous evaluation process, the final decision was made and the preferred HIS system was adopted in 2002. This system was first implemented in King Abdulaziz Medical City in Riyadh, and after a while, it was also implemented in the remaining hospitals.

The HIS system has become the heart of NGHA's HIT infrastructure and all the different systems must integrate with it. The HIS system is HL7 v2.3 compliant so every system adopted by NGHA must conform to HL7 v2.3 in order to be integrated. However, no HIS system covers all the medical modules and functions needed by the hospitals (and because sometimes there is a better solution and module available on the shelf), any new application is welcomed by NGHA as long as either it is HL7 v2.3 compliant if it is an information system, or DICOM 3.0 compliant if it is image system and has been integrated somewhere into the same HIS system. In order to eliminate integration problems and difficulties between the systems, NGHA authorities took another route and decided that every relatively large system (e.g. HIS, RIS, lab and pharmacy), known as an enterprise system, must be implemented in each hospital. As a result, all hospitals have the same large systems and therefore the core infrastructure for each hospital is the same. This uniformity is restricted to the core systems. Thus, other small systems are welcomed as long as they are HL7 v2.3 compliant and have been somewhere integrated into the NGHA HIS system. In addition, NGHA decided to implement a corporate middleware integration solution engine (that is HL7 v2.3 compliant) to integrate the different separate systems and hospitals, and to minimise, as far as possible, the point-to-point integration links.

7.2.2 Background to King Faisal Specialist Hospital and Research Centre (KFSH&RC)

KFSH&RC is one of the leading healthcare institutions in both the Kingdom of Saudi Arabia and in the Middle East. Based on a royal decree, the Board of Directors of KFSH&RC is

chaired by the Ministry of Health and ten members, including the hospital CEO. Its mission is to provide the highest level of specialised medical services to citizens and eligible patients, thus alleviating hardship and the cost of care and travel abroad. In addition, it promotes medical research and education programmes, and contributes to the prevention of disease. In 2010, KFSH&RC ran three main hospitals located in Riyadh and Jeddah with approximately 1129 beds, 1275 physicians and 3062 nurses. KFSH&RC in Riyadh is an 894-bed tertiary healthcare hospital; it was established in 1970 by King Faisal who laid its cornerstone. At that time, the hospital was administered and operated by the Hospital Corporation of America (HCA), as commissioned by the government. In 1975, the hospital was expanded to a capacity of 120 beds to provide tertiary care to local citizens. In 1978, the first cardiac surgery centre in the Kingdom of Saudi Arabia was established and the first cardiac surgery was initiated by an American team. In 1985, the administration and operation of the hospital was transferred to a national team based on a royal decree.

Today, KFSH&RC in Riyadh is a tertiary care facility with an average annual patient referral of over 32,000 patients and over 500,000 outpatient visits. KFSH&RC in Riyadh has been a leader in advanced medical treatments for, amongst others, open-heart surgery, transplants and cancer. For example, the total number of transplants in 2005 was 390, of which 222 were bone marrow, 127 kidney, 29 liver, 2 pancreas, 7 heart and 3 lung transplants. This results in one transplant in less than every 24 hours all-year round. This is an outcome similar to that of eminent international institutions. Owing to this progress, the hospital received a letter from the Centre for International Blood and Marrow Transplant Research (CIBMTR), Minnesota, USA, confirming that the hospital is placed in the top rank of centres worldwide. KFSH&RC is the Cancer Registry for the Kingdom and for the Gulf region and it treats approximately 40% of all registered cancer cases in the Kingdom of Saudi Arabia. KFSH&RC in Riyadh also runs postgraduate education programmes, thirteen are residential training programmes and 39 are fellowship training programmes. In addition, the hospital runs the Saudi Medical Journal. This annual journal is a bi-monthly, multidisciplinary medical journal, written in English; its emphasis is placed on matters relating to medicine in Saudi Arabia and the Middle East.

KFSH&RC in Jeddah, established in 2000, has an important role in setting healthcare standards locally, nationally and internationally. Its vision is to be the one of the leading international centres of excellence for health, medical training and research in the region of

the Middle East. KFSH&RC-Jeddah experienced considerable and rapid growth throughout its first year of its operation as its capacity was increased from an initial 50 beds to 100. Due to the expansion of all its medical services in 2001, the capacity of the hospital was increased to 200 beds. In 2001, the hospital also established international collaboration policies with major centres around the world while, in 2002, another expansion was also achieved when the hospital's capacity reached 235 beds and the first lung and bone marrow transplantation operations were carried out. Currently, KFSH&RC-Jeddah has four centres of excellence: oncology, cardiovascular, neurosciences and intensive care units. In addition, KFSH&RC-Jeddah, established, in 2003, is a department of excellence in academic and training affairs. This department was founded to ensure that trained healthcare professionals would be available as the hospital needed to expand. The King Fahad National Centre for Children's Cancer and Research, located in Riyadh and known locally as the Children's Cancer Centre, or more affectionately as CCC, is the only children's cancer centre in Saudi Arabia and the Middle East. CCC, established in 1997, is an integrated part of KFSH&RC-Riyadh and provides both inpatient and outpatient services to paediatric, haematology and oncology patients. Out of more than 600 new malignant paediatric cases reported annually to the Saudi National Cancer Registry, CCC accepts approximately 400 cases, with approximately 70 paediatric stem cell transplantations being undertaken per year. CCC also houses a research centre to allow greater interaction between the clinical and research facilities. This therefore applies innovative concepts of therapy in a timely manner to actual patient treatments.

In addition to the hospitals, KFSH&RC has three centres of excellence, the research centre, King Faisal Heart Institute, and the Oncology Centre. The Research Centre has undergone significant and rapid transformations in its brief history since it soon became an important participant in the field of biological research across the region. Since its establishment, the research centre has sponsored 123 major research projects (with over 148 papers published in reputable journals), and has achieved 11 patents and 7 invention disclosures. Its primary focus is on the following five main areas, cancer, genetics, cardiovascular diseases, environmental health, and infectious diseases. King Faisal Heart Institute (KFHI) is a tertiary cardiac care delivery centre with international standards of excellence and with a mission to provide the Saudi people with the highest quality of medical services for all types of cardiovascular disease. Patients are evaluated in highly specialised clinics that are consistent with disease-specific management guidelines in accordance with international standards. The Oncology Centre, known as King Faisal Cancer Centre (KFCC), is an adult patients' cancer

117

care centre with a mission to provide excellent cancer treatment, as well as education and research, by means of integrated team work. KFCC was founded in 1982. Since its establishment, KFCC has sought to become the best international centre for the research, prevention and treatment of cancer in accordance with disease-specific and internationally accepted management guidelines. As a result, KFCC has been accredited by several international groups and commissions as a collaborating centre for cancer prevention and control. KFCC is the largest bone marrow transplant centre in the region; it has 103 inpatient beds with 46,400 cancer cases being registered in the hospital tumour registry to date.

In relation to the HIT infrastructure of KFSH&RC, the hospital has had four IT development eras over the past 30 years. The first stage started in 1975 when the hospital had just been established. At that time, the hospital adopted systems that were available then, such as PDP-11 and IBM system-3. The second stage was initiated in 1982 when the hospital implemented the IBM patient care system and the Mainframe system. Other departmental systems were developed in-house at that time using programming languages such as COBOL. The third stage began in early 1990. At that time, the hospital adopted solutions based on the best of breed concept; this means that the hospital evaluated every department's requirements, needs and functions independently and then looked for the best solution available in the market. Thereafter, the hospitals integrated the new system with the related systems through a point-to-point integration approach. The fourth stage started in 1998 and placed emphasis on a completely integrated solution. This became hospital policy from 2000. KFSH&RC looked to maintain interoperability between the systems, so KFSH&RC authorities had to find an integrated solution, rather than an interface one. An integrated solution indicates that all the different systems should be from one vendor, which would result in one integrated product coming from the same vendor. Subsequent to many years' searching and preparation, a contract was signed in 2000 for the implementation of the Integrated Clinical Information System (ICIS), an implementation which would take two years. The vision of ICIS is to improve communication and information sharing, to create improved operational efficiencies and to improve patient safety and the utilization of resources, whilst making available comprehensive data for analysis and research. This system also comprises the Computer-based Patient Record (CPR), thus paving the way for a paperless chart. CPR is a longitudinal record of a patient's medical history; it provides more complete and easier access to information that will increase continuity of care and improve efficiency through patient care processes.

Since there is no ICIS that supports all the functions, needs, requirements and exceptions of a tertiary hospital, whenever a request is received to adopt a new system that is not supported by the ICIS vendor, there are certain requirements that the new system must fulfil in order to be adopted and integrated into the hospital's backbone system. One of the main requirements is the compatibility of the new system to HL7 v2.3. Furthermore, if this is an image system, it has to be DICOM 3.0 compliant. In addition, KFSH&RC implemented a HL7 v2.3 integration engine to act as a middleware layer between the ICIS and the different clinical applications. This was to allow KFSH&RC clinicians and management to access seamlessly information that is located in multiple, functionality-rich systems. The future HIT infrastructure in KFSH&RC has placed emphasis on the solution being robust and integrated; workflow will be seamless between the systems as this will increase the efficiency of care, based on best practice and decision support. In addition, this opportunity will be translated into decision-support using Key Performance Indicators (KPIs). These will be presented to clinicians and management through desktops so that the hospital authorities will be able to measure and value hospital productivity in general. The future plan also stresses the need to take advantage of the Internet, by providing stakeholders with information that is both reliable and valuable via fully-integrated portals, as well as exchanging health data with third parties such as the MoH. The portal will provide access to a wealth of information, including the organisational intranet, a virtual library and management reports. In addition, KFSH&RC has recently established a new department, known as the Department of Medical and Clinical Informatics. This department, in collaboration with the IT department, aims to provide KFSH&RC with knowledge about how best to integrate technology and statistical methods with clinical information systems and executive decision support systems for the purpose of providing quality care. This new department involves a combination of different medical personnel who have come from business backgrounds in order to enhance the aims and achievements of the Department.

7.2.3 Background to King Fahad Medical City (KFMC)

In 2010, KFMC in Riyadh was considered to be one of the largest independent tertiary medical institutions in the Middle East with a total of 1095 beds. KFMC is expected to treat annually more than 50,000 inpatients and more than 600,000 outpatients. Since its establishment in 2004, KFMC has aimed to be the premier healthcare centre in Saudi Arabia by providing therapeutic and training services using the best resources available. KFMC

consists of four hospitals, the main hospital, a specialist hospital for women, a children's hospital and a rehabilitation hospital. The main hospital aims to excel in providing the best specialist medical care to its referral patients and to contribute to programmes in medical training and research, as well as to the provision of outstanding healthcare services at both local and international levels. The tertiary care women's hospital is an academic institute that provides high-quality, specialised medical care for women, while the children's hospital, with 237 beds, is recognised by the MoH as the ultimate referral hospital; it carries the responsibility for improving the healthcare provided to children and adolescents at a national level. The rehabilitation hospital aims to become a model system for interdisciplinary rehabilitation services, including the provision of patient care and medical education, as well as being a centre for research.

In addition to the hospitals, KFMC also has four medical centres: the Prince Salman Heart Centre, the Neuroscience Centre, the Prince Sultan Haematology and Oncology Centre, and a specialist Diabetes and Endocrine Centre. Since its establishment in 2005 with 42 beds, the Prince Salman Heart Centre has dedicated itself to providing patient care of the highest quality, through updated clinical practice and research, and the most up-to-date technology, to adults with heart disease, including those with congenital heart problems. Prince Salman Heart Centre is the MoH's main tertiary referral centre for patients from all over the Kingdom of Saudi Arabia. The Neuroscience Centre serves both to prevent and treat complex and under-served nervous system disorders in the region through well-integrated and highly specialised multidisciplinary clinical management programmes. It also provides state-of-the-art diagnostic and therapeutic services, and conducts and promotes specialised training and research programmes in neuroscience. The Prince Sultan Haematology and Oncology Centre aims to provide state-of-the-art medical care, and to offer opportunities for clinical training and scientific research in different fields of Haematology and Oncology. The Diabetes and Endocrinology Centre is an integrated medical facility where highly specialised medical and educational services are provided to patients with diabetes and endocrine disorders. The centre is equipped to deal with complex diabetes cases and endocrine disorders of the pituitary, parathyroid, thyroid and adrenal glands, as well as disorders concerning bone and calcium metabolism.

Given that KFMC itself has only been recently established, its department of Information Technology and Communications (ITC) is also still developing. It is intended, however, for

this department to be responsible for building an efficient, reliable and secure technology infrastructure to help KFMC in achieving its goal to provide excellent patient care. ITC aims to become a state-of-the-art information technology and telecommunications centre that can drive KFMC to become a digital hospital by adopting efficient and appropriate technical and medical solutions and by forming a strong technical team that could also deliver technical support of the highest quality to other MoH hospitals. Since the ITC has only recently been launched, the HIT infrastructure is new and has been equipped with the latest technologies. However, since no completely integrated HIS system was available in the market which could supply all the functions and modules required by a tertiary hospital, KFMC decided to adopt a customised system. So, KFMC purchased a HIS system and the vendor customised it based on KFMC's requirements. This system has become the heart of the HIT infrastructure and therefore KFMC depends on it from the day a patient is admitted until the day that patient is discharged. In addition, KFMC looked for a method to integrate the different systems, such as PACS or lab systems, into the HIS system and so, for this reason, an integration engine was implemented. This engine controls the workflow of the messages among the clinical information systems whilst maintaining the availability, integrity and confidentiality of the data. After this, KFMC established a new unit under the umbrella of the ITC department. This was called a system development and integration unit, the aim of which was to lead the integration of systems in the medical city, as well as to facilitate the exchange of medical information horizontally and vertically, and to share such information with all the medical sectors in Saudi Arabia. This unit also adopted a medical imaging integration platform to capture images, video and data from any medical imagery modality; to convert artefacts to DICOM images, video and data; to edit, index and route medical imaging using DICOM and HL7 standards; to send and store selected images in any medical repository or database (e.g. PACS, DICOM Storage); to convert any PACS images from any manufacturer in a global repository for any medical speciality; and to allow medical images to be retrieved and reviewed easily from any network access point.

KFMC also established a new department known as the Health Information Management (HIM) department in response to the international trend and belief in the importance of the field of health informatics in hospitals as a way of improving the quality of the medical services provided to patients. HIM has five main departments, classification, release of information, information management, file management, and eligibility and registration. Information classification aims at achieving excellence in analysing, verifying, extracting,

121

coding and reporting healthcare data; release of information aims at achieving excellence in patient services and the provision of timely and accurate access to patient information; and information management seeks to promote the automation of HIM business processes and workflow, while complying with international standards for patient privacy. File management supports KFMC services through the provision of integrated medical records and accurate medical transcriptions of reports according to the principle of HIM; finally, eligibility and registration aspires to achieve excellence in the coordination of transferred cases, allowing these to be displayed in the KFMC using the latest systems and technologies in a short a time as possible.

7.2.4 Background to the Security Forces Hospital Programme (SFHP)

SFHP is one of the leading healthcare providers in Saudi Arabia with in 2010, 447 physicians and 760 nurses; its primary focus is to provide high quality medical services to Ministry of the Interior personnel and their dependents. Its inception took place 35 years ago, more specifically in 1972, when a small dispensary was opened in Riyadh with very limited resources. In 1975, this dispensary was expanded to offer 20 beds and thus became the first security forces' hospital to be established (SFH-Riyadh). In 1981, the capacity of the hospital was increased to 120 beds and, at this time, the administration and operation of SFH-Riyadh were outsourced. In 1998, the decision was taken by the Ministry of the Interior to self-manage and self-operate SFH-Riyadh in order to optimise the cost and improve the quality of care provided to its employees and their families. Today, SFH-Riyadh is a 500-bed hospital with the mission to provide high-quality medical services to its patients in an integrated healthcare environment, while promoting healthcare education, research and the development of healthcare in Saudi Arabia, as well as optimising the use of the available resources. Because of the large volume of individuals referred to SFH-Riyadh, SFHP has established two other such hospitals in Dammam and Makah, which are located in the east and west regions respectively of the Kingdom of Saudi Arabia; these hospitals are expected to be operational soon.

In order to deliver effective healthcare services, SFH-Riyadh has used IT sources and systems as enabling tools to reengineer the hospital's systems and processes in order to maximise the use of resources and improve the quality of care it delivers. The IT department has jurisdiction over all issues relevant to the procurement and use of the computers, and to the

network and communication systems in the hospital. Such issues include, but are not limited to, IT standards; hardware; IT support; and the definition, specification, procurement, distribution, installation and maintenance of network and software requirements. Any computer system or system component, including hardware, networks, software and associated services, together with their planning, design, implementation and support, are the responsibility of the IT department. The IT department has developed an initial strategic plan to serve as a road map to guide SFH-Riyadh in the use of IT to achieve the hospital's mission and goals, and to ensure that any investments made in IT resources and systems generate high returns in terms of reducing operating costs and improving the quality of services, specifically patient care. The primary aim of this strategic plan is to define the mission of the IT department, as well as the strategic goals which must be achieved in the development and deployment of IT resources, systems and solutions.

The main system in SFH-Riyadh is an HIS system which was implemented as a complete integrated solution in late 1980. The main components of the HIS system are the Patient Master Index System, Admission Discharge Transfer (ADT), which includes registration and appointment systems, and Pharmacy and Lab systems. Since the HIS system was very old and had few modifications, the IT department developed an HL7 v2.2 engine to deliver certain messages between the HIS system and related systems since the HIS does not conform to HL7 standards. So, the HL7 v2.2 has become the messaging standard in the hospital and therefore every adopted system must conform to HL7 v2.2 in order to integrate with the HIS system. In addition, the HIS system's vendor has given the hospital the source code of the system and permission to update and customise it as support from the vendor ceased owing to the system's legacy. Thus, an excellent opportunity arose for the hospital to develop the functions and modules it needed. In addition to HL7 v2.2, the imagery systems must conform to DICOM 3.0 as the hospital PACS system standard. Since SFHP will operate soon in two other hospitals, a plan has been launched to evaluate, from best practice solutions, a completely integrated clinical information system that could be implemented, first in Dammam and then in Makah. This system will replace the legacy HIS system in SFH-Riyadh. In addition, SFHP is currently evaluating, from best of breed systems, a clinical information system that could be implemented across all the affiliated clinics distributed around the Kingdom of Saudi Arabia. Having a completely integrated clinical information system implemented across all the different hospitals would facilitate integration among the hospitals by creating one central database. This would, in turn, enhance the development of a

123

data warehouse system that is required in order to gain meaningful insights from the data through the provision of accurate statistics and reports.

7.2.5 Background to Riyadh Armed Forces Hospital (RAFH)

RAFH, established by the Medical Services Department (MSD) of the Ministry of Defence and Aviation (MODA), is one the premier tertiary hospitals in Saudi Arabia. It aims to provide comprehensive healthcare by offering high-quality services, and professional education and medical research opportunities, for the benefit of MODA personnel and their dependents. RAFH also aims to be the benchmarked hospital in Saudi Arabia and to achieve excellence in all specialties in the region. RAFH was officially opened in December 1978, with a capacity of 385 beds, by King Khalid bin Abdulaziz. Since then, RAFH has been growing in terms of the number of facilities, dispensaries, beds and staff, having in 2010, for example, 1350 beds and 7179 staff. During recent years, RAFH has achieved many accolades in Saudi Arabia, including, but not limited to, achieving first place in terms of its scientific research, trained physicians, trained paramedics, kidney transplants, paediatric liver transplants and registered patients. In addition, RAFH is one of the two centres in Saudi Arabia to carry out bone marrow transplants and is the only centre for the treatment of and surgery in epilepsy. Moreover, RAFH possesses the leading central laboratory and is the largest centre for dialysis in Saudi Arabia.

RAFH has also other two satellite hospitals, the Al Kharj Military Factories' Hospital (KMFH), which was established in February 1979, and the King Abdulaziz Military Academy Hospital (KAMAH), which was opened in September 1983. While the Al Kharj Military Factories' Hospital has 110 beds with 58,146 outpatient attendances in the current year, KAMAH has a capacity of 28 beds (of which 16 are used as observation beds) and approximately 3,427 outpatient attendances. In addition to the hospitals, RAFH runs eight satellite clinics located in different areas of Riyadh. To accommodate the growing population, and to further enhance the quality and performance of patient healthcare, additional facilities have also been constructed and established. For example, cardiac services have been given a separate identity by creating the Prince Sultan Cardiac Centre (PCCC) as an independently functioning institution. The PCCC has been operating with 344 beds since September 1997. Today, the PSCC is considered to be one of the most advanced cardiac centres in the Middle

East due to the quality of patient care it provides, and for the research papers it publishes in the most reputable journals.

The RAFH authorities have also launched an initiative known as the Health Informatics Department because of the importance of medical information in the development of highly standardised healthcare and medical services. This department aims to develop a robust medical information infrastructure in order to support the hospitals with reliable, timely and accurate information. However, this department is at an early initial stage and so many plans are still in the process of development. The RAFH's HIT infrastructure is very old because most of the systems were adopted 30 years ago, for example the HIS system (the hospital's main system) has operating since 1982. Due to the legacy of this HIS system, little modification is allowed since vendor support ceased; in addition, the HIS dos not conform to HL7 messaging standards. Moreover, the HIS system runs a proprietary format database that is complicated both to understand and to manage. Furthermore, the other satellite hospitals, KMFH and KAMAH, still lack fundamental clinical information systems and therefore most work is done manually. Before 2004, all the related systems in RAFH were connected to the HIS system via a point-to-point integration approach. However, in 2004, when the idea of adopting a PACS system was put forward, the IT department, together with the PACS vendor, looked for a method to integrate the PACS into the HIS system. So, a bi-directional HL7 v2.2 integration engine, with limited types of message, was developed to integrate the PACS system into the HIS system.

According to the IT department, an idea was put forward to replace all the HIT infrastructure legacy systems with the latest clinical information systems in the market today in order to restructure the HIT infrastructure and improve the quality of the medical services. However, this initiative was terminated by the MSD of the MODA and a number of reasons were given to justify this action. For example, MSD runs more than 30 hospitals around the Kingdom of Saudi Arabia and so it was looking to adopt an EHR system in all the hospitals in order to have a central medical records database, thus reducing both effort and cost. However, this project is still in its infancy and little or no progress seems to have been made. There are several reasons for this failure: for example, there is no clear organisational structure since no one appears to wish to take the lead with this project. In addition, there is a lack of adequate policies and procedures with regards to the adoption process so political and bureaucratic issues always arise that disable the project. Moreover, there is a shortage of professionals to

125

manage and lead this kind of project since it requires a team from different business backgrounds, such as experts in IT, biomedical engineering and health informatics, as well as radiologists, pharmacists and doctors. Furthermore, financial concerns are an issue because a project of this size requires a very substantial budget.

7.2.6 Background to the University Hospitals (UHs) in Riyadh

Currently, the medical services of the College of Medicine at King Saud University (KSU), with 856 physicians and 1736 nurses, are delivered mainly through two university hospitals: King Abdulaziz University Hospital and King Khalid University Hospital. Services are also offered via a number of clinics around the campus, such as the staff clinic, students' clinic, staff housing clinic, and the female students' clinic. King Saud University's College of Medicine, established in 1967 (although studies actually started in 1969), was the first college of medicine in Saudi Arabia. In 1975, the College of Medicine opened a new department for female students hosted by Prince Talal Bin Abdulaziz Hospital. The original Prince Talal Bin Abdulaziz Hospital, founded in 1955, was the only private hospital in Riyadh but, in 1960, it became affiliated to the MoH to accommodate Saudi Arabia's growing population and to provide medical services free of charge. In 1975, the Prince Talal Bin Abdulaziz Hospital became part of King Saud University and was used for the clinical stage training of both male and female students as the need emerged at this time to find an educational hospital affiliated to the University. The name of the Prince Talal Bin Abdulaziz Hospital was later changed to King Abdulaziz University Hospital (KAUH).

KAUH is the first educational hospital in Saudi Arabia whose vision is to be a leading healthcare provider whilst having a major global impact on health and contributing significantly to the science and practice of medicine worldwide. Today, KAUH, with a capacity of 104 beds for academic specialities only, is one of the best hospitals in the Middle East in the field of ophthalmology and ENT because of the availability of skilled physicians in those areas. In 1981, at the 25th anniversary of the inauguration of KSU, the buildings of the College of Medicine were inaugurated for teaching and health services. Another dedicated university hospital was established in the same location under the name of King Khalid University Hospital (KKUH). Today, KKUH is an 800-bed hospital providing all general and sub-specialty medical services. Due to the excellence of the medical services

provided, KKUH is considered as a referral tertiary hospital by the MoH, it provides tertiary care services, including medication, to all Saudi citizens free of charge.

The IT department in the University Hospitals was renamed as the Computer and Information Department to reflect the importance of medical information in enhancing the quality of the medical services provided. The Computer and Information Department aims to provide high-quality control of all IT services and systems in order to ensure that the services provided to patients are of the highest quality, and to support the academic mission of the College of Medicine which looks for the optimal utilisation of HIT applications to improve the quality of care, maximise the use of resources, and reduce the time and cost of its operations. This is being accomplished through the seamless integration of many systems, which results in a paperless environment. Many achievements have been reported in this regard, such as reductions in errors, improved quality of care, improved safety, increased efficiency and functionality of hospital management, enhanced speed of response from various business units, enhanced transparency of financial management and reporting, and the interoperability of information systems.

The heart of the HIT infrastructure in the University Hospitals is the HIS. However, this is a very old system that was adopted 22 years ago. The HIS system does not conform to HL7 messaging standards and, moreover, it is a relational-based, proprietary database format. In 2006, when the University Hospitals made the decision to adopt the PACS system, the Computer and Information Department discussed, with this system's vendor, ways of achieving integration between both systems. As recommended by the PACS vendor, the hospitals developed in-house a HL7 v2.2 integration engine to act as a middleware integration layer between the different systems, including the PACS system and the HIS system. However, due to the complicated structure of the HIS system database, the IT personnel were able to provide the different systems with only a limited number of messages. The image modalities were integrated into the PACS system through DICOM 3.0 technology and so every new image system must conform to this version in order to be integrated into the PACS system. Due to the high level of financial support given by the government to KSU in recent years, a decision was taken by the University Hospitals to replace the current HIS system as soon as possible with one of the best of breed solutions available in the market. Thus, a task force was assigned to evaluate rigorously the available solutions and then

recommend the most suitable one. It is planned that the new HIS system will be adopted in 2012.

7.3 The Current Health Data Standards

Only a few health data standards have been adopted by the cases studied. The following sections explain the reasons for this and describe each standard, as shown in Table 7.1, in more detail.

Table 7.1: The versions of standards adopted by the hospitals in the studied cases.

	NGHA	KFSH&RC	KFMC	SFHP	UHs	RAFH
ICD	ICD-10 AM	ICD-10 AM	ICD-10 AM	ICD-9 CM	ICD-9 CM	ICD-9 CM
SNOMED	CT	CT	No	II	II	II
CPT	No	In-house customised version	No	No	No	No
HL7	v2.3	v2.3	v2.3	v2.2	v2.2	v2.2
DICOM	3.0	3.0	3.0	3.0	3.0	3.0

7.3.1 ICD

ICD-9 Clinical Modification (CM) was the official system used in Saudi hospitals to classify and assign codes to health conditions and related information since the late 1980s. However, only a few tertiary hospitals adopted this version in order to report the occurrence of some diseases to the MoH; in addition, ICD-9 CM was used only for inpatients. This was because the physicians were not ready to cope with the terminology standards due to limitations in their backgrounds and the lack of coders of terminology standards in Saudi Arabia. It was also because the hospitals' policies and procedures were not designed to force physicians to apply the terminology standards on a daily basis. Therefore, a great deal of medical information was either missing or corrupted owing to the limited use of ICD in Saudi Arabia. For example, one chief director said:

128

We could not produce accurate mortality statistics and reports due the corrupt
nature of the mortality data. (Participant 14)

In 2005, the MoH announced the conversion to ICD-10 Australian Modification (AM) based
on a Royal Decree. Since that time, only three healthcare organisations, as shown in Table
6.1, have converted to this standard. This is because the other hospitals are not ready to apply
this standard because of the lack of ICD-10 AM coders and owing to technical concerns. In
this regard, one executive commented:

We were disappointed when the Ministry of Health selected ICD-10 AM without
informing us and checking the hospitals' capabilities and this is why only three
hospitals have switched to this version since 2005. (Participant 1)

In addition, the hospitals which adopted the latest version, have not integrated it into the HIS
system and so the application of ICD-10 AM in those hospitals is based on a standalone
system for research, statistical and reporting purposes. This is because the HIS systems in
these hospitals are ICD-9 CM compliant as they came from American vendors who are still
using systems based on ICD-9 CM as the American national code for diseases and diagnoses,
as one executive explained:

The application of ICD-10 AM does not meet the hospital's expectations since
what we are looking for is to have it integrated into the hospital's HIS system with
the code finder system to enable physicians to assign automatically the proper
codes for the treated cases. (Participant 1)

Nevertheless, ICD is being used in Saudi hospitals for different uses, such as for statistics,
reporting and benchmarking, and research.

7.3.2 SNOMED

Five healthcare organisations have adopted SNOMED. The initial adoption of SNOMED
comes as a result of these Saudi hospitals adopting best of breed systems depending on the
availability of adequate budgets. This is because, according to some participants, the vendors
of the best products are involved in some way in the development of the international
standards and so they have a stake in them. By using only these vendors, the hospital
authorities can be sure that their system conforms to international standards. However, the

129

participants argued that the dictionary terminology standards are only one feature of the systems; also, if the hospitals want to use these on a daily basis, they should activate and update them regularly and also pay the annual license fees. One lab information manager said:

> *SNOMED falls within the lab information system so we should update the*
> *dictionary and pay the license fees if we want to use it on a regular basis.*
> *(Participant 32)*

The data revealed that SNOMED is being used in a limited way in the lab departments of the hospitals. SNOMED's main function is to register with the Saudi Oncology Centre the cancer cases that are reported annually. SNOMED is being also used in some rare cases to facilitate research into certain cases and diagnoses in order for the hospitals to generate statistics and reports.

7.3.3 CPT

Only one healthcare organisation has adopted CPT, as shown in Table 7.1, to report the medical procedures and services performed by the different related departments in the hospital for administrative, financial and analytical reasons. For examples, CPT is being used to measure the hospital's performance and compare it, through KPIs that have been introduced worldwide, to other leading international healthcare organisations. In addition, KFSH&RC provides medical services that are charged for so their medical services should be CPT coded in order to facilitate the management of financial issues and to integrate their services with the insurance companies. CPT is also being used to produce certain reports and statistics for benchmarking purposes. However, CPT initially began 30 years ago when KFSH&RC was operated by an American medical group. In 2007, KFSH&RC developed its own customised CPT version to meet the hospital administration's need for accurate information. This new version is a comprehensively coded dictionary for medical services and procedures which was developed for a range of purposes, such as measuring productivity, producing statistics, benchmarking and billing, and carrying out research. One director said:

> *We wanted to make sure that every medical service introduced by the hospital was*
> *properly coded and so we developed our own CPT version with an American*

130

group to be able to benchmark with others and produce accurate reports and statistics. (Participant 11)

7.3.4 HL7

All the studied cases have implemented HL7 but with different versions, as shown in Table 7.1. While some adopted HL7 v2.3, others are still using v2.2. This depends on the capabilities of the HIS systems. In other words, the hospital must adopt the system with the version that conforms to the hospital's HIS version in order to tackle the integration barriers since the HIS system is at the heart of the hospital's HIT infrastructure. HL7 has been adopted as the market integration and communication protocol between different clinical information systems and so the hospitals have no choice but to adopt HL7. One manager noted:

HL7 is the market communication protocol between the different clinical applications. However, if the systems do not comply with HL7, how will we integrate and exchange data between the systems? For example, we had legacy systems developed in-house and when we wanted to let the systems talk to each other or exchange data, we approached the integration as point-to-point. So, every time, we had to develop a new point-to-point integration between the systems which was an endless process. (Participant 6)

Thus, HL7 is mainly used to facilitate integration between the different clinical information systems. Every new system must conform to the hospital's HL7 version in order to integrate into the hospital's HIT infrastructure. In addition, every hospital has implemented a HL7 integration engine to act as middleware in order to facilitate medical data exchange seamlessly between the different systems, as one executive said:

The ultimate goal is to make the messages across the systems uniform and, even more complicated, across the regions and hospitals, through the integration engine that will provide us with total ownership solutions and easy integration between the solutions. (Participant 1)

However, the participants explained that there is always an issue concerning integration although the systems are HL7 compliant. This is because the vendors of the clinical

131

information systems customise HL7 to types of proprietary format which, in turn, means that the healthcare organisations must find solutions to integrate any new system into the hospitals' existing HIT infrastructures. As a result, some of them prefer to go with the vendors of the hospital HIS systems rather than to other vendors since the vendor system is an integrated solution, not an HL7 interfaced one. One manager explained:

> *When we choose a clinical information system, we always ask ourselves if this system can be fulfilled by our vendor's components so we do not have to go through the HL7 interface solution. If the answer is yes, we go with our vendor and there is no need for any interface because our vendor offers an integrated solution. But if our vendor does not have a solution and this product can do what is needed by the users, then the second question is: Is this product HL7 compliant? If yes, then we look for this product and integrate it into the hospital infrastructure through the HL7 integration engine. (Participant 13)*

In addition, the participants explained that there are hundreds of HL7 messages and therefore the project management team should evaluate and specify carefully the messages that are required since each message has an annual licence fee. This depends on the experience and the qualifications of the project management team. As mentioned by the interviewees, the RFP project and the contract are therefore the most critical stages of the adoption process as they will determine the quality of the system and the relationship between the hospital and the vendor. Moreover, participants agreed that HL7 is one solution that can facilitate the integration between different systems; however, it is not a complete solution since the hospitals require an integrated solution that offers a comprehensive workflow as one simple data integration solution does not meet the hospitals' expectations. One executive explained:

> *HL7 is one of the tools that can be used for integration but it does not give a comprehensive workflow that is integrated as one solution. I think the next phase, and the new trend in the process of achieving healthcare automation, is the middleware, integration, messaging and simplifying the messages across the systems. (Participant 1)*

7.3.5 DICOM

All the studied hospitals have implemented the latest version of DICOM, which is DICOM 3.0. This is because the PACS system has recently been adopted in Saudi hospitals and the new PACS systems are DICOM 3.0 compliant. Since DICOM 3.0 has been chosen to be the communication protocol for integrating the different image systems into the PACS system, every image system is suitable as long as it conforms to DICOM 3.0. However, the participants explained that they had encountered many integration problems between the PACS system and the image systems. This is because the concept of image modalities and systems is a new area for the Saudi healthcare community and, as a result, Saudi hospitals are lacking experts in this area. In addition, other older image systems which do not conform to DICOM 3.0 still exist and this requires endless support processes for these to be integrated into the PACS system.

The participants also explained other deficiencies with the DICOM system. For example, the image system industry is still developing and therefore DICOM is not mature enough to support many of the functions and procedures needed by radiology departments. In addition, the technical respondents agreed that there is an issue regarding integration even though the image systems are DICOM compliant. This is because every vendor has its own customised version of DICOM. The participants also explained that there are numerous DICOM functions and messages which have annual license fees and so the project's RFP must be drafted carefully since problems arise when some features are missing. It requires the availability of experts (which Saudi Arabia lacks) to lead the adoption of image systems in the hospitals, as one director of medical imaging informatics said:

> *We believe that the imagery systems are new and are still developing; therefore, there is no 100% satisfactory DICOM system; even the companies say we are DICOM compliant since every vendor has its own DICOM version. So, there is always an integration barrier between the different imaging modalities. This is also because we are new to advanced image systems and we still lack people to deal with these kinds of project. (Participant 3)*

7.4 The Drivers of the Current Health Data Standards

By analysing the data collected from the cases, the researcher identified four areas that led to the decision to adopt health data standards. These are managerial, technical, educational and governmental. The following sections describe each one.

7.4.1 Managerial Driver

The researcher identified three main managerial driver behind the adoption of health data standards in Saudi hospitals, analytical, accreditation and performance purposes. Data analysis is required for decision support systems, and success or failure depends on the quality of data and how well the data are structured and predefined. This was made clear by some interviewees, as one of them said:

> *If we want to run reports across the systems, it will be difficult, if not impossible, if the systems do not conform to certain standards. We need accurate reports to support decision making. (Participant 6)*

A solid information infrastructure is also required since it will enable the hospitals to have a meaningful insight into the data through accurate statistics and reports, therefore excluding any human bias, as one manager reported:

> *The impact of adhering to certain standards is positive since we can easily identify the top ten diagnoses and procedures, extract some reports and statistics and then benchmark them against others. (Participant 19)*

With regard to accreditation driver, one of the main initiatives taken by the top management in Saudi hospitals is the acquisition of accreditation from some leading international medical commissions. Being accredited means that the hospital not only provides high-quality medical services based on best practices, but also is internationally recognised as a highly standardised hospital. Therefore, the hospitals must follow certain standards, including health data standards, in order to be accredited. This was stated by one of the respondents who reported:

The initiative of following certain standards comes sometimes from the management as one of the hospital's aims is to be accredited by some international commissions. (Participant 13)

Concerning the last driver, that of performance, Saudi hospitals have realised the importance of having a data warehouse system in order to improve the hospitals' performance; this reflects on the quality of medical services and patients' satisfaction. Having a data warehouse system also helps the hospitals to measure their performance based on unbiased statistics and reports which, moreover, are in accordance with international KPIs. However, this requires the hospitals to develop a highly standardised and interoperable HIT infrastructure in order to manage effectively the data warehouse. In the majority of the studied cases, hospitals have come up with such plans to move towards the development of a data warehouse system, as one executive explained:

When we have a structured data warehouse, we have greater ownership of the data and so we can enhance the hospital's performance in terms of, for example, occupancy of beds; we can then use an international KPI to measure the hospital's performance and benchmark it against others. (Participant 2)

7.4.2 Technical Driver

The main technical benefit of adopting HIT related standards for the hospitals is the increase of interoperability between the systems. In other words, standards normalise communication between different systems, thus facilitating integration and data exchange between them. This was made clear by the majority of respondents. For example, one reported:

Standards make the interface between the systems easier and this, in turn, facilitates the communication and integration between the systems. (Participant 29)

By enhancing interoperability between the systems, many technical benefits to the hospital might also emerge, as reported by a number of participants, including increasing the scalability, portability, maintainability, consistency, uniformity, linearity, stability, accessibility, availability and efficiency of the systems. Another valuable technical benefit is receiving enhanced vendor support, as hospitals have adhered to market standards. The

interviewees also explained that when the hospital has an integrated standardised HIT infrastructure, the ownership of the system solutions and the data becomes high, this increases the systems' data privacy, security and reliability. In addition, it enhances the development of advanced systems such as data warehouse, Computerized Physician Order Entry (CPOE), and knowledge management systems, as one executive said:

> *The ownership of the system solutions and the data is a very important issue in a multi-site healthcare organisation, and this requires the development of a fully integrated infrastructure. (Participant 1)*

7.4.3 Educational Driver

The majority of the healthcare organisations studied in this research are involved in educational programmes in some form or another, such as research groups or centres or medical universities. The hospital authorities strongly believe that the improved quality of life in Saudi Arabia is due largely to advances in science which have solved, to a great extent, the biological puzzle of human diseases. Therefore, the research groups and centres, and the medical universities, should work hand-in-hand, building on their knowledge and experience to accomplish this task. However, this requires the hospitals to have robust information infrastructures in order to provide the research centres and medical universities with medical information to achieve their aims. This explains why some Saudi hospitals are accelerating towards developing an integrated infrastructure and data warehouse in order to support a range of medical research groups in Saudi Arabia by providing the required data. For example, one manager stated:

> *We need data to support our education system because we are an academic centre with a research centre and medical university. (Participant 1)*

The data offered several examples concerning the importance of medical data in the development of medical research. For example, Saudi hospitals have failed to supply medical research groups with accurate data and statistics with regard to the last outbreak of Swine Flu; this was because of the lack of a national health data standards authority. A second example concerns mortality data. The different medical research groups have failed to obtain accurate mortality data because of the lack of a unified standard and procedure for the collection of mortality data in Saudi Arabia, as one chief director noted:

The mortality data in Saudi Arabia are corrupt and so we cannot retrieve accurate information from the system to support research. (Participant 14)

Another director also said:

We were not able to produce accurate research with regards to the last outbreak of Swine Flu because we lack accurate data. (Participant 11)

7.4.4 Governmental Driver

The data showed that the tertiary hospitals in Saudi Arabia, including the studied cases, are pushed by some government bodies, such as the MoH, the Saudi Oncology Centre and the Saudi Council of Cooperative Health Insurance, to adhere to certain standards such as ICD, SNOMED and CPT. This is because, for example, the tertiary hospitals are required to report some medical information annually to the MoH. Based on ICD, the tertiary hospitals report such statistics and cases annually to the MoH in order to produce medical statistics and reports, such as mortality data, concerning the health situation in Saudi Arabia in general. In addition, the tertiary hospitals are required to register cancer cases in the Saudi Oncology Centre. Thus, the tertiary hospitals should adhere to ICD and SNOMED terminology standards in order to facilitate the search and registration of cancer cases. Moreover, some tertiary hospitals have recently carried out treatment and provided medication for which patients pay direct. Therefore, they need to adhere to the standards of the Saudi Council of Cooperative Health Insurance in order to be linked with the health insurance companies. One manager said regarding this:

In the absence of regulations, standards are driven based on need. However, ICD-10 AM is government-initiated and CPT is for billing and insurance purposes. (Participant 14)

However, the participants revealed that the attitude of the government towards the adoption of health data standards is very low-profile for many reasons. For instance, MoH hospitals are still lagging behind other governmental hospitals and are therefore deficient in many ways (e.g. in terms of networks, platforms, experts and adequate budgets) from the point of view of being ready to implement advanced clinical information systems. As a result, the main focus of the majority of MoH hospitals is to develop the HIT infrastructure by providing the basic

software and hardware applications; medical data exchange and health data standards are now outside of their account. Secondly, Saudi Arabia is still lacking a nationally recognised body to set the direction for clinical information systems and medical data exchange between different healthcare providers. Thirdly, most of the Saudi hospitals, and in particular those which are controlled by the MoH, are short of professional people to understand or cope with advanced technological solutions, such as health data standards and medical data exchange. Fourthly, the national healthcare system has not been set up properly with many independent and interrelated entities and components which are complicated to understand or be communicated. For example, since the establishment of health insurance companies in 2000, these companies still lack a suitable national policy to explain clearly their roles with regard to the national healthcare sector.

7.5 Factors Influencing the Adoption Process of HIT Related Standards at the Decision-Making Stage

By analysing the data collected from the cases, the researcher identified many factors which influenced the adoption process of HIT related standards at the decision-making stage. These factors were grouped into two main categorises, enabling factors and hindering factors. The sections below describe each category in detail. In addition, Tables 7.2 and 7.3 present each factor and the total number of participants who supported it.

Table 7.2: The enabling factors and the total number of supporting participants.

No	Factors	Participants	Total
1	Systems Integration	1,2,3,4,5,6,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31	29
2	Relative Advantage	1,2,4,5,6,9,10,11,12,13,14,15,16,17,19,21,22,23,27,30,31	21
3	Observability	1,2,3,4,6,10,12,13,15,16,17,19,20,24,27,29,30,31	18
4	External Pressure	1,2,6,9,10,11,14,15,17,19,22,24,30,31,32,33	16
5	External Support	1,2,4,5,6,10,12,13,15,19,20,21,24,25,26,33	16
6	Data Analysis	1,2,5,6,10,11,13,14,19,30,31,32,33	13
7	Trialability	1,4,10,13,15,17,18,20,24,30,31	11
8	Size of Healthcare Organisation	1,2,4,5,6,10,15,28,29,30,31	11
9	Accreditation	1,4,5,7,13,14,17,19,32	9
10	Education	2,6,14,19,24,32,33	7
11	Organisational Culture	1,6,9,11,19,29	6
12	Network Externalities	1,15,18,20,30,31	6
13	Type of Healthcare Organisation	2,6,11,17,19	5
14	Enhancing the Use of Advanced Systems	2,16,19,31	4

Table 7.3: The hindering factors and the total number of supporting participants.

No	Factors	Participants	Total
1	Lack of a National Regulator	1,2,3,4,5,6,9,10,11,12,15,16,17,18,19,20, 21,22,23,24,25,26,27,30,31,33	26
2	Shortage of Professionals	1,2,3,4,6,8,9,11,17,19,20,21,22,23,2427, 30,31,32,33	20
3	HIT Infrastructure	2,3,6,10,14,17,21,22,23,24,25,26,27,28,2 9,30,31,32,33	19
4	Complexity	1,2,3,4,6,7,11,15,17,19,23,24,27,30,31,3 3	16
5	Switching Costs	1,2,4,5,6,8,9,10,11,15,17,27,29,33	14
6	Compatibility	4,6,11,14,21,22,23,25,26,27,29,30,31	13
7	Market Uncertainties	1,2,3,4,10,15,16,20,21,23,27,32,33	13
8	Resistance to Change	2,4,5,6,8,9,13,15,17,21,22	11
9	Lack of Clinicians' Engagement	1,2,6,9,11,17,19,27,30,31	10
10	Lack of Adequate Policies and Procedures	4,5,6,21,22,23,27,33	8
11	Lack of an Information Management Plan	1,2,6,11,15,30,31	7
12	Organisational Structure	4,6,10,23,24	5
13	Lack of a National Plan for Medical Data Exchange	6, 30, 31	3
14	National Healthcare System	30,31	2

7.5.1 Enabling Factors

The enabling factors represent those factors which have a positive impact on the adoption process of HIT related standards at the decision-making stage in the case organisations. The researcher identified fourteen factors throughout the collected data. The sections below explain each one by offering a detailed analysis.

7.5.1.1 Systems Integration

The majority of the participants agreed that one of the main reasons for adopting systems based on standards is to facilitate integration between the different systems. This is because the point-to-point interface solution has turned out to be an endless process since it requires a high degree of interface engineering and support. The importance of system integration to the hospitals was indicated by many participants. For example, one executive said:

> *We believe today that we cannot run a proprietary solution enterprise because interoperability and integration are the name of the game. (Participant 15)*

Thus, integration has become a strategic aim for the hospitals in order to gain the benefits that HIT applications would introduce. As a result, every new system is welcomed as long as it is HL7 compliant if it is a clinical information system or DICOM compliant if it is an imaging system. In addition, all the hospitals implemented a middleware integration solution engine that is HL7 based in order to facilitate the integration process between the different applications.

7.5.1.2 Relative Advantages

Most of the interviewees pointed out many relative advantages that could be gained from the adoption of HIT related standards. These benefits to the healthcare organisations can be grouped into five main categories which include operational, managerial, technical, organisational and strategic benefits. In terms of operational benefits, adhering to health data standards can improve the ownership of data by facilitating the workflow of and access to such data and by increasing the efficiency of processes between the systems, thus increasing performance and productivity. As one manager said:

Drug interaction is now helping doctors to ensure they have the right medication before giving it to the patient. In terms of DICOM standards, this helps us in placing the images of one patient in one profile so the doctor can log into the system from one log-in; there is no need to log in to different systems. (Participant 10)

Concerning managerial benefits, health data standards can make the systems more intelligent, thus supporting managerial control, decision-making and resource allocation. For example, the bed occupancy procedure is enhanced since a patient's length of stay is now based on a systematic process and not just on a doctor's decision. In addition, the performance of physicians is controlled by a defined and structured treatment producer. Every treatment cycle is therefore well defined and controlled. Another managerial benefit reported by many participants concerns staffing. When the hospitals follow certain international standards, they can find suitable staff easily, in less time, and without the necessity for major training. The main technical benefit for the hospitals of adopting HIT related standards is the increase of interoperability between the systems. In other words, standards normalise the communication between different clinical information systems, thus facilitating integration and data exchange between them.

With regards to organisational advantages, various benefits were reported by the participants, such as, facilitating the automation of work; increasing consistency among medical staff since they will then use the same medical language; extracting accurate information, producing statistics and reports to support decision-making; and enhancing vendor support as hospitals will adhere to market standards. Three main strategic benefits in adopting systems based on standards were mentioned by several interviewees. These benefits were: improving the quality of care by reducing medical errors and death rates; reducing the cost of medical services making them more cost-effective, thus achieving more sustainable healthcare; and in building blocks in an e-health domain that is an essential part of e-government. For example, one manager said:

Having standards will be moving us closer to e-health and then e-government which is a worldwide trend. (Participant 9)

142

7.5.1.3 Observability

The data revealed that the IT infrastructures in the hospitals in Saudi Arabia before 2000 were based on legacy HIS systems and isolated departmental systems. These were complicated to integrate or manage and so the main aims of these systems at that time were based on administrative purposes such as patients' registration and appointments. After 2000, the hospital authorities started to realise the importance of making the hospitals' IT infrastructures more interoperable and constructive. Thus, the hospitals had to consider the integration aspects in a systematic way while acknowledging the essential part that health data standards would play. The interviewees explained various methods that have been used by the hospitals to expand their employees' knowledge with regard to HIT related standards, thereby facilitating observations of the new technologies and solutions in medical environments. For example, the hospitals encourage their employees to attend relevant conferences in order for them to be updated on the latest technologies and solutions. In addition, some of the hospitals have advanced memberships with some relevant leading international organisations which are helping them to acquire knowledge, thus facilitating decision making regarding HIT related standards. All the hospitals also have advanced online libraries and subscribe to journals to explore the area of clinical information systems in order to identify the necessary specifications to make their IT infrastructures more interoperable and constructive. The majority of participants also explained that making site visits to some international exhibitions and leading hospitals in the area of clinical information systems is another significant method undertaken to observe and experience related medical technologies and solutions in order to facilitate the medical data exchange between the systems. Moreover, the hospitals work with certain partners to run training sessions in order to increase their staff's awareness in the area of health data standards.

7.5.1.4 External Pressure

From the data, the researcher identified three types of external entity which have put pressure on hospitals to adopt certain health data standards. The first external entity is government bodies. For example, all the interviewees agreed that ICD was adopted by the hospitals as recommended by the MoH. In 2005, the government took the decision, based on a royal decree, to convert from ICD-9 CM to ICD-10 AM as the national code for diseases and

Abdullah Ibrahim Alkraiji 2011

diagnosis. Hospitals were recommended to adopt this version as soon as possible. This was verified by one manager who said:

> *We used to have ICD-9 as the national code for diseases and diagnosis up to the end of 2008 and then, at the beginning of 2009, we converted to ICD-10 AM according to the royal decree. (Participant 2)*

The data analysis also showed that the hospitals must conform to certain terminology standards (e.g. ICD and SNOMED) to report annually some medical information to the MoH and to facilitate cancer registration in the Saudi Cancer Centre. The data also showed that some government hospitals provide paid medical services and should therefore be corresponding to the standards adopted by Saudi Council of Cooperative Health Insurance and health insurances companies, as stated by one respondent who said:

> *We want to make sure that we are following other hospitals and the insurance companies unless there is a standard pointed out by the government. (Participant 24)*

The second external entity is the market. The data analysis revealed that the market is a source of pressure since the hospitals only follow industry standards because they do not want to lose market compatibility and vendor support. One of the managers noted:

> *There is no specific department with regards to standards' adoption and international standards, such as HL7 and DICOM, are imposed because they are the communication industry's standards. (Participant 18)*

The third external entity is international trends. For example, the hospitals try to follow some leading international organisations and conform to their standards, as one manager mentioned:

> *We look at the national level and to what extent these standards conform to international standards. For example, we follow FDA standards because the government is following the American FDA. (Participant 33)*

7.5.1.5 External Support

The researcher identified various external parties that had been contacted by healthcare organisations to help them understand and cope with health data standards owing to the complexity of this subject and the absence of a government role. For example, the data showed that some healthcare organisations rely on consultants in order to understand and activate certain standards on a regular basis, as one of the senior participants stated:

> *If we want to use certain standards, such as SNOMED, we need to bring in a consultant to activate this standard in our daily tasks. We think that being with a consultant regarding medical terminology will have a positive impact on the hospital's clinical information systems. One of the objectives of having consultations with Harvard is to identify the direct and indirect costs associated with the standards. (Participant 6)*

The data also revealed that vendor support is a major driver in the adoption of HIT related standards. For example, one of the roles of the vendor is to help healthcare organisations to draft the requirements, specifications and standards of the new system, as one respondent explained:

> *The vendor provides us with the interface statement document and then we review this statement precisely because there are many issues in HL7 and DICOM. We then discuss the statement with the vendors. (Participant 4)*

The role of the vendor regarding the adoption of HIT related standards was also mentioned by another manager when he said:

> *The new lab system will conform to SNOMED, LONIC, ASTM and other standards, and we are incorporating them in the RFP based on recommendations from the vendors. (Participant 32)*

The interviewees also explained some other roles played by the vendors during the adoption of HIT related standards. For example, vendor support during the implementation and integration of the new system into the hospital HIT infrastructure is essential to set and define the required standards and messages between the systems. As one manager said:

In terms of the integration between medical information systems, there is a need for the vendors to sit together and agree on specific standards because what I have noticed is that every vendor has its own customised standard version. Therefore, good lines of communication and coordination with the vendor are necessary because sometimes we cannot succeed through our own individual efforts and this is also part of the vendor support license. (Participant 17)

The necessity of obtaining vendor support in the integration stage was also mentioned by another senior participant when he said:

When we wanted to integrate the PACS into the HIS system, we sat together with the vendor since the HIS system does not conform to HL7. So, we identified the required messages and then we developed an in-house HL7 engine to read and convert the HIS system messages to HL7 messages which were then sent to the PACS system. (Participant 24)

In addition, vendor support, offered through some training sessions to hospital staff, was seen by the interviewees as essential since there is a lack of experienced professionals with regard to HIT related standards. For example, one respondent said:

We always work with the vendor in the integration; also, there are some training sessions run by the vendor to enhance our team's knowledge. (Participant 21)

Another interviewee expressed a similar view when he said:

The vendor of the code finder system has run some training sessions for the coders and we made this training part of the RFP project. (Participant 27)

7.5.1.6 Data Analysis

The findings showed that the analysis of data is an important factor for healthcare organisations, not only from the perspective of market competition, which is far beyond the public healthcare sector in Saudi Arabia, but also to help top management to acquire meaningful insights from the data by carrying out accurate statistical analysis, excluding any human bias. Data analysis is a decision-supporting system and its success or failure depends on the quality of the data that are inputted; it also relies on how well the systems are

146

integrated and how well the data are structured and predefined. The researcher identified four main reasons, in terms of data analysis, for the hospitals to gain meaningful insights into the data. These are to support decision making based on best practice solutions; to extract accurate reports and statistics required by different groups, such as management and the departments; to measure the performance of hospitals based on international KPIs; and to benchmark against other national and/or international organisations.

7.5.1.7 Trialability

The IT department managers agreed that the evaluation stage is one of the most important stages of the adoption process and so every new system must be systematically evaluated before adoption. The majority of the technical participants felt that the evaluation of the new system is an important step in the adoption process in order to examine, in a practical setting, to what extent the new system meets the hospital's needs, requirements and standards. For example, one manager reported:

> *We always carry out a pilot test for the new system and we call it proof of concept. In general, we do a small-scale pilot test to prove that this system is fulfilling our needs, requirements and standards, and that it is working and functioning well with other systems. We want to make sure that the integration part is working fine and that the messages are being exchanged properly; so, the test is very important in ensuring that the system meets our standards and needs. (Participant 17)*

The results showed that the evaluation procedure passes through various stages. These stages include class reports, vendor confirmation, pilot demonstration, and site visits for vendor references. The evaluations carried out through reading class reports were seen by the majority of the technical respondents as crucial before taking further steps in the adoption process. So, there is a need for the project team to search the Internet, websites, journals and white papers to expand their knowledge of the new system and so identify the expected specifications and features of the new system. However, the possible (or candidate) vendors must also confirm with the hospitals their required specifications and features with regard to the new systems. This is because the theoretical reports do not reflect the market capabilities so there is a need to check if any specifications and features are missing, to what extent this has an impact on the quality of the new system in general, and how the market and candidate

vendors will respond in terms of these features in the future. As revealed by the technical participants, every candidate vendor must make a pilot demonstration in virtual environment software simulator in the hospital to allow the stakeholders to inspect the system's features over some period of time. This is to help the hospital draft the RFP and the contract for the new system wisely. The IT department managers agreed on the importance of existing references concerning the new system and felt that it was the vendor's responsibility to arrange site visits to some locations and hospitals to check and examine the new system's capabilities in a real-life setting. One manager said:

> *We do not adopt a system that does not have references or one that has not been adopted elsewhere. We refer to references to assess the vendor's capabilities. (Participant 31)*

7.5.1.8 Size of the Healthcare Organisation

All the studied cases were large healthcare organisations with hundreds of thousands of registered patients. They included some hospitals and clinics which carried out various medical services, such as treatment, education and research. The data revealed that the size of the healthcare organisation has a positive impact on the adoption of HIT related standards. For example, a multi-site hospital must be integrated via an integration solution in order to exchange medical data and to have a single, integrated virtual database. This requires the systems to conform to certain standards such as HL7 and DICOM. One manager said:

> *The size of the organisation plays a major role in the adoption of the standards. We have the most sophisticated and complicated interface engine to connect the multi-site hospitals together. (Participant 4)*

Another participant said:

> *Physically, every site has its own database and we have a single virtual database through the integration engine. (Participant 6)*

In addition, the hospitals look for standards to manage the organisation's complexity since multi-site hospitals are growing both in number and in complexity. One manager explained, for example:

148

The complexity grows with the expansion of the entire organisation and so you need standards to manage this complex situation; without standards, this will be so difficult. We are expanding and growing; imagine if we do not have some sort of standard, how complicated will the situation be then! Therefore we adopt standards to manage the complexity of the environment. (Participant 5)

Another participant expressed a similar view when he said:

We are a big healthcare organisation with multi-site hospitals, clinics and a research centre. Besides that, we have many systems and if we are not following certain standards, how difficult it will be to manage the work processes. In this case, we will get lost between the systems. (Participant 1)

Moreover, the interviewees explained how difficult it is to adopt a system in a large healthcare organisation since it takes a long time to become oriented and to implement the system successfully. Once the system is being used and the processes that are built are based on it, it is difficult to get rid of the system. The participants showed that the systems in hospitals are intended to remain there for a long period of time. Therefore, the system's specifications must conform to the required standards since the procedures to replace the system are very costly and time consuming. One manager said:

In a healthcare organisation, the system is like a cancer because we cannot get rid of it easily. So, we must ensure that the system conforms to the right specifications before its adoption. (Participant 4)

Another director expressed a different perspective when he said:

We must adopt the systems carefully. The systems in hospitals are intended to be operated for years as they are not easy to get rid of and replace them with others. (Participant 18)

7.5.1.9 Accreditation

The data revealed that one of the main initiatives taken by the top management in leading Saudi hospitals is the acquisition of certain accreditation from leading international medical commissions. Being accredited means that the hospital not only provides high-quality

149

medical services based on best practices, but is also internationally recognised as a highly standardised hospital. Therefore, the hospitals must follow certain standards, including health data standards, in order to be accredited. According to some interviewees, although the MoH has recently established a national initiative to accredit those hospitals following certain standards, the majority of the hospitals, and in particular the leading hospitals in Saudi Arabia, are looking for accreditation from the United States, Europe, Canada and Australia. This is because acquiring accreditation from those countries means that the value of the hospital is increased; this, in turn, reflects on the reputation of the top management. In addition, MoH is still lacking a national agent to oversee the accreditations and to also cooperate with the leading international commissions in this regards to encourage the hospitals to apply the required standards. All the hospitals, and the majority of the main departments in these hospitals, have established plans to acquire international accreditation since the management encourages this and offers certain incentives in this regard. One manager reported:

> *Every department works closely with consultants to be accredited. Currently, we have been accredited by one leading American commission in this regard and so we are following their standards since there is a team which comes regularly to the hospital to inspect and evaluate us. (Participant 5)*

Another participant explored a similar issue when he said:

> *Because we are going to have Canadian accreditation, they have given us a sample of all the standards and we try to follow them. They have simulation standards' software; they gave this to us to review and try to follow. We have passed the first phase and we are preparing to achieve the second phase by 2011. (Participant 29)*

Some interviewees were disappointed because, although the systems include standards and the hospitals may be following these, this does do not mean that the hospitals actually use those standards on a daily basis or that the quality of the care they deliver is improving. This is because the majority of the systems that were adopted in the hospitals were built based on best practices according to the availability of adequate budgets, and they consist of the standards required by the accreditation commissions. So, the hospitals will obtain the accreditation since their systems conform to the required standards even though the

standards, for example, LONIC, may not be activated on a daily basis in those hospitals. The interviewees suggested that the procedures for acquiring accreditation should be changed to reflect to what extent the hospitals are conforming to the standards in a practical setting, not a theoretical one.

7.5.1.10 Education

The majority of the cases studied provided excellent academic opportunities, conducted research and medical education, and participated in industry and community service programmes in the health field. The aim of the education and research centres is to provide a specialised scientific environment that supports clinical research in order to promote excellent medical services and the continuous development of diagnostic approaches and methods for the treatment and prevention of diseases. Since these education and research centres rely on information in pursuing their aims and achievements, they frequently require information from the hospitals. In order for the hospitals to provide these education and research centres with valuable information, the hospitals must sustain high-quality medical information. This requires the development of an intelligent HIT infrastructure which requires, among other things, the infrastructure to be more interoperable and constructive. It also requires the data warehouse and knowledge management systems to be based on a standardised format and to conform to international health data standards. For example, and according to one director of medical and clinical informatics, the hospitals in Saudi Arabia failed to support research into the last outbreak of Swine Flu with accurate cases and statistics because of the lack of a national standardised methodology to deal with this disease.

7.5.1.11 Organisational Culture

The data showed that the healthcare organisations in Saudi Arabia are part of a multi-cultural environment. This is because most of the medical staff are foreign, coming from many different nations and backgrounds. There are approximately 65 nationalities in the hospitals in Saudi Arabia. So, culture plays a major role in making the hospital authorities more enthusiastic about adhering to international health data standards, as one respondent reported:

> *One thing is that we have employees from more than 65 countries with different cultures and backgrounds and therefore standardising clinical terminology locally and internationally is very important to us. (Participant 6)*

This is because, first, having a non-standardised medical language in the hospitals requires a great many training programmes. This was considered by the majority of the participants as one of the challenges and the most costly aspect facing the hospitals in Saudi Arabia. So, management is always concerned about how a hospital can synchronise the knowledge of its medical staff to the required level because of the considerable demands on new medical people and the lack of standards. One manager said:

> *The orientation of the users is one of the most serious challenges because we do*
> *not have the same level of users and there is a need for users' synchronisation.*
> *(Participant 29)*

Secondly, there is a high turnover rate of medical staff in Saudi hospitals; for example, the average length of stay of nursery staff in Saudi Arabia is about one year. This is because most medical staff are foreign and once they find a better job in a different country, they break their contract. This results in substantial demands for the hiring of medical staff which, in turn, requires a great many training sessions. One manager explained:

> *There is a high turnover rate of employees in the hospitals since the average stay*
> *of nurses in the hospital is about one to one-and-a-half years and so we are hiring*
> *100 new nurses a week who must be well trained. We are also hiring other*
> *medical staff such as pharmacists, laboratory people, physicians … etc.*
> *(Participant 6)*

In addition, the data showed that ICD-10 AM has not been adopted in some Saudi hospitals due to certain cultural considerations. For example, most of the hospital systems in Saudi Arabia are either North American or European based as the majority of Saudi physicians have come from the two schools. When the government took the decision to convert to ICD-10 AM, the physicians were disappointed; this, in turn, has resulted in some resistance, as one director explained:

> *I think the decision to have ICD-10 AM was wrong because one of the greatest*
> *benefits introduced by ICD is benchmarking and therefore we always compare*
> *ourselves to North American or UK countries; also, most of the literature that we*
> *read in order to compare ourselves is based on journals in those countries. Thus,*
> *we are continuing to use the CPT standard because we think it is the best*

152

procedural terminology standard. This standard has been adopted since the hospital was run by American management. We are also happy to continue using this standard because it is still used in the United States. (Participant 11)

7.5.1.12 Network Externalities

The participants differentiated in their opinions, with regard to network externalities between messaging standards (e.g. HL7 and DICOM) and terminology standards (e.g. ICD and SNOMED). For example, the majority of the participants agreed that HL7 and DICOM have been imposed because they are the current market standards for communication between different clinical information systems and so hospitals cannot choose other standards if they want to retain market compatibility and support. One executive commented:

There is no choice for us but to adopt HL7 and DICOM because they are the industry communication protocols. (Participant 1)

Another executive reported a similar perspective when he said:

International standards such as HL7 and DICOM are imposed because they are the communication industry standards. (Participant 18)

In addition, the participants revealed that they only followed and adopted the best of breed systems which were built based on the market or international standards. Therefore, the hospitals are restricted by the market standards, as one manager explained by saying:

We know that the vendors of the best of breed products are somehow involved in the development of health data standards and they are the stakeholders of them. (Participant 1)

Moreover, the hospitals' authorities always think about integration, either within the hospital's HIT applications, or with other hospitals. As a result, they must conform to the market or international standards in order to facilitate such integration. As one senior manager stated:

Abdullah Ibrahim Alkraiji 2011

We are always making sure that our systems are the best of breed products because, if the system is not capable, the integration cost will be very high. (Participant 1)

Regarding terminology standards, the participants agreed that ICD and SNOMED had been adopted because they are international terminology standards that are used throughout the world. These standards must be adopted in order for the hospitals to report certain medical information to some national bodies and for them to use this information to benchmark against other national or international hospitals. One senior manager said:

We were not able to extract reports or statistics or to benchmark against others before using ICD; now we can generate accurate statistics and report the cases of disease to the MoH. (Participant 1)

The researcher identified several communication channels which have been utilised to varying degrees by healthcare organisations to increase their industry knowledge regarding health data standards. For example, one of the main methods, which has had a positive impact on the adoption of health data standards, is to use consultants. Since there is a shortage of knowledgeable people in this regard, either at an organisational or national level, obtaining the services of a consultant is therefore more meaningful in looking at how the hospitals are functioning and to assess what value the hospitals will obtain from adopting health data standards. The data revealed that the vendor is a major resource tapped into by the hospitals to understand and cope with health data standards. The vendor not only gives information about health data standards, it sometimes goes beyond this to propose specific standards. Other communication channels are memberships, conferences, site visits to some leading international hospitals, the Internet, and training.

7.5.1.13 Type of Healthcare Organisation

The data showed that there are three types of healthcare in Saudi Arabia, primary care (e.g. GPs), secondary care (e.g. general hospitals) and tertiary care (e.g. specialist hospitals). All the studied cases were tertiary hospitals. The interviewees revealed that, although the standards are required in every healthcare sector, the tertiary hospitals are most in need of adhering to the health data standards in order to operate efficiently and effectively. As a result, the hospital authorities have no option but to adopt certain standards. The participants

154

listed several reasons for this. First, the tertiary hospitals are complex systems whose processes are complicated. So, this requires, among other things, a high level of standardised and interoperable systems to facilitate workflow processes and support decision-making at any stage of a patient's care. One director explained:

> *Awareness of interfaces is becoming very high because, in a medical environment that is very complicated and sophisticated like the tertiary hospitals, we have to have an interface technology that is rigid enough to facilitate the workflow through different systems. (Participant 3)*

Secondly, the lifecycle of just one case in a tertiary hospital may sometimes require sophisticated treatment involving numerous physicians and medical staff. So, the medical language must be consistent and the data must be synchronised between the different groups of physicians in order to maximise the success of the treatment and to reduce medical errors. A high degree of interoperability between the systems is required in order for this to be successfully accomplished, as one manager said:

> *We are a tertiary healthcare organisation and decision making by physicians must be based on a solid integrated infrastructure, For example, the team who are involved in caring for or managing one single patient in a tertiary hospital is sometimes up to 100 strong. If they do not use the same terminology standards, this will result in confusion which will finally affect the care of the patient and the quality of the care. (Participant 6)*

Thirdly, the interviewees revealed that there is no one single complete HIS system available "off-the-shelf" today which addresses all the functions needed by the tertiary hospitals since every tertiary hospital has its own policies and procedures. For example, as reported by some interviewees, every tertiary hospital in Saudi Arabia has its own policies with regard to patient admission and discharge; these are sometimes based on Royal Decrees. Since no complete HIS solution meets the needs of all the required functions, the tertiary hospitals must adopt only HIT related standards to facilitate integration between the systems and move towards the development of a data warehouse that is coherent and consistent. One director said:

There is no complete HIS integrated solution available in the market which can meet all the required tertiary hospital functions, modules and expectations. (Participant 18)

Fourthly, the majority of the tertiary hospitals carry out some sort of medical research and education programmes which require, among other things, the existence of a robust information infrastructure in order to achieve the desired objectives. This requires the systems to conform to health data standards in order to improve the consistency of the data and to make integration possible.

7.5.1.14 Enhancing the Use of Advanced Systems

The data showed that the hospitals in Saudi Arabia are hesitant about adopting certain advanced clinical information systems. This is because such systems require a robust standardised information infrastructure in order to be successfully implemented. The interviewees also described other advanced clinical information systems (e.g. data warehouse, knowledge management and CPOE) that are currently being used in the hospitals in a less than effective way because of the nature of the proprietary format of the data structure in the hospitals. For example, one director/manager reported that there was a plan to implement a data mining system in his hospital but, after one year in which many problems and difficulties were encountered with this system, the project team decided to terminate the project. According to the director/manager, one of the problems was due to the lack of appropriate health data standards. This was because the hospital HIS was a very old system with a proprietary format of data structure and limited integration solutions. Another director of health informatics mentioned the same issue when the hospital failed to implement a business intelligence system because of the lack of a solid information infrastructure. A further example was offered by one executive who explained that the use of the CPOE was limited in his hospital since a complete dictionary of problems list had not been integrated into the CPOE system. He explained:

We are going to expand the CPOE system because we currently have it for only a limited entry profile. When we have it with our plan for a diagnosis and problem list, this will be our driver to adopt health data standards. (Participant 2)

In addition, most of the cases studied had already started a data warehouse project in some form or another for both managerial reasons (e.g. statistics, reports, performance, decision support and benchmarking) and medical purposes (e.g. top most common diagnoses and procedures and research). However, having a data warehouse system requires, among other things, highly integrated systems and a well-structured data format. So, this is why the studied cases have largely failed to implement such systems and subsequently receive the benefits they offer. One manager said:

> *Due to the lack of standards, there are some difficulties in terms of digging for information because we cannot extract the information from free text or images. This is preventing us from obtaining fruitful data through the data warehouse; the need for information from the data warehouse will push management to work hard on the health data standards in order to have a date warehouse that will replicate fruitful data. (Participant 2)*

7.5.2 Hindering Factors

The hindering factors define those factors which have a negative impact on the adoption process of HIT related standards at the decision-making stage in healthcare organisations. The researcher identified fourteen factors through the data and the sections below explain each one by offering a detailed analysis.

7.5.2.1 Lack of a National Regulator

Due to the lack of a formal reference for health data standards, there is confusion amongst the hospitals in Saudi Arabia about which standards they should pay attention to, which they should embrace, and those they should adopt. Although several government entities and commissions have spoken about the standards, no one has taken the lead to develop and promote such standards in Saudi Arabia. All the interviewees agreed that the lack of a national regulator is a negative factor which hinders the widespread use and adoption of health data standards in Saudi Arabia. For example, one manager said:

> *One of the negative factors regarding health data standards is the absence of a national regulator. Who is responsible for the ICD-10 AM? It is not the MoH, not*

the Saudi Commission of Health Services and not the Saudi Commission of Health Insurance. (Participant 6)

A similar view was also expressed by another manager who said:

One of the main problems in the country is the absence of a government role and that is why different hospitals follow different standards. (Participant 33)

Another manager also explored the same issue when he said:

We do not have a group for clinical information technology in Saudi Arabia and there is, for example, no HIMSS or HIPAA representative group in the country. So, there is no national reference in this regard; we use the internet and websites to explore the standards. (Participant 31)

For example, the data showed that the application of ICD-10 AM in Saudi Arabia has failed due to the lack of ICD-10 AM coders and also because of technical concerns. This is because the MoH took a sudden decision to convert to ICD-10 AM without involving the stakeholders and healthcare providers in making this decision. As one executive said:

I think the decision to convert to ICD-10 AM was not reviewed well so the decision behind moving to ICD-10 AM was wrong since it was not based on a survey study, did not involve the stakeholders and did not measure the capabilities of the hospitals and possible ways and solutions for adopting ICD-10 AM. (Participant 1)

The data also showed that some medical data have not been produced or extracted due the lack of a formal national regulator with regard to health data standards. For example, the last Swine Flu cases were not recorded accurately as one executive said:

There must be a central respected authority to handle all the health data standards processes. For example, during the last swine flu outbreak, we did not have any mechanism to report the exact number of people who had the flu and therefore the cases were reported manually to the MoH; also, the number of cases was not accurate. (Participant 11)

The data also revealed that, in the absence of a formal reference for health data standards, there are some difficulties facing healthcare organisations in understanding and coping with these standards. For example, every healthcare organisation has a consultant to deal with or understand health data standards. In addition, the hospitals affiliated to the MoH are not able to recruit and hire non-Saudi coders because the Saudi Commission of Health Specialists does not have a career under the name of coder. One manager said:

> *The Saudi Commission for Health Specialists does not have a career under the name of coder and therefore, when we tried to hire a non-Saudi person as a coder, the Commission refused as they did not have this as a career. (Participant 19)*

The majority of the respondents confirmed the importance of the existence of a formal reference for health data standards. The existence of a formal regulator is important because most of the hospitals in Saudi Arabia are still developing and therefore they will be less demanding and resource consuming in terms of the current HIT infrastructure, as one manager stated:

> *There is a need for a regulator at the national level, especially in Saudi Arabia, because we are still developing and we need such an entity soon before the high level of investment in the HIT infrastructure has taken place. (Participant 31)*

The formal reference body should lead the development, promotion, adoption and use of health data standards. It should also customise the international standards to meet the national healthcare organisations requirements, as one participant said:

> *Standards must be customised to meet local requirements, such as, for instance, providing information in Arabic, so there should be a national committee to set up the required standards and the national patient unique ID number, as well as to customise the standards to meet local requirements. (Participant 26)*

Such a body should also become involved in the existing international standardisation initiatives rather than focusing its resources on developing its own standards and then customising the international standards according to local needs, as one chief executive mentioned:

We have to educate ourselves, sit on the boards of those standards' organisations and participate in the development of the standards. (Participant 15)

A similar view was also put forward by another manager who said:

We are not contributing to the standards' development organisations and therefore we should be actively participating in the development process and customising the standards to meet our local needs. (Participant 10)

In addition, the proposed regulator should monitor and govern the national market so that every system will be certified before it can be marketed. Moreover, it should cooperate and coordinate with the Ministry of Higher Education and different national universities to redesign the curricula of medical colleges in order to establish a new education programme and career in Health Informatics to overcome the shortage of national professionals.

7.5.2.2 Shortage of Professionals

Since Saudi healthcare organisations are newcomers in the area of advanced HIT applications, there is a shortage of national experts who are knowledgeable about this subject; this is hindering the improvement and development in health informatics and, in particular, health data standards in Saudi Arabia, as one of the executives reported:

There is a shortage of technical expertise and human resources in the country and, even if we can find such people, they are very expensive to recruit. (Participant 20)

A similar view was also expressed by another manager when he said:

The lack of human resources in the country is one of the main barriers to the development of clinical information systems. (Participant 31)

As a result of this shortage, many problems have been encountered during the adoption of HIT applications which have resulted in money and time being wasted, and sometimes in the failure of the system. This was explained by one of the executives who said:

The problem is when you have someone who is not a health informatics person and you let him buy, design and run the medical systems; he may even not know

160

what HL7 and DICOM are. This unfortunately is the problem across the board and in particular in Saudi Arabia: it lacks qualified people to run clinical information systems. (Participant 1)

Another respondent expressed the same view:

The implementation of clinical information systems in Saudi Arabia costs three times what it costs in the United States, European countries or in Canada due the lack of qualified people. (Participant 8)

A similar view was also expressed by another participant when he said:

The evaluation of clinical information systems is usually carried out by consultants because there is a lack of qualified people in Saudi Arabia in this area. (Participant 24)

For example, the data showed that Saudi Arabia is in dire need of about 1500 ICD-10 AM coders. Moreover, Saudi coders represent less than 5% of the total number of coders in Saudi Arabia, as one respondent said:

Most of the coders are expatriates and you will be surprised because the Saudi coders might be less than 5% of the total number of coders in Saudi Arabia. (Participant 1)

This was also indicated by another manager who said:

One of the main problems in Saudi Arabia is the shortage of coders since there is no training in Saudi Arabia in this regard. We have only 3 coders for ICD-10 AM and they are of non-Saudi nationality. (Participant 33)

Another senior manager reported the same issue and said:

We are lacking coders; I think Saudi Arabia is in dire need of about 1500 coders. (Participant 9)

The reason for this shortage is because the current education and training in health informatics cannot meet the need. Therefore, there is a long-term government plan to

161

establish many university programmes in the subject of health/medical informatics to overcome this barrier. Also, there is a plan to send students to some advanced countries for training and study in this area as one executive said:

> *We have a long-term plan to establish health informatics departments in some universities while benefiting from government scholarships to dedicate some places to the study of those subjects. (Participant 1)*

7.5.2.3 HIT Infrastructure

The data showed that the current hospital HIT infrastructure must be capable before a new system is adopted. The capability of the infrastructure means that the new system should operate within the current available resources in terms of technical issues, such as platforms and networks, and human aspects, such as knowledge and skills. One of respondents said:

> *The main concern is the capability of the new system to integrate with the hospital information system and that there is no need for other investments. (Participant 6)*

Every hospital has made a large investment in terms of infrastructure and so the IT department has its own requirements, specifications and standards that the new system must conform to in order to be accepted and adopted, as one executive reported:

> *Our policy states that whenever there is a new system to be purchased, it must fulfil the data centre department's standards and requirements because the investment of the platform is very expensive and therefore it is difficult to change the platform to new platform to fit the new system. (Participant 2)*

Other interviewees explored another interesting theme which is the conflict between the selected standards and the standards of the vendor. For example, the government took the decision to convert from ICD-9 CM to ICD-10 AM yet some hospitals are still waiting for the upgrade to come from the vendor. This is because most of the systems come from American vendors who are still using ICD-9 CM in their systems as the United States' national code for disease and diagnoses. In addition, the decision to convert to the Australian version was made by the top management of the MoH without full stakeholder consultation. As a result, they have not yet upgraded their systems to this version and so most of the hospitals have either

162

postponed the upgrade stage or they have adopted ICD-10 AM as a standalone system for research and reporting purposes only. One chief manager said:

We use ICD-10 AM as an external component because the hospital information system is still ICD-9 CM compliant. This is because the vendor is from the United States and they are still using ICD-9 CM there. (Participant 14)

Another issue which was reported by some interviewees is that the HIT infrastructure is very old in some hospitals and so it does not allow modifications to be made. This is why some dictionary standards, such as ICD-10 AM, were postponed to a later stage when the new HIS would be replaced. One manager noted:

We have not applied the ICD-10 AM version because the hospital IT infrastructure is very old. (Participant 33)

7.5.2.4 Complexity

Most of the participants agreed that health data standards are very complicated and so they require champions and a national initiative to take the lead in setting out the national health data standards required for medical information exchange. Saudi Arabia is a newcomer to the area of advanced HIT applications and is therefore deficient in many areas that are necessary to understand or cope with the standards. For example, when the government took the decision to convert from ICD-9 CM to ICD-10 AM, only three hospitals converted to this version. Moreover, the conversion was carried out partially in those hospitals and as a stand-alone system in order only to facilitate research and to report some cases annually to the MoH and the Saudi Cancer Centre. As a result, many problems were encountered and have been raised during the conversion process, such as mapping from the old version to the new. In addition, when lab information system managers were asked about SNOMED, the answer was that SNOMED is limited in its use profile and is mainly used to register cancer cases in the Saudi Cancer Centre. This is because SNOMED is a very comprehensive standard which requires experts in the field in order to maximise its benefits, as one information systems manager noted:

SNOMED is very comprehensive and therefore we need to concentrate on what we need and how the standards will support our work. (Participant 32)

163

A similar view was reported by another manager who said:

> *Terminology standards are comprehensive and if you want to know everything, this will be waste of time. Therefore, the benefit is to use them for your local needs; you should focus on what you need. (Participant 2)*

Moreover, the data showed that efforts are being made by some hospitals to code, for managerial and analytical purposes, all the medical procedures and services that are provided to patients. However, the hospitals have either failed to carry out this process due to the many difficulties they have encountered, or they have outsourced this project to some leading organisations which has cost a lot of money as this is a long-term process. This was explained by one of the executives who said:

> *Coding is very complicated process and therefore we brought in a well-known company in this area to code all the services that we provide to the patients. We also hired charge description master coordinators to handle and maintain the coding to ensure that every service introduced to the patients is automated and coded. We thought before that coding was an easy job but when we came to the field we discovered that coding is a very complicated process. (Participant 11)*

Another participant expressed the same view when he emphasised the importance of hospitals having a consultant to help them with the coding processes. He said:

> *We are thinking now of bringing in a consultant from Harvard to do the coding structure. Getting experts from outside will be more meaningful as they will be coming here and looking at how the hospital is functioning and what the value is of the coding structure that we are going to obtain. (Participant 5)*

7.5.2.5 Switching Cost

The interviewees emphasised the importance to the adoption of health data standards of the cost factor in switching standards. The data showed that the cost of health data standards has a negative impact on the adoption of certain standards, especially when the ensuing benefits of the standards compared to the cost of switching are uncertain. This was explained by one of the managers when he said:

Abdullah Ibrahim Alkraiji 2011

We intended to adopt HL7 CCOW, but when we discovered that the adoption of CCOW necessitated some non-existent requirements and infrastructures in order to function properly, we decided not to adopt it since the expected outcomes and benefits compared to its installation costs made it not worthwhile. (Participant 10)

Another manager indicated the importance of knowing the cost of the adoption of health data standards before making a decision to adopt them when he commented:

One of the objectives of having a consultation with Harvard is to know the cost associated with the standards. (Participant 6)

This was also made clear by one executive who said:

We were disappointed when the government chose ICD-10 AM. Now, we are suffering with the mapping process which I think is going to cost a lot of money. (Participant 11)

Every participant put forward some switching costs associated with the adoption of health data standards; the researcher grouped these into direct and indirect switching costs. This aligned with the comments of one respondent who said:

Cost is always related to the cost of software, change management, and changing the mindsets of people to use the new system. There are some quantitative and some qualitative aspects. The quantitative aspect is the cost directly related to the adoption process. The qualitative aspect is the indirect cost that is difficult to quantify. (Participant 13)

Direct cost refers to any cost that can be traced and quantified throughout the different activities which are launched during the adoption process while indirect cost refers to costs that cannot be conveniently traced or quantified. For example, the respondents listed many direct costs, such as software, hardware, education, training, awareness raising, conferences, memberships, consultations, maintenance, vendor support, licence fees, online journals and library subscriptions, manpower, and incentives. Concerning indirect costs, the researcher identified three types of cost. These included the cost of change management, lost manpower while staff were attending training sessions, and paying employees while attending training

sessions. Nevertheless, the data showed that the most important switching cost associated with the adoption of health data standards is for training and change management whilst the least important cost is for hardware and software because the standards fall within the project's budget and are therefore treated as a feature of the new system. However, systems that are built based on standards are more expensive compared to others. The subjects of training and change management were explored by many participants. One of them said:

> *The greatest cost associated with the standards is training people to use the standards and to be aware of them. Mostly, this involves training issues and overall organisational readiness because you cannot convert from certain standards to others overnight. (Participant 11)*

7.5.2.6 Compatibility

Some interviewees agreed that health data standards must be compatible with a country's regulations, the environments of the organisations and the HIT infrastructure in order to be accepted and adopted. For example, the interviewees explained that the standard must support local needs, such as the need for information in Arabic (e.g. names, dates and numbers). Therefore, there is always a need to customise the standards to suit local requirements. This was explained by one engineer when he said:

> *We customised the HL7 messages to support Arabic information such as names and dates. (Participant 25)*

Another engineer agreed on the importance of compatibility by saying:

> *There might be incompatibility issues with the new standard. According to the CERNER Company, which has been working in the Middle East for ten years, there is a need to customise the standards to meet regional requirements such as providing Arabic dates which many activities, such as doctor appointments, vacations, and training programmes, etc., are based on. (Participant 26)*

The standards must be compatible with the hospital's work environment in order to enhance their benefits. For example, when the government took the decision to convert from ICD-9 CM to ICD-10 AM, the hospital authorities were disappointed because the medical environment in Saudi Arabia is either American or European based since medical staff in

Saudi Arabia have backgrounds from those schools. It should be note that the environment is not Australian based. The specifications of the new system must also be compatible with the technical infrastructure so that additional resources do not need to be invested. For example, the data showed that testing the compatibility of the new system with the IT infrastructure is one of the main requirements in the policies and procedures of the hospitals and, as a result, many test phases must be undertaken (e.g. demonstrations and site visits for some vendor's references) before the new system is adopted. This was stated by one respondent who reported:

The first requirement is the compatibility of a new system with the hospital's backbone system. The new system must be integrated somehow and interfaced with our vendor's system to check with those references. This is expected because there are always compatibility issues. (Participant 9)

7.5.2.7 Market Uncertainties

The interviewees strongly emphasised that there are always variations between vendors in terms of the extent to which they conform to health data standards and, in particular, communication standards such as HL7 and DICOM. Most of the technical participants agreed that every vendor customises the standards based on a proprietary format and therefore each has its own customised standard version. This results in an integration barrier between the systems although the vendors advocate that their systems are standard compliant. For example, one executive said:

What I have noticed regarding communication standards such as HL7 and DICOM is that, although the companies say their systems are standard compliant, when it comes to the real situation, there is an issue of regarding integration. (Participant 19)

Another respondent expressed the same point of view and reported:

We have noticed that there are some variations between the companies' versions because every company modifies the standards based on its own requirements and needs. (Participant 12)

In addition, several interviewees asserted that health data standards, such as HL7 and DICOM, are not the complete solution in terms of integration between different systems. Therefore, great effort always has to be made during the integration stage and in medical data exchange. In addition, there is a need to have an integration engine to act as middleware between the systems because simple data integration does not solve the integration problem since healthcare organisations require a comprehensive workflow integration solution. The respondents emphasised that health data standards are just one of the tools that facilitate the structuring of data and data exchange between the systems. They do not provide a comprehensive workflow exchange between the systems. For example, one executive director explained:

> *What I want to emphasise is that integration in healthcare is not plug-and-play although your systems are standards-based and therefore hard work is needed during the integration process...so, health data standards are one of the tools to facilitate such integration but they do not provide a comprehensive integrated workflow as a solution. (Participant 1)*

Another senior manager expressed a similar thought when he reported:

> *There are some variations between the companies in the application of the same version of the standards and it is always hard work to achieve integration between the different systems. This is why the companies ask a high price for the integration part between the different systems; it is because there are always risks in the integration. There is also a need to have both companies of the two integrated systems take part in the integration because clinical information systems are not plug-and-play. So, there is always debate with regard to the standards; this makes the hospitals hesitant to change to the required standards. (Participant 23)*

In addition, the IT department managers reported another two dilemmas facing the national market today. The first is that the leading companies and vendors of clinical information systems cannot gain access to national markets directly, as they are required to have a national broker in order to market their systems in Saudi Arabia. This results in two barriers. First, some brokers are not qualified to work or deal with HIT applications; this has prevented market transparency and made the hospitals uncertain about detailed information. Second,

168

some leading international companies in clinical information systems prefer not to have a broker. They want to negotiate with their customers directly and therefore the national market has lost some leading vendors. The second dilemma concerns the national companies. The IT department managers stated that even many of the national clinical information systems companies do not know what standards are and yet they are marketing their systems to some government and private healthcare providers. This will result in interoperability and integration barriers in the future.

Given the problems mentioned above, the majority of interviewees agreed that the strategy of the hospitals must be to support only the best of breed systems to reduce the risk of system failures and interoperability problems. This is because, according to the interviewees, the vendors of the best products are involved in the development of the health data standards themselves; they are stakeholders in them and so, by adopting only the best products, the hospital authorities will ensure that their systems are compliant with international standards. The IT department managers agreed that there must be a commission to monitor and govern the market; every system should be certified before being marketed, as one of them reported:

> *The national vendors always advocate that their systems are standard compliant but this is not the truth. We need a national body to certify them. If the systems are certified and evaluated by non-profit third parties, then the systems should be of good quality. (Participant 20)*

7.5.2.8 Resistance to Change

The majority of the interviewees agreed that, in order to support the adoption and use of health data standards on a daily basis, a dedicated change management programme must be established. This programme should ensure that a highly collaborative approach is undertaken by the hospital authorities, different departments and related groups to regulate successfully the rate of change and ensure the organisational change objectives are fully realised. For example, the commitment of top management to support the implementation is a key factor in the success of every HIT related standards project since it is necessary for top management to allocate an adequate budget and make available the resources required (e.g. financing training sessions and awareness-raising initiatives) during the adoption process. The dedicated change management programme should also examine the implementation of technical metrics, measures of acceptance, and the use of health data standards by staff and physicians. This is

because, for example, there is likely to be a high level of resistance from physicians to the use of terminology standards in their daily work because clinicians lack a background in health data standards and are often unaware of the benefits that standards can bring to the organisation; thus, it must be hospital policy to force them to use the standards. This is also because following the standards will result in reducing work flexibility. Therefore, organisational commitment is critical in achieving the required changes. The hospitals must recognise the importance of engaging clinicians in the development of a highly standardised medical information infrastructure. Thus, clinical leadership, collaboration, effective communication, and commitment to education, training and awareness-raising sessions, are critical success factors in maintaining the application of health data standards on a daily basis. In addition, there is a need to offer incentives and forms of compensation to encourage medical staff to use terminology standards in their daily routine tasks. Moreover, support from management is essential to force physicians to carry out their tasks in a standard way to achieve uniformity in the work they do.

The dedicated change management programme should also assess how the hospital is structured and should examine what changes are necessary to increase the success of the adoption of health data standards. For example, IT department managers commented on the necessity of having health informatics personnel or those with medical backgrounds to work closely with IT experts since medical information systems require not only technical people, but also a mixture of those with business or care backgrounds in order to ensure that the needs and requirements of the stakeholders are addressed. As a result, IT departments must be restructured to involve a mixture of different people from different backgrounds. One IT department executive director said:

> *The IT department people are not qualified to understand hospital processes and procedures, which are the core of any successful project implementation. So, there is a need to have clinicians work closely with the IT department in this regard. You know that the leading companies in clinical information systems employ people from different backgrounds, such as those from the field of IT and health informatics, as well as medical personnel, such as nurses, laboratory assistants, radiologists, pharmacists and so forth. (Participant 19)*

Moreover, the dedicated change management programme should redefine how business processes operate and flow, how the systems are integrated, how the data are predefined and saved, and how the documentation is structured and located. This will bring about significant and potentially overwhelming changes to the flow of work and to day-to-day operations. The dedicated change management programme must be managed carefully and with sensitivity as it will have a considerable impact in the form of change for employees and medical staff. Critical to the success of this programme is the commitment of the organisation in managing and sustaining the substantial changes that will result from the implementation. In short, adapting to the new system is a challenge. This is because there is always a need to change people's reactions and mindsets to adjust to the new system and its policies. In this regard, one manager said:

> *There is a need for change management. Changing the mindset of people to use the new system is also a challenge. (Participant 13)*

7.5.2.9 Lack of Clinician Engagement

The collected data revealed that there is less engagement on the part of clinicians and, in particular, the older generation of doctors in adhering to the use of clinical information systems as most of them still use notes or a paper-based system. The interviewees listed some reasons for this problem. For example, most Saudi physicians have not undertaken any education programmes with regard to health data standards and their applications in a medical environment, as one manager reported:

> *The standards group should gather together and meet on a regular basis to discuss issues concerning the current standards. Education is very important and this is one of the most serious challenges we are facing with the physicians because they have not taken any education programmes at university in this area. So, it is important to offer education and training, to bring up the new concept regularly and get feedback from the users; if they do not want to use it, we need to know why. We should offer some incentives to physicians who use the coding system. (Participant 5)*

In addition, the resistance of some physicians to adhere to certain standards is because that they are unaware of the benefits that standards can bring to the organisation. This is because

they have never used a data exchange model between different hospitals and therefore they think that the benefits are managerial, not clinical. One manager said:

> *People's reactions are a barrier to the adoption of health data standards because they lack an understanding of the benefits brought by standards. Therefore, we should use some educational programmes to train and make people in the medical field aware of the value of the information and its role in improving healthcare. (Participant 5)*

So, many physicians think that using health data standards on a daily basis just amounts to extra work so they do not want to accept such standards because they are already overloaded. One executive said:

> *The standards are meeting with some resistance from the physicians because they do not realise the importance and benefits of the terminology coding; they think that it is just extra work. It is the role of high-level management in the medical services to force the physicians to adopt and use terminology coding. The IT role is to help the medical services enforce compliance by producing reports and to show who is using the system and who is not. (Participant 2)*

Moreover, the data showed that there is no clear policy and procedure to encourage or force physicians to use health data standards so it is up to clinical departments to encourage their staff to use certain standards, with one manager reporting:

> *I think the resistance from the physicians is a negative factor because the policy does not support us in forcing physicians to use the terminology standards. (Participant 6)*

Furthermore, the interviewees revealed that there is no incentive programme to encourage clinicians to adhere to certain standards. The hospitals policies and procedures should be reformed to include some incentives (e.g. money and professional accreditation) to encourage the physicians to use the standards in the daily basis (see recommendation two, page 239). A role of top management should be to establish such a programme to monitor to what extent physicians adhere to health data standards and then use some sorts of incentive and/or punishment to ensure the application of health data standards in hospitals on a daily basis.

The interviewees emphasised that the hospital must recognise the importance of engaging clinicians and should employ a highly collaborative approach in developing the hospital information infrastructure plan in order to ensure the organisational objectives are realised. Clinical leadership, collaboration, strong communication, and commitment in particular to education and training, are essential factors for the success of this plan. In addition, the role of the clinical departments should go beyond the use of the clinical information systems and extend to participating in suggesting, selecting and adopting such systems.

7.5.2.10 Lack of Adequate Policies and Procedures

The data showed that clear hospital policies and procedures are essential to the success of any system that is adopted and in particular to the adoption of HIT related standards. Hospital policies and procedures are a set of guidelines that should be defined precisely. These should be developed for all the different activities when a request is made to purchase a new system and should be followed rigorously until the system is used on a regular basis. Although the participants agreed that some policies and procedures exist with regard to the adoption and implementation of clinical information systems, all the hospitals still lack sufficiently well documented and detailed policies and procedures. One manager stated:

> *We lack documentation or "lessons learned" databases which will enable parties to review the experiences of others, thus lessening the problems. Every time there is a problem, a dedicated committee is established to resolve the problem since no clear policy or procedure exists in the hospital. (Participant 19)*

For example, every purchase is treated differently and therefore the success of the project is based entirely on the qualifications of the project team. In addition, the adoption of small- and medium-sized systems is sometimes based on the decision of an individual, not on a particular policy or procedure; as a result, the percentage of system failures is very high. As reported by some participants, the role of top management is also not precisely defined. For instance, top management is sometimes involved in the adoption process which increases the likelihood of the success of the system implementation, but sometimes it is not. This depends on how close the top management is to the project team. In addition, some systems have been adopted by high-level managers directly without involving the stakeholders; this is why some systems have, either completely or partially, failed to be integrated with the hospital's backbone system owing to conflict and compatibility issues with some standards.

Some interviewees described another phenomenon in the medical environment which is the troubled relationship between physicians and administrative personnel (e.g. IT administrators) and the power struggle between them. This always results in the creation of political barriers. For example, there is frequently a struggle for power between the two groups concerning who should lead the adoption of clinical information system projects since there are no clear policies and procedures in this regard. This has a negative impact on the quality of the adoption of clinical information systems in general. This troubled relationship also has a negative influence on the necessary coordination and cooperation between the two groups. There is often either missing or incorrect input into the processes required for data gathering between the project team and the stakeholders. In addition, some interviewees emphasised that some physicians in the public healthcare sector refuse to enter data or follow certain procedural standards since there is no policy which forces them to use computers. One manager said:

> *I do not think that the doctors in the public healthcare sector will enter the ICD codes by themselves, especially the older ones, since there is nothing to force them to do so. (Participant 19)*

Therefore, clear policies and procedures with regard to the adoption of clinical information systems must be developed in alignment with the hospitals' visions in order to facilitate the development of interoperable HIT infrastructures, thus achieving the hospitals' aims. The adoption policies and procedures must also predefine each step in the adoption process. They must state who the stakeholders are and how the required resources are to be allocated. In addition, they must also stress the importance of the involvement of top management and medical staff in the adoption process in order to increase the likelihood of the adoption's success. Moreover, raising the medical staff's awareness of the new system will maximise their adherence to health data standards and maintain the interoperability between the different systems. One respondent said:

> *The clinical departments are the system's owners and their commitment to the system is the main driver in the system being a success. (Participant 29)*

174

7.5.2.11 Lack of an Information Management Plan

The data emphasised that hospitals rely on information to pursue their vision of making healthcare services more sustainable. This was explained by some hospitals' strategic plans which stressed that information is a building block for the development of best practices in a healthcare environment, fuelling everything from research to education and patient care. However, the participants revealed that hospitals still lack an information management plan at the level of how data are, for example, predefined, characterised, structured, stored, exchanged, integrated, accessed and governed. This is why the hospitals are hesitant to change to the supported standards since they still do not have a clear vision and mission in this regard. One project manager explained that:

> *We have long-term plans to make the system infrastructure more interoperable. However, at the level of how the data are structured and governed, we do not have a plan. This function will be part of the consultants' job when they come to see how the hospitals are working and functioning, and to discuss what value the hospital is going to obtain from health data standards. (Participant 5)*

The interviewees emphasised that there is a need for the hospitals to develop and establish a clear strategic plan for information management in order to pursue their vision of having interoperable HIT infrastructures with rich data and the ability to manage all the related activities required in the adoption of health data standards. For example, there is some concern about the current information and how mapping the old data to the new structured format and system will be carried out. The majority of the interviewees stressed this point and one data centre manager said:

> *The concern is that we have data from the last 19 years and we will not start with new data. Therefore, the data must be immigrated and integrated; the integration is the most difficult part and when any company comes, we always ask how they will maintain and immigrate the old data. So, the hospital's policy is that the new system must accept the old one and must ensure that the data will be transferred accurately. (Participant 29)*

Another participant expressed a similar view:

There is concern about the current information infrastructure. We must review the new version of the terminology standards and then extract some old data to compare them with the new version to see what the differences are and what is needed in order to carry out the mapping. For example, we have undertaken some mapping procedures for the radiology department and we have experienced some mapping difficulties since the new version is more comprehensive and detailed compared to the old version. (Participant 19)

In addition, there is concern about how to encourage the commitment of the hospitals' management and the clinical community in developing a rich, robust and sustainable health information infrastructure since it requires significant engagement if the standards are to be adhered to on a daily basis. Such commitment involves continued emphasis being placed on developing the information infrastructure by increasing the depth and breadth of electronic clinical content through the utility of the systems at any point of care. Management must also show commitment by supporting the funding required for managing and developing the hospitals' information infrastructures with an incremental investment of 2.5% of capital expenditure, as reported by one chief manager of IT affairs. This is because, in order to develop an information infrastructure, it requires a programme which is reviewed on a regular basis to ensure alignment with internal healthcare providers and to be consistent with other international academic healthcare organisations which have a mature and leading-edge information management environment. It is also because there is a need to conduct an annual third-party evaluation of the strategic implementation efforts and to correct courses as required. Moreover, there is concern about the privacy and confidentiality of patients' information since there is no specific health privacy legislation governing hospitals in Saudi Arabia. In Saudi Arabia, there is an urgent need for establishing a national agent concerning health data legislation and standards (see recommendation three, page 239-240). Security and protection of patient information are not only demanded by the patient himself, but in most developed countries they are also required by law (Haak et al. 2003). In addition, healthcare organisations must have a long-standing, privacy-sensitive culture based on professional ethics and strict safeguards regarding access to data whilst moving further towards integrated medical information system solutions. This was explained by one chief manager when he said:

With the absence of specific health privacy legislation governing hospitals in Saudi Arabia, the hospital has pursued a self-regulatory approach and has modelled its policies on internationally recognised privacy principles for the protection of personal information of both Saudi and non-Saudi nationals. (Participant 15)

7.5.2.12 Organisational Structure

The interviewees explained that, if a healthcare organisation has a poor structure, this might have a negative impact on the quality of projects concerning HIT related standards. This is because there are always political and bureaucratic issues in the public healthcare sector. The data revealed that the high degree of politics and bureaucracy in such organisations means there are numerous faults in terms of drafting and proposing the specifications and requirements of a new system. For example, during the adoption process, a high degree of cooperation and coordination is necessary between the related departments to facilitate the success of the new system's implementation. In addition, a poor organisational structure results in a conflict of orders between the related departments during the adoption processes. This is likely to increase the number of faults and duplication whilst decreasing the performance. One chief director explained:

The university hospital is different from other hospitals because the structure of the hospital is not clear since we do not know who the hospital CEO is. Is it the Dean of the medical colleges, the General Director of the university hospitals or the Chief Medical Officer? We always have a conflicting structure! (Participant 24)

Moreover, a poor organisational structure may increase the phenomenon of strained relationships between medical and non-medical staff, thus exacerbating the power struggle in the healthcare environment, as one manager noted:

There is a phenomenon in all the hospitals around the world which is the strained relationship between non-medical and medical staff. There is a power struggle to see which group has the most power although usually medical people have power in hospitals over the non-medical people. However, a clear structure will make for a satisfactory balance. (Participant 6)

177

7.5.2.13 Lack of a National Plan for Medical Data Exchange

The data revealed that, due to the lack of a national plan for medical data exchange among healthcare providers in Saudi Arabia, healthcare organisations prefer to invest in their IT infrastructure, in areas such as networks, platforms and other advanced clinical information systems, rather than focusing on standardisation from which they cannot benefit directly. As one manager reported:

> *If the adoption of the standards is very expensive and has to be allocated a high proportion of the annual IT budget, then why do we need to adopt health data standards while we are not exchanging data with others? (Participant 6)*

Another manager pointed out that the hospitals still lack fundamental systems and therefore they prefer to invest in the infrastructure rather than in standardisation. He said:

> *I think the hospitals prefer to invest in the network and the systems rather than the standards because they still lack fundamental infrastructure requirements. (Participant 31)*

Since the majority of the technical participants are involved in the pilot project for medical data exchange that has been recently established by the Saudi Council of Health Services, they agreed that the lack of a national plan for medical data exchange among healthcare providers in Saudi Arabia is one of the main reasons that hinders the adoption of health data standards in such organisations. For example, one participant said:

> *There is no progress in the development of health data standards in Saudi Arabia or in the region because there is no data exchange between the related healthcare organisations except within the organisation itself. (Participant 6)*

Another respondent also reported that:

> *There is no national plan for medical data exchange between the hospitals and, with the absence of the government's role, we always work based on the hospitals' needs and requirements. (Participant 30)*

A similar view was also reported by another manager who said:

The standards must be there to facilitate the work and integration between the systems but their application is very limited because we do not exchange data with other hospitals; we just report annually some cases to the MoH and this is done manually, based on some template reports from the MoH. (Participant 31)

The data revealed that when there is a plan for medical data exchange, healthcare authorities will realise the importance of having structured data to ensure the quality of health information workflow; this will then lead the authorities to acknowledge health data standards and the need to have systems that are based on such standards. In order to maximise the adoption of HIT related standards, there is a need for an agreed national strategic direction regarding health data standards and specifications. Part of this plan is to set and define the standards, policies and information specifications which will be required to enable the exchange and interoperability of medical data across the health sector. Government funding will also be required for different resources and activities which are crucial in the development of health data standards. A continuous evaluation process is also necessary where there is a need to demonstrate the usefulness of an existing standard, or to find another solution, or for when there is need to show the impact of health data standards on clinical information systems or the hospitals in general. For example, one of the managers reported:

There should be a national strategic plan and an annual plan to know what we have achieved thus far, what problems we have encountered and how we will achieve the remaining parts. (Participant 29)

However, the data showed that the national plan must be compatible and developed in coordination with the current HIT infrastructure of the healthcare organisations in order to be applicable. This was explained by one senior participant who said:

If the selected standards are not used in our hospital, we might refuse because we will need to modify our infrastructure and replace some systems; changing what we have is time-consuming and costly. (Participant 12)

The national plan must be also developed based on market capabilities, as well as following best practice solutions, since most Saudi healthcare organisations follow the market and adopt "off-the-shelf" packages and systems, as one chief officer explained:

Abdullah Ibrahim Alkraiji 2011

I think one day we will have our own standards but before then we should follow international standards and big companies, especially those in the United States which is the leading country in this area. So, we should not apply some standards that will restrict hospitals in the choice of the best solutions since these solutions are built based on the best practices. Therefore, I am afraid that we will establish some standard specifications and requirements that do not conform with the leading companies, therefore limiting us to a small number of options that are not the best and that we will not stick with. (Participant 15)

7.5.2.14 National Healthcare System

Two senior managers claimed that the national healthcare system is not sufficiently organised to allow data exchange amongst healthcare providers and this might be one of the reasons that the adoption of health data standards by healthcare organisations remains frustratingly low. The data revealed that there are substantial variations in the provision of medical services in Saudi Arabia. This is because a clear national policy is lacking regarding how medical services are provided to patients. As a result, every healthcare provider has its own policy and procedures that usually depend on the hospital's qualifications. For example, and at the level of the MoH, two senior managers indicated that there are deficiencies in the management of the healthcare services in the primary care centres, and in the relationships between primary care centres, general hospitals and tertiary hospitals regarding the treatment lifecycles of patients. For instance, there is no clear policy concerning how a patient is admitted into a primary care centre and then referred to a general or tertiary hospital. This depends on the patient and his/her ability to open a communication channel with a preferred hospital for admission for a course of medication. Regarding other governmental bodies, such as the NGHA and the KFSH&RC, every healthcare organisation has its own policy regarding a patient's eligibility, and there are always many exceptions. As one of the senior managers stated:

I think the healthcare system in Saudi Arabia is not organised enough to support data exchange; for example, every healthcare provider has its own policy regarding patient eligibility and there are always exceptions. (Participant 30)

The two senior managers also indicated that there is no coordination between the MoH hospitals and other governmental bodies regarding patients' referral. In addition, many

Abdullah Ibrahim Alkraiji 2011

general and tertiary hospitals have started a new business called business centres. These centres provide healthcare services at a cost for Saudis and non-Saudis, with their aims to reduce the burden on hospitals and also to provide another source of income for those hospitals. This makes the situation even worse since patients can move from hospital to hospital, based on their own preference and their ability to pay. At the level of the private sector, the two senior managers explained that there is no documented policy within those hospitals with regard to how patients are admitted and treated. Every resident, whether or not a Saudi citizen, can be treated as long as he/she is able to pay for the cost of the treatment and any medication. In addition, the role of the MoH in the private sector is very limited. The two senior managers also pointed out that medical insurance in Saudi Arabia has just begun and there are many challenges in its application. For example, some private sector clinics and hospitals are still not connected to the medical insurance system and so only accept direct payments from patients. Moreover, most insured patients are employees of private companies and therefore large sections of the population in Saudi Arabia do not have medical insurance since the majority of the medical insurance companies have not yet initiated medical insurance for individuals. The two senior managers were of the opinion that, when medical insurance is activated in the country, this will be the driver for the adoption of health data standards as one of them said:

> *Unfortunately, the benefits from the application of terminology standards in Saudi hospitals in general are very limited compared to the enormous benefits of the standards and I think we will not be able to maximise these benefits unless medical insurance is activated in the country. (Participant 31)*

The two senior managers agreed that the healthcare sector in the country needs to be redesigned in order to operate as an integrated, coherent sector with clear policies and workflow mechanisms which would allow data to be exchanged seamlessly among the different entities within the sector.

7.6 Summary

This chapter has analysed, at the decision-making stage, the adoption processes and practices of the HIT related standards in six healthcare organisations in Saudi Arabia. The six organisations were seen by the researcher to be relatively similar in terms of their significance in the collection of rich empirical data. The data for the present study were

extrapolated through various sources, such as unstructured interviews, semi-structured interviews, and an analysis of the existing documentation. The main purpose of the data collection was to investigate the adoption process of HIT related standards in order to examine the concepts of the proposed model presented in Chapter Six. Through the investigation, the researcher was able to identify:

a) The different health data standards adopted by healthcare organisations in Saudi Arabia.

b) The ways that these standards were adopted.

c) The purposes for adopting these standards.

d) The motivations and enabling factors in the adoption of these standards.

e) The barriers and hindering factors in the adoption of these standards.

However, a full assessment and a revision of the proposed model for the critical factors influencing the adoption process of HIT related standards at the decision-making stage are offered with further elaboration in Chapter Eight. The main conclusions drawn from the analysis of the empirical data are summarised below:

■ With the absence of a government role, every healthcare organisation in Saudi Arabia is at a different stage in terms of adopting health data standards. These standards are therefore often based on the organisation's needs and expectations. Five main standards have been adopted by the studied cases: ICD, SNOMED, CPT, HL7 and DICOM. Only three healthcare organisations in Saudi Arabia adopted ICD-10 AM as recommended by the MoH, and the remaining organisations are still using ICD-9 CM due to the lack of ICD-10 AM coders and owing to technical concerns. However, ICD is currently being used for in-patients only in all the cases. SNOMED is in limited use in terms of lab information systems; two cases have adopted the SNOMED-CT version while only one organisation has adopted its own customised version of CPT for analytical, administrative and financial purposes. While some organisations adopted HL7 v2.2, others are still using HL7 v2.2 because of the legacy of HIS systems in those cases. DICOM 3.0 was applied by all the cases since they had recently adopted the PACS system.

■ Four reasoning perspectives behind the decision to adopt health data standards were identified; these were for managerial, technical, educational and governmental reasons.

From a managerial perspective, various reasons were identified which could be grouped in terms of data analysis and decision support systems, accreditation and enhancing the hospitals' performance. The main technical benefit of adopting standards for the healthcare organisations is to normalise communications between different clinical information systems, thus facilitating integration and data exchange between the systems. From an educational perspective, the healthcare organisations must accelerate the development of their data warehouse repository systems based on a well-structured and integrated HIT infrastructure in order to support the different medical research groups and education centres with rich and accurate medical data. From the point of view of government reasoning, the tertiary hospitals are required to report some medical information annually to the MoH and to the Saudi Oncology Centre; therefore, they must apply certain standards, such as ICD or SNOMED, in order to complete this task.

■ Twenty eight factors were identified by analysing the data which have a direct impact on the adoption process of HIT related standards at the decision-making stage in healthcare organisations. While fourteen factors of these were seen as having a positive impact on decision making in the adoption process, the other fourteen factors emerged as having a negative impact on this stage of the adoption process.

Chapter Eight: Revised Adoption Model of HIT related Standards

8.1 Introduction

The literature presented in Chapter Four showed that there is shortage of research concerning the evaluation of the adoption process of HIT related standards; thus, both in theory and in practice, a holistic model of those factors which influence this adoption process at the decision-making stage in healthcare organisations is still lacking. In order to fill this gap, a conceptual model was proposed, as presented in Chapter Six. Using a suitable research methodology (presented in Chapter Five), this model was examined and evaluated within the context of Saudi healthcare organisations to satisfy the aim of this thesis, and to offer both practitioners and researchers an empirical research model for the adoption of HIT related standards. The research's findings, as presented in Chapter Seven (see also Appendix D), were sent to five key participants in order to validate their constructs. The five key participants commented that these results seemed to be reasonable within the context of Saudi healthcare organisations. Therefore, the aim of this chapter is to revise the conceptual model of the adoption process of HIT related standards whilst taking into consideration the evidence derived from the Data Analysis chapter. In doing so, Section 8.2 presents a summary of the main issues raised and the lessons learned as a result of the analysis of the case organisations. These were then considered in the revision of the conceptual model. Section 8.3 discusses the research findings in accordance with the literature and attempts both to analyse critically and put forward arguments in this regard, while providing reasons relevant to the findings. Section 8.4 revises the conceptual model of the adoption process of HIT related standards at the decision-making stage in healthcare organisations. Modifications, which were derived from the empirical evidence, were made to the conceptual model mainly in three areas. First, the pre-adoption stages were adapted to include the organisation's needs in the first stage, alongside motivation, conception, proposal and decision. Secondly, the decision criteria were modified to include educational and governmental purposes, alongside managerial, technical, strategic, operational and organisational issues. Thirdly, the critical factors were also modified to include eight new factors and four modified factors, with one factor being abandoned. The results of this chapter contributed to the proposal of a novel model of reference for the adoption process of HIT related standards.

184

8.2 Lessons Learned from the Case Studies

A synopsis of the key lessons learned, derived from the empirical data, is given in this section. However, this section does not offer prescriptive guidelines of the adoption process of HIT related standards. It rather describes healthcare organisation perspectives since it offers a broader understanding of the decision-making process for the adoption of HIT related standards, thus allowing others to relate their experiences to those reported. The lessons were seen as helpful to healthcare authorities and organisations, as well as to researchers and other related groups of practitioners. The lessons are summarised as follows:

LESSON 1: Who is taking the lead? Although several government entities and commissions speak about the standards, no one has taken the lead in developing and promoting them in Saudi Arabia. Accordingly, only a few health data standards, including some messaging standards and terminology standards, are applied in the healthcare organisations. In addition, every healthcare organisation is at a different stage in terms of adopting these health data standards; they are therefore often based on the organisation's needs and expectations. Moreover, the terminology standards are in limited profile use and so most of the data are built somehow based on a proprietary format structure; thus, exchanging medical data semantically among healthcare providers is impossible. In addition, obtaining meaningful insights into the medical information, through the provision of accurate statistics and reports, is limited due to the insufficiency of the data. Therefore, producing medical statistics and reports, such as mortality data, concerning the health situation in Saudi Arabia in general is a real concern.

LESSON 2: Lack of national plan for medical data exchange! Due to the lack of a road map for medical data exchange between healthcare providers in Saudi Arabia, the case organisations preferred to invest in their IT infrastructure, in areas such as networks, platforms and other advanced clinical information systems, rather than focusing on standardisation from which they could not gain benefits directly. This is also because the medical information exchange among the healthcare providers in Saudi Arabia is a project that is impossible to achieve at the present time for many reasons. For example, healthcare organisations run a variety or range of different formats of information infrastructure that are difficult to manage and integrate. There is also a shortage of professionals in Saudi Arabia due to the complexity of health data standards and that medical information exchange is a recent concept in the Saudi healthcare community. In

185

addition, the national healthcare system is not sufficiently well structured and organised to allow data exchange amongst healthcare providers. Moreover, there is concern with regard to who will take ownership of the national health information network (NHIN) since the MoH is deficient in many attributes (e.g. HIT infrastructure, expertise and budget) needed to manage and govern the NHIN; also, the majority of the leading hospitals in Saudi Arabia are not affiliated to the MoH. Furthermore, there is concern about the privacy and confidentiality of patients' information since there is no specific health privacy legislation governing hospitals in Saudi Arabia.

LESSON_3: **Lack of official plan for the management of medical information!** No official plan for the management of medical information has been established by the case organisations; nor has any committee been assigned to deal with the health data standards. Thus, health data standards have been treated by the hospitals as one of the system's specifications and they depend on the project team's qualifications being included into the project's RFP. Although the majority of the case organisations have either changed the IT department's name in some way or have established another department to reflect the importance of the concept of medical information management for the organisation's authorities, the main function of those new initiatives are not to manage the medical information. Rather, they are to help the IT department in the adoption process in terms of, for example, acquiring user requirements or training the users how to use the new system.

LESSON_4: **Shortage of national professionals!** With the shortage of professionals in Saudi healthcare organisations who can understand or cope with advanced clinical information systems, the hospitals seek advice from reliable external sources, such as consultants and/or partners. This is also because advanced clinical information systems and medical data exchange are new concepts to the Saudi healthcare community. Every case organisation had established some communication channels with certain international consultants and partners to help in the adoption process of its clinical information systems owing to the availability of an adequate budget. Although some universities have established health informatics education programmes to tackle the shortage of national expertise in this field, there is concern regarding how the universities, with a lack of experience in this subject, will support such advanced education programmes in order to ensure a generation of qualified graduates is produced.

LESSON_5: **What are the health data standards' drivers?** Although some health data standards (e.g. HL7 and DICOM) have been imposed (since these are the market standards), meaning that healthcare organisations had no other option but to adopt these in order to retain market compatibility and support, the current standards were also adopted for other reasons. From a managerial perspective, health data standards were adopted by healthcare organisations to support the data analysis that is required for decision support systems, to acquire accreditation from certain leading international medical commissions, and to be able to benchmark themselves against other leading international hospitals. From a technical point of view, the main benefit of adopting health data standards is the increase of interoperability between the different systems while, for educational purposes, most of the case organisations run education programmes and are affiliated to a medical research group. As a result, the terminology standards, such as ICD, SNOMED and CPT, were imposed in order to facilitate searching and the provision of programmes with accurate cases, reports and statistics. From a government perspective, the tertiary hospitals are required to report some medical information annually to the MoH and to the Saudi Oncology Centre in order to produce medical statistics and reports, such as mortality data, concerning the health situation in Saudi Arabia in general.

LESSON_6: **The uncertainties of the clinical information systems market!** Although a variety of completely integrated HIS packages is currently available "off-the-shelf", no one single system provides all the functions and modules required by the tertiary hospitals in Saudi Arabia since every tertiary hospital has its own unique policies and procedures. For example, every tertiary hospital has its own policy regarding a patient's eligibility and administration. The healthcare organisations must ensure that any new system conforms to certain specifications, and in particular to HL7 and DICOM, in order to facilitate its integration into the backbone infrastructure HIS system. Every vendor customises the standards in some way based on a proprietary format in order to compete in the market and so no vendor has conformed entirely to the international standards. This requires the case organisations always to come to some solution with the vendors during the integration. This is considered to be one of the most complicated issues in the adoption process. Due to the uncertainties in the market today, the tertiary hospitals in Saudi Arabia only adopt "best of breed" solutions to maximise the success of the new system since the projects are always supported by an adequate budget. However, there are always

some exceptions owing to the lack of rigorous and comprehensive policies and procedures with regard to the adoption process.

LESSON 7: **The capabilities of the current HIT infrastructures!** Concern was expressed amongst the IT department managers with regard to the hospitals' HIT infrastructures. This is because they were afraid that the government would establish commissions for national health data standards without involving the hospitals and assessing the capabilities of the hospitals' HIT infrastructures. For example, when the government took the decision to convert from ICD-9 CM to ICD-10 AM, the hospitals were not able to change to this version. This was because of certain compatibility issues, such as the legacy of the hospitals' HIS systems or since the majority of the HIS systems were bought from American vendors who are still using ICD-9 CM as the United States' national code for disease and diagnoses. In addition, the hospitals have already made a large investment in terms of HIT infrastructure and so the new standards should not require the replacement of the current systems with other additional resources. Another concern is that the national standards should be developed based on international standards, as well as the capabilities of the market and large companies. The national commission for heath data standards should not apply some standards that do not conform to those of leading companies; this limits the hospitals to a small number of options, leading to the acquisition of systems and solutions that are not the best.

LESSON 8: **Advanced systems are being utilised in less effective ways!** Various advanced systems are currently being used in the hospitals for different purposes in a less than effective way because of the nature of the proprietary format of the hospitals' data structure. For example, most of the case organisations had already started a data warehouse project in some form or another for both managerial reasons (e.g. statistics, reports, performance, decision support and benchmarking) and medical purposes (e.g. top most common diagnoses and procedures, and research). However, the hospitals are still lacking certain benefits that the system could offer owing to the inconsistency, the nature of the structure and the proprietary format of the data. In addition, some other systems (e.g. CPOE, knowledge management and data mining) were found to have completely or partially failed to be implemented owing to the lack of appropriate health data standards.

LESSON 9: **Less engagement of clinicians!** There was less engagement on the part of clinicians and clinical departments in applying the terminology standards on a routine, daily basis. This barrier was due to a number of reasons, such as Saudi physicians not

having undertaken any education programmes with regard to health data standards and their applications in the medical environment. Thus, they are unaware of the benefits that standards could bring to their organisation; they also think that using health data standards on a daily basis just amounts to extra work so they do not want to accept them because they are already over-loaded. In addition, the public healthcare organisations in Saudi Arabia still lack adequate policies and procedures in this regard. The hospital authorities must recognise the importance of engaging clinicians and clinical departments in developing hospital information infrastructures. This is part of the change management programme that hospital authorities must carry out in order to ensure that the organisational objectives of adopting health data standards are realised. The change management programme must emphasise that clinical leadership, collaboration, effective communication, and commitment to education and training are essential in the development of a greatly standardised health information infrastructure.

LESSON_10: Healthcare organisations characteristics! There are strained relationships between medical and non-medical staff, exacerbating the power struggle between the two groups in the hospitals. A greater balance in organisational structure between the two groups must be established in the public healthcare organisations. This is because the high degree of politics and bureaucracy in such organisations means there are numerous faults and conflict of orders in terms of drafting and proposing the specifications and requirements of a new system. This is largely due to the lack of the necessary cooperation and coordination between the related departments and groups. The general attributes of the healthcare organisations, such as type, culture and size, were found to be pushing the organisations in Saudi Arabia to adopt systems based on international health data standards. For example, the lifecycle of just one case in a tertiary hospital may sometimes require sophisticated treatment involving numerous physicians and medical staff. The medical language must be consistent and the data must be synchronised between the different groups of physicians in order to maximise the success of the treatment and to reduce medical errors. In addition, healthcare organisations in Saudi Arabia are part of a multi-cultural environment. Having a non-standardised medical language in the hospitals requires a great many training programmes. This was considered by the majority of the participants as one of the challenges, and the most costly aspect, facing the hospitals in Saudi Arabia. Moreover, the hospitals look to standards to manage the organisation's

complexity since the case organisations are growing both in terms of number and in complexity.

8.3 Discussion

Once the analysis was completed, the researcher sent the findings of the research, as presented in chapter Seven (see also Appendix D), to five key participants to offer their views with regard to the results. This process was recommended by Yin (2003, pp. 33-39) to increase the construct validity of the research's findings. Based on the researcher's experience with the interviewees in the data collection journey, the researcher has contacted by e-mail only eleven participants from the entire interviewee sample (see Table 5.1). The participants are self-selecting. Only five participants responded and agreed to participate in the validation process. Those five key participants, as shown in Table 5.1, are participant 4, 6, 17, 23, and 31. The participants agreed with the findings that were sent to them and also provided the researcher with some recommendations, as presented in Chapter Nine, to promote the adoption of HIT related standards in Saudi healthcare organisations. The research's findings also needed to be linked to and discussed in accordance with the literature in order to carry greater weight. This is seen as promoting the validity of the results as these may be consistent with the findings of some relevant studies. The main findings of this research, the enabling and hindering factors identified in Chapter Seven, can be grouped according to the Technology-Organizations-Environment (TOE) framework. According to West (2004), the TOE categorisations are posited to interact with each other and to influence technological decision-making with reference to the adoption of IT related standards. The TOE framework is simply a taxonomy that can be used to categorise those factors which influence decision-making regarding the adoption of IT related standards. It does not represent a well-developed framework or theory (Thomas *et al.* 2008). the TOE taxonomy was simply used as a framework to group the enabling and hindering factors identified in this research.

8.3.1 Technological-related Factors

Nine factors were identified via the analysis of the empirical data, as presented in Figure 8.1. Five of these were subsumed into the five innovation attributes of the DOI theory devised by Rogers (1995). These were relative advantage, compatibility, complexity, trialability and

190

observability. The sixth factor was the switching cost, which is one of the two theories in the economics of standards. The remaining factors were market uncertainties, systems integration and enhancing the use of advanced systems. Enhancing the use of advanced systems, as coloured in Figure 8.1, is a new factor resulted from the analysis of the empirical data in this group. The following sections explain each one.
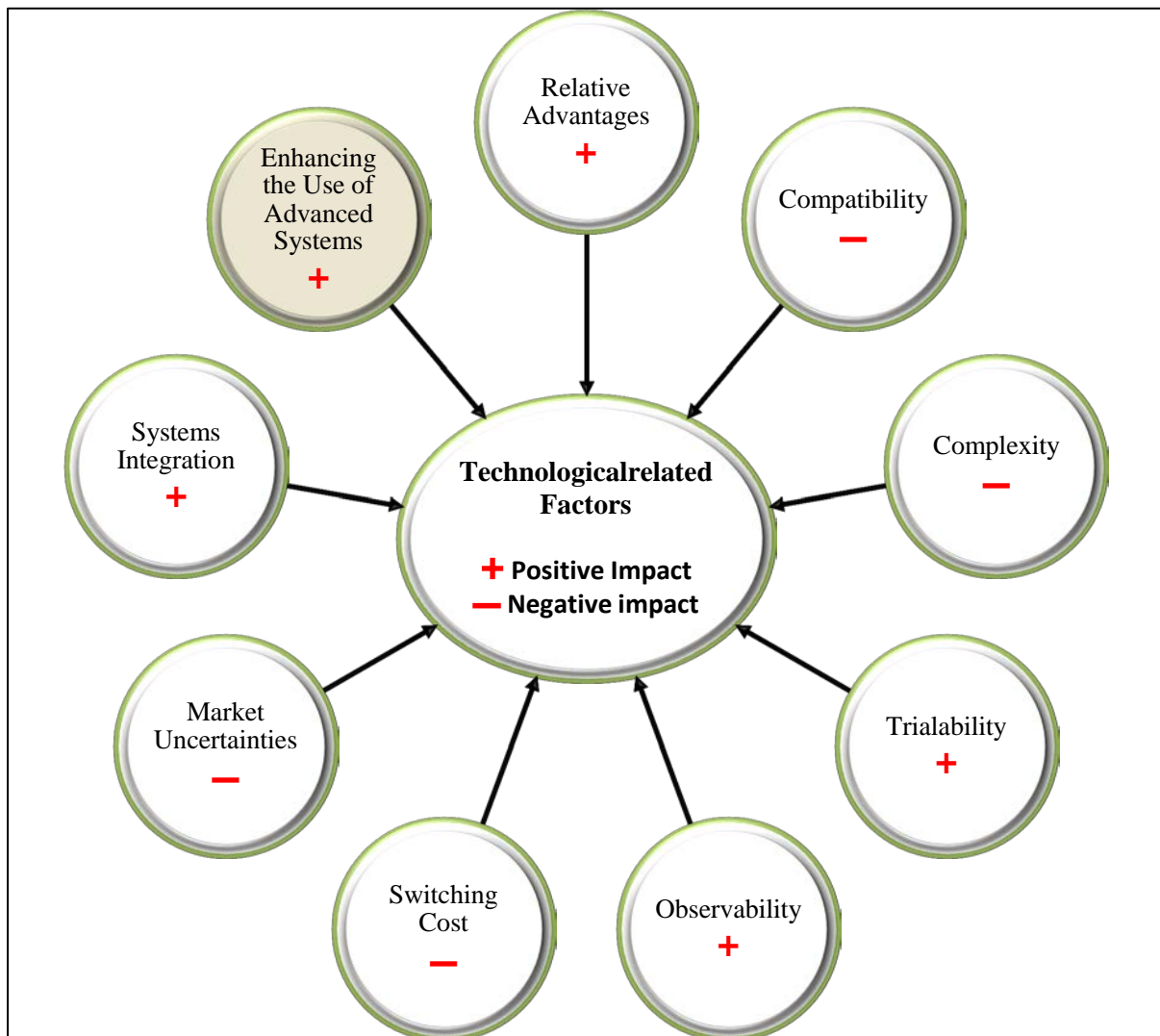
Figure 8.1: The technological-related factors and their impact on the adoption of HIT related standards, developed by the researcher.

8.3.1.1 Relative Advantages

This factor refers to the level of benefits that health data standards can provide to healthcare organisations. This study found that awareness among healthcare organisations of the many different benefits introduced by health data standards had a positive impact on decision-

making regarding the adoption of HIT related standards in the case organisations. The participants explained many different benefits in this regard. These can be classified, using the model proposed by Shang and Seddon (2002), into operational, managerial, strategic, technical and organisational benefits. This model was also used by other relevant studies, such as those of Khoumbati *et al.* (2006), Wu (2004), Chen (2003) and Kuan and Chau (2001), in order to classify the different benefits resulting from the use of various technologies (e.g. EAI, web services and EDI) to make the organisation infrastructure more integrated. Table 8.1 presents some of the benefits reported by the participants. These are classified based on the model proposed by Shang and Seddon (2002). In addition, these benefits are seen to be in accordance with the findings of previous relevant studies.

Table 8.1: Examples of some reported benefits resulting from the adoption of HIT related standards.

Category	Benefits found from this research	Also highlighted by previous researches
Operational	Increase performance	(Park & Hardiker 2009; Walker *et al.* 2005)
Operational	Promote the effectiveness of healthcare systems	(Park & Hardiker 2009; Walker *et al.* 2005)
Operational	Enhance vendors' support	(Zhang *et al.* 2007; Thomas 2006)
Managerial	Facilitate decision support	(Spooner & Classen 2009; Jenders 2007; Hammond 2005)
Managerial	Facilitate searching and the production of accurate statistics and reports	(Fitzgerald *et al.* 2008; Zhang *et al.* 2007)
Managerial	Facilitate benchmarking	(Doebbeling *et al.* 2006)
Strategic	Reduce medical errors	(Park & Hardiker 2009; Spooner & Classen 2009)
Strategic	Promote clinical research	(Spooner & Classen 2009; Jenders 2007; Hammond 2005)
Strategic	Reduce medical services costs	(Park & Hardiker 2009; Walker *et al.* 2005)
Technical	Increase interoperability among systems	(Walker *et al.* 2005)
Technical	Reduce maintenance costs	(Thomas 2006)
Technical	Maintain data consistency	(Khoumbati *et al.* 2006)
Organisational	Increase medical services based on best practices and guidelines	(Chaudhry *et al.* 2006)
Organisational	Increase the data and system ownership	(Doebbeling *et al.* 2006)
Organisational	Reduce complexity	(Fitzgerald *et al.* 2008; Khoumbati *et al.* 2006)

8.3.1.2 Compatibility

Compatibility was indicated by different participants as a very important issue regarding the adoption of HIT related standards and was discussed in relation to two main points, technical infrastructure, and the work environment and culture. The interviewees explained how the compatibility of the standards with the technical infrastructure was thought to have a negative impact on the adoption of HIT related standards. For example, the case organisations, with regard to legacy HIS systems were found to face difficulties when they adopted HL7. This was because their legacy HIS systems did not conform to HL7. They were therefore required to produce data from the HIS system and then convert them to HL7 messages using another application before attaching them to the HL7 integration middle layer. In addition, when the government advocated conversion to ICD-10 AM as the national coding system for diseases and diagnoses, only three healthcare organisations in Saudi Arabia converted to this version owing to technical compatibility issues. For example, those case organisations with legacy HIS systems were not able to convert to this version since the HIS systems are based on old databases that are impossible to adapt to ICD-10 AM.

The negative impact of the technical incompatibility of the adoption standards is one of the main issues that has emerged from research on IT standards. For example, Lin *et al.* (2010) found that the incompatibility of HL7 with the existing HIT infrastructures in Taiwanese hospitals resulted in a low rate of HL7 adoption. Egyedi and Loeffen (2002) explained that IT related standards are often a problem. The advantages of any improvements in and between the versions must be weighed against those issues related to their compatibility or otherwise. Thomas *et al.* (2008) asserted that the successive versions of IT related standards often cause problems and challenges regarding compatibility for the implementers. The compatibility of the new standards with the organisational environment, in terms of factors such as experiences, culture, resources, practices, values and skills, was also found to be a negative factor facing the adoption of health data standards. The participants explained that the hospital authorities were disappointed when the government took the decision to convert to ICD-10 AM. This is because the medical environment in Saudi Arabia is either American or European based because the backgrounds of most medical staff are from those areas; they are not Australian based. This finding was in accordance to that of Khoumbati *et al.* (2006) who indicated that compatibility can be related to the prior experience of the medical staff, which may have a negative impact on innovation adoption. This was also further confirmed by

193

Fichman (2004) who explained that the accumulative experiences of the organisations' staff can be seen as an antecedent to the adoption of innovation.

8.3.1.3 Complexity

Although adopting health data standards is a very complex subject in nearly every country, and it requires champions and national initiatives to take the lead in the development of standardised health data, the situation in Saudi Arabia, as pointed out by many interviewees, is much more difficult. This is because Saudi Arabia is a newcomer to the area of advanced HIT applications and is therefore deficient in many areas that are necessary to understand or cope with the standards. For example, there is a shortage of national experts to deal with advanced practices and solutions with regard to HIT. Most of the leading hospitals in Saudi Arabia rely on consultants and vendors in the adoption of HIT applications. In addition, no national initiatives have been undertaken by the government to lead or support the adoption of HIT applications in the hospitals. Every hospital is at a different stage in terms of adopting HIT applications or the required standards. These are therefore often based on the needs and expectations of each organisation. Moreover, the concepts of such important fields (e.g. health informatics and biomedical engineering) are still in their infancy in Saudi Arabia owing to that just a few universities in the Kingdom have recently begun to offer some new courses in those fields. Furthermore, no government entity has contributed to the international efforts that have been made to develop clinical and medical technologies. Even worse, no government entity has become a member of those institutions and organisations dealing the development of clinical and medical technologies. If any such membership exists, it is most likely based on the efforts of individuals.

Complexity as a barrier to the understanding of health data standards was made clear in the literature. For example, Lin *et al.* (2010) found that the complexity of HL7 had a negative impact on its introduction into Taiwanese hospitals. Eichelberg *et al.* (2005) explained that the clinical information itself is very complex to deal with and there are many interrelated but different types of coding system available today. Begoyan (2007) revealed that clinical and medical information is constantly evolving and changing, unlike certain other fields. This requires substantial efforts to be made in order to keep up-to-date. Chheda (2007) and Hammond (2005) stated that there is a wide range of health data standards available today; these are sometimes overlapping and conflicting, making it difficult for healthcare

194

organisations to know those standards to which they should pay attention, those they should embrace, and those they should adopt. Accordingly, this has led some authors, such as Zhang *et al.* (2007) and Hammond (2005), to emphasise that the standardisation of health data must be established by governments in every country; for this, government funding and support are necessary.

8.3.1.4 Trialability

Health data standards were seen by the hospitals in Saudi Arabia as features of a new system and so were treated in similar ways to other features. Different stages were undertaken by the case organisations in order to evaluate the new systems and their features. Participants agreed that a systematic evaluation of these new systems had a positive impact on their adoption because the hospital authorities and decision makers had the opportunity to assess, in a practical setting, to what extent the new system could meet the hospital's needs and standards. They could draw conclusions about the advantages and disadvantages of the new system compared to other available systems. Also, because there appears to be confusion in the market concerning health data standards, using a range of different evaluation methods enabled the organisations to explore, before the actual adoption, the benefits that could be achieved from using such standards. The case organisations explained the different methods that were employed to evaluate the new systems. These included, for example, class reports, vendor confirmation, pilot demonstrations and site visits to other national and/or international hospitals that had adopted the vendor's system for reference.

The finding regarding trialability was confirmed by several related studies. For example, Byrne and Golder (2002) asserted that an anticipated standard should have an example installation; this could then be used as a reference by other implementers during any evaluation of such relevant standards. Thomas *et al.* (2008) found that trialling standards using pilot projects had a positive impact on decision making in the adoption of data exchange standards within the UK Ministry of Defence. Moreover, Khoumbati *et al.* (2006) explained that the available assessment tools for the evaluation of integration technologies were seen as essential in guiding a hospital in terms of decision-making in the adoption process of such a technology. Mykkanen and Tuomainen (2008) noted that interoperability standards must be evaluated when there is a need to demonstrate the usefulness of the

195

existing models or to find an open solution with regard to the development of applications and integration projects.

8.3.1.5 Observability

The empirical findings indicated that the range of methods available to the case organisations to observe the HIT market revolution and general industry issues had a positive impact on the decision making in the adoption of HIT related standards. The researcher identified several methods used by the case organisations to gain some market knowledge, these included, for example, conferences, seminars, workshops, memberships, internet searches, site visits (i.e. attending exhibitions and visiting leading international hospitals), training, and consulting vendors. The reason these strategies were positive was that, for example, the case organisations lack experts in the area of advanced medical technology solutions and practices; thus, they have the opportunity, through the use of such methods, to expand the knowledge of their staff, to observe the experiences of others, to look for appropriate solutions to their problems, and to create an international network of references. These methods were available to the case organisations because of the existence of an adequate budget, since these organisations are the leading healthcare organisations in Saudi Arabia. Some of the participants explained that government support and funding were vital to enable healthcare organisations in Saudi Arabia to use such methods, and also to find other means to observe the market and related activities. For example, one case organisation experienced some funding difficulties concerning renewing its memberships with certain international organisations for healthcare information and management systems.

Observability as a critical factor in the adoption of IT related standards was in accordance with previous literature. For example, Thomas *et al.* (2008) found that a lack of information regarding other success stories, case studies and implementations of standards was a challenge in the adoption of such standards. Nilakanta and Scamell (1990) and Arthur (1988, pp. 590-607) noted that the availability of effective communication channels, with regard to general industry knowledge, can encourage the community of potential adopters to implement standards, while Hammond (2005) observed that adequate and appropriate manuals, information and tool sets are highly desirable in supporting the implementation and use of standards. Carr and Moore (2003) found that the lack of technical information amassed by standards' groups regarding the provision of solutions to specific interoperability

196

problems within clinical information systems, had resulted in major efforts being made by implementers to achieve a significant level of integration with multiple systems.

8.3.1.6 Switching Cost

The empirical findings indicated that there will be a high degree of drag and sunk costs in the adoption of HIT related standards by Saudi healthcare organisations. The high degree of drag cost is due to the unfamiliarity of the case organisations with the existing resources and skills regarding the new standard. For example, there is a lack of experts who can deal with or lead the adoption of HIT related standards. As a result, a great deal of staff training and a high degree of change management will be required. In addition, many participants revealed that the mapping issues from the old information infrastructure to the new standardised one will be a real cost concern.

The high degree of sunk cost is because some case organisations run many legacy systems. These systems do not conform to international standards or allow further customisation; so, the case organisations may be required to discard equipment and invest an amount of capital as a result of adopting a new standard. Many major work processes and functions are based on some of these legacy systems and therefore, discarding them is a real concern. In addition, some case organisations have new HIT infrastructures which are based on the vendors' standards; this increases the risk of conflict with national standards. For example, many Saudi healthcare organisations adopted HIS, developed by American vendors who conform to ICD-9 CM, while the national standard today with regard to the disease and diagnosis code system is ICD-10 AM. Table 8.2 presents the different identified costs associated with the adoption of health data standards in Saudi healthcare organisations, together with their categorisation and importance.

The findings regarding the high drag and sunk costs associated with switching are in accordance with the study carried out by Hovav *et al.* (2004) who noted that these factors represent a challenge to the adoption of standards. The cost factor is also in accordance with the findings of other studies, such as those of Khoumbati *et al.* (2006), and Kuan and Chau (2001). These showed that the cost factor has a negative impact on the adoption of various integration technologies, such as EAI and EDI. Doebbeling *et al.* (2006) found that a lack of financial support was considered to be a primary barrier to the adoption of HIT applications in healthcare organisations while Hammond (2005) emphasised the need for government

197

support and funding for the development, promotion and adoption of health data standards. Zhang *et al.* (2007) indicated that financial barriers were one of the main obstacles facing the standardisation process for health data in China and the study by Zhang *et al.* (2007) stressed the importance of the government's role in funding the development of national health data standards.

Table 8.2: Costs associated with the adoption of HIT related standards and their importance (i.e.●: important; ◉: neutral; and O: less important).

Category	Costs	Importance
Direct Costs	software	O
	hardware	O
	education	●
	training	●
	awareness raising	◉
	conferences	O
	memberships	◉
	consultations	◉
	maintenance	◉
	vendor support	●
	licence fees	◉
	online journals	O
	library subscriptions	O
	manpower	●
Indirect Costs	change management	●
	lost manpower while staff attend training sessions	◉
	paying employees to attend training sessions	O

8.3.1.7 Market Uncertainties

The majority of the technical participants agreed that the healthcare organisations' policies and procedures should only support best of breed solutions and products in order to reduce the risk of system failures and interoperability barriers. The reason for this is that the vendors

198

of the best of breed products are generally involved in the development of the health data standards themselves and therefore their systems comply with international standards. In addition, in order to gain competitive advantages in the market, every vendor customises the standards based on a proprietary format of requirements. By dealing only with leading vendors, the hospitals will ensure that the extent of customisation is reasonable and has also been proven in the industry not to be in conflict with other standards and/or specifications. Those systems that have been developed based on best practice solutions are thought to be costly compared to other systems; thus, they require the availability of an adequate budget.

There also appears to be confusion within the HIT market today in Saudi Arabia owing to the lack of a national regulator or national initiatives in this area. Many companies have established businesses to develop and market HIT applications but some of these are merely brokers to various international HIT companies as policy in Saudi Arabia states that every foreign company must have a national broker in order to establish a business in Saudi Arabia. Others are national companies, many of which have only just established businesses focussing on the development of clinical information systems. Many participants were concerned about these national companies because their systems were thought to lack many of the necessary international specifications and standards; if so, achieving interoperability among the clinical information systems will be a real challenge. Some companies have also taken advantage of the lack of experts in many hospitals, as well as the absence of a government role, to market their systems to some government and private healthcare providers.

The market uncertainties with regard to health data standards was made clear in the literature where authors such as Hammond (2005) and Feldbaum and Dick (1997, pp.59-77) asserted that the development of health data standards, as an industry, is at least 20 years behind all other major industries such as insurance, banking and transport. According to Hammond (2005), there are main two reasons for this. The first is the lack of serious international efforts to consolidate and harmonise the development of such standards while the second concerns the increasing proprietary interests amongst vendors of HIT applications for reasons to do with market competition. According to Chheda (2007), Jenders (2007) and Hammond (2005), market uncertainty with regard to health data standards today has led to a confused situation for the potential adopters who do not know the standards to which they should pay attention, the ones they should embrace, and those which they should adopt. However, Eichelberg *et al.*

(2005) offered a justification for such market uncertainties within the health data standards industry. According to this study, health data specifications and standards developed for a particular market (e.g. the North American market) cannot, in general, be applied in other markets (e.g. the European market) without modification. This is because of differences between countries regarding medical policies and procedures. Accordingly, this has led some authors, such as Zhang *et al.* (2007), to emphasise that health data standardisation is an authoritative field in which market mechanisms do not work; thus, the role of the government is essential.

8.3.1.8 Systems' Integration

The majority of the participants agreed that one of the main reasons for adopting systems based on standards is to facilitate integration among the different systems. The case organisations were running a variety of systems distributed among different remote locations and sites. These systems cannot be integrated through a point-to-point interface solution as this turned out to be an endless process, requiring a high degree of interface engineering and support. Accordingly, the case organisations turned to a middleware integration solution engine. Every new system, whether it deals with images or information, must conform to certain specifications and standards (e.g. HL7 and DICOM) to integrate into the backbone infrastructures of the hospitals. The aim of the case organisations is to make the HIT infrastructure more integrated and constructive with rich data to support their daily organisational tasks and routines. Integration as the main technical benefit resulting from the adoption of health data standards is in accordance with a large proportion of the literature. For example, Lin *et al.* (2010) pointed out that the purpose of health data standards is to reduce the complexity of interface design and to facilitate information exchange among various HIT applications. Zhang *et al.* (2007) stated that many of the interoperability problems among HIT applications can be solved or reduced through the implementation of consensus standards while Hammond (2005) pointed out that health data standards can reduce the expensive custom-made interfaces required in making changes to any of the systems involved. Luic and Striber-Devaja (2006) claimed that health data standards are critical in enabling integration between a large number of primary and secondary healthcare organisations and referred service organisations (e.g. pharmacies, laboratories and radiology providers).

8.3.1.9 Enhancing the Use of Advanced Systems

The empirical findings showed that the case organisations are hesitant about adopting certain advanced clinical information systems. This is because such systems require a robust standardised information infrastructure in order to be implemented successfully. The interviewees also described other advanced clinical information systems (e.g. data warehouses, knowledge management and CPOE) that are currently being used in the hospitals in a less than effective way because of the nature of the proprietary format of the data structure in the hospitals. Therefore, the case organisations are looking to health data standards as a factor to increase and enhance the use of the advanced clinical systems which are thought to have a positive impact on decision-making in the adoption process of HIT related standards. Although this new finding has not been discussed in the literature as a factor on its own, several indications were found in the literature to support it. For example, Hu *et al.* (2000) stated that the successful adoption of telemedicine in healthcare organisations depends on the healthcare providers addressing the technological and managerial challenges associated with its adoption and implementation. The non-integrated nature of the HIT infrastructures of many healthcare organisations does not allow for a wide use of telemedicine systems and the result of this is a failure to reap the advantages of telemedicine (Khoumbati *et al.* 2006).

Spooner and Classen (2009), Jenders (2007) and Hammond (2005) emphasised that health data standards are a vital foundation for creating and aggregating a patient-centric EHR system, building national health information networks, and facilitating clinical-decision support systems. Similarly, Sittig *et al.* (2008) identified that the lack of the standards was a great challenge in the application of clinical-decision support systems. Different studies considering the adoption of EHR systems, such as those by Boonstra and Broekhuis (2010), Lin *et al.* (2010), Vishwanath and Scamurra (2007), and Zhang *et al.* (2007), noted that the lack of consistent data standards within the industry is one of the main reasons for the low rate of EHR adoption. Correspondingly, Rozenblum *et al.* (2011) and Fitzgerald *et al.* (2008) explained that the slow progress of implementing the e-health concept in every nation is due to the lack of national standards which must be set first.

8.3.2 Organisational-related Factors

Twelve factors, as presented in Figure 8.2, were identified via the empirical data and within the organisational context which influenced the adoption of HIT related standards at the decision-making stage in healthcare organisations. These factors are related to the descriptive measures of the organisations, and the motivations and concerns within the organisations towards the adoption of health data standards. In Figure 8.2, the coloured factors are new ones resulted from the analysis of the empirical data. The following sections explain each factor.
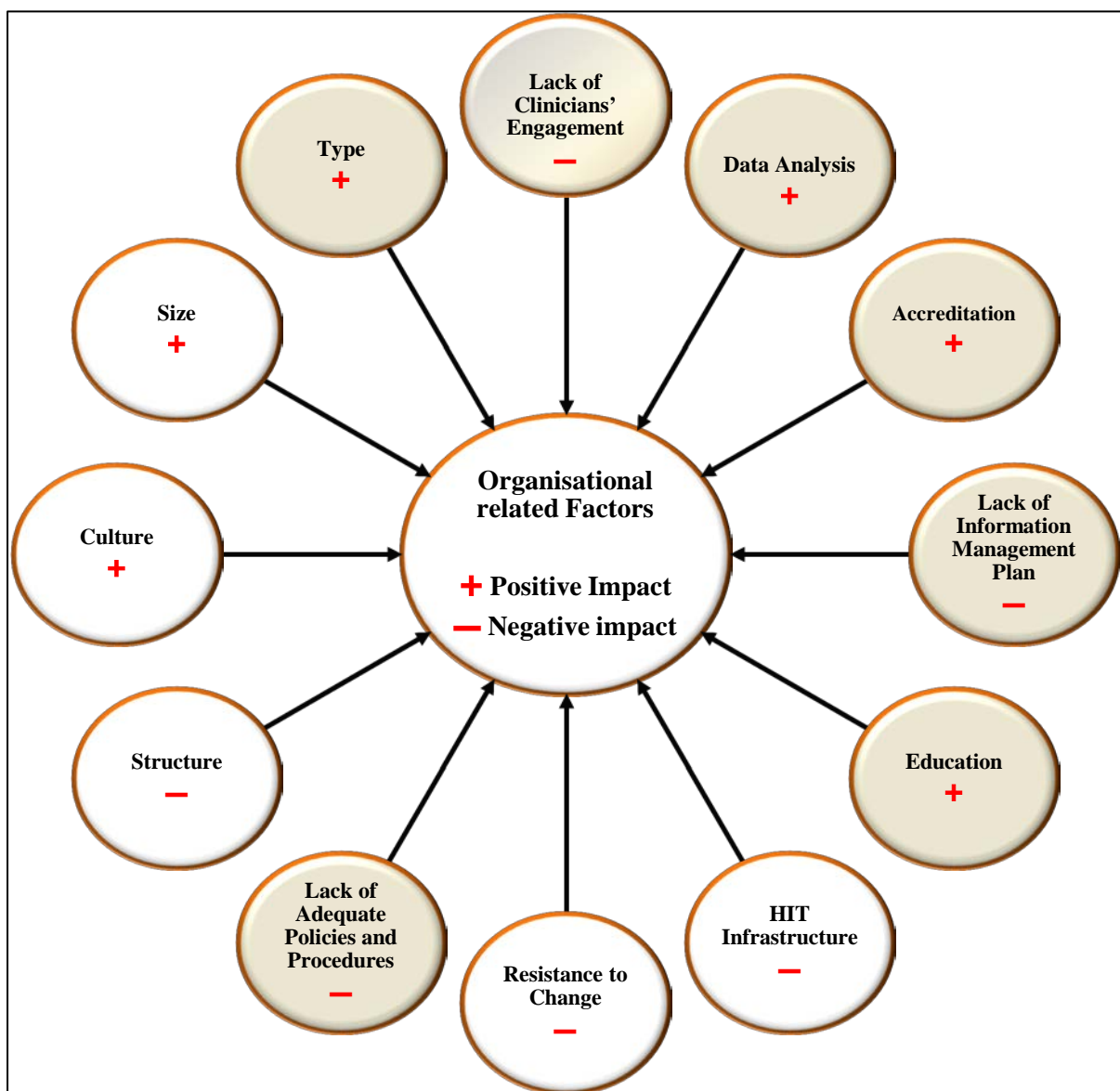
Figure 8.2: The organisational-related factors and their impact on the adoption of HIT related standards, developed by the researcher.

Abdullah Ibrahim Alkraiji 2011

8.3.2.1 Type of Healthcare Organisation

This is a new factor which was derived from the empirical evidence. In Saudi Arabia, there are three types of healthcare system, primary, secondary and tertiary care. All the case organisations in this study were tertiary hospitals. The participants explained that, although the standards are required in every healthcare system, the tertiary hospitals are most in need of adopting such standards. For example, the tertiary hospitals run complex systems which require, among other things, a high level of interoperable HIT infrastructures in order to operate efficiently and effectively. This was supported by Jacucci *et al.* (2006) who stated that standardisation for health information systems in advanced medical hospitals tends to receive more attention due to the greater complexity of the interventions. This was also confirmed by some participants who reported that the lifecycle of just one case, for example, in a tertiary hospital may sometimes require sophisticated treatments involving numerous physicians and medical staff. The medical language must be consistent and the data must be synchronised between the different groups of physicians; such information must also be available and accessible at any point in the care in order to maximise the success of the treatment and to reduce medical errors.

Another finding was that there is no single and complete HIS system available "off-the-shelf" today which can address all the functions needed by the tertiary hospitals. For example, every tertiary hospital has its own operational policies and procedures. This might be because every tertiary hospital is affiliated to a different government entity that is responsible for setting the hospital's policies and procedures owing to the lack of an adequate national strategy in this regard. This might also relate to issues concerned with politics and bureaucracy since every government entity looks to have full control over the hospitals belonging to it. Therefore, the tertiary hospitals must adopt only those systems which conform to standards that facilitate their integration into the HIT infrastructure. In the literature, this was also considered as an important issue owing to the fragmented nature of complex healthcare systems (Khoumbati *et al.* 2006); this consequently led several authors, such Zhang *et al.* (2007), Jacucci *et al.* (2006) and Hammond (2005), to advocate that the interoperability barrier amongst HIT applications could be solved or reduced by implementing consensus standards.

Another additional issue relates to clinical and medical research. All the case organisations have medical research groups and education centres; these require the existence of robust

information infrastructures in order to realise their objectives. This might be because the government believes that the tertiary hospitals are the best places to run medicine education and research in order to increase the number of national professionals and contribute to the continuous development of diagnostic approaches and methods of treatment, as well as the prevention of diseases. This is in accordance with previous studies (for example, Spooner and Classen (2009), Jenders (2007) and Hammond (2005)) which stated that standardised information infrastructures in healthcare organisations are required to support the high demand of medical cases and information by the different medical research groups and education centres.

8.3.2.2 Size of the Healthcare Organisation

All the cases in this study were multi-site healthcare organisations with hundreds of thousands of registered patients. The empirical evidence showed that the large healthcare organisations tend to be more innovative with regard to health data standards than other medium and small healthcare organisations. This is because multi-site hospitals are growing both in number and in complexity. Thus, HIT applications in multi-site hospitals must conform to certain standards (e.g. HL7 and DICOM) in order to enhance integration between the different systems and to manage the complexity of such organisations. Another reason is that these HIT applications are intended to remain in situ for a long period of time since the procedures to replace such systems in large healthcare organisations are very costly and time consuming. The empirical data showed also that all the case organisations were rich in terms of the resources (i.e. financial and/or human) required for the adoption of health data standards compared to other organisations in Saudi Arabia. This is the case as these organisations are the leading hospitals in Saudi Arabia and the Middle East; therefore, the government looks to maintain their positions as leaders by supporting them with the required resources.

The positive impact of large healthcare organisations on the adoption of health data standards is consistent with the findings of previous studies. For example, Fichman (2004) and Thong, and Yap (1995) stated that large organisations tend to invest in the implementation of an innovation before others because of the availability of the required resources. Jacucci *et al.* (2006) reported that smaller hospitals are statistically less significant, usually have less infrastructural support, and are less attractive to skilled workers. Lin *et al.* (2010) found that

the higher scale of a hospital did increase the likelihood of it adopting HL7 owing to the existence of abundant resources and the capabilities for handling possible risks. Chen (2003, pp. 271) reported that "large government agencies are traditionally strong supporters of standardisation efforts due to the distributed nature of their organisation structures and IT infrastructures." This strong support for standards is also because that large organisation is made up of many agencies and industry partners; thus, effective exchange and the sharing of information are greatly enhanced by the use of standards (Thomas *et al.* 2008).

8.3.2.3 Organisational Culture

Organisational culture was found to be a key aspect in making the hospital authorities more enthusiastic about conforming to international standards. The qualitative data derived from the case organisations revealed that Saudi healthcare organisations are multi-cultural environments as a result of the existence of approximately 65 nationalities working as medical staff in the health sector in Saudi Arabia. This means, on the other hand, that a great number of costly training programmes are required because of the high turnover rate and the considerable demands placed on new medical personnel. The high turnover rate might be linked to the culture that revolves around the Islamic religion and the tribal system; these still affect the different activities and aspects of life in Saudi Arabia at both an individual and organisational level (Al-Shehry *et al.* 2006). Another reason might be because Saudi Arabia is considered to be one of the toughest countries in terms of granting nationality. Although organisational culture was reported as an important factor in many previous studies (e.g. Lin *et al.* 2010, Thomas *et al.* 2008 and Zhang *et al.* 2007), it was found that this issue was discussed mainly with regard to three aspects, the organisation itself (i.e. referring to the extent to which the organisation adopted innovation often, early and thoroughly (Fichman 2001)); the attitude of top managers towards standards; and the opinions and beliefs of the organisation's staff towards standards. This aspect has never been discussed based on multi-cultural organisations. The reason for this is possibly is that only those developing countries with a strong economic base, such as Saudi Arabia, have such large multi-cultural healthcare organisations. To illustrate, due to a shortage of medical staff, the government recruits thousands of medical personnel from different nations every year to work in Saudi hospitals as a result of the solidity of the national economy.

Another issue concerning culture reported by the participants was the attitude of top management towards health data standards. Top management in the case organisations believed that health data standards would help the organisation to achieve some of its objectives, such as to be internationally recognised as a highly standardised healthcare organisation. This finding was confirmed by previous studies (for example, Thong & Yap (1995)) which explained that the solid knowledge and experience of top management, together with an understanding of the advantages of the innovation, have a positive impact on decision-making in the adoption of the innovation. Culture can also have a negative impact if it is not taken into account seriously during the adoption of health data standards. For example, most of the hospital systems in Saudi Arabia are either North American- or UK-based since the majority of Saudi physicians have come from these two schools. This might be because the Saudi government has dedicated the majority of the scholarships in medicine to those countries, based on the belief that they are the best. When the government took the decision to convert to ICD-10 AM, physicians were disappointed. This has resulted in some resistance and only three hospitals in Saudi Arabia have adopted ICD-10 AM. This issue was explained by Walker and Whetton (2002) who indicated that the culture of professionals in healthcare organisations, which might make them reluctant to adapt their processes to follow new paths of care delivery, could result in a barrier to the adoption of an innovation; therefore, an appropriate strategy of intervention is required.

8.3.2.4 Organisational Structure

From the empirical findings, it appears that the case organisations lack an adequate organisational structure, in particular with regard to decision-making in the adoption of HIT applications. As a result, numerous faults occurred in drafting and proposing the specifications and requirements of the new systems. This might be because the managements in the government organisations in Saudi Arabia use a centralised and formalised approach and top management looks to have full power and control over all the organisational resources. Davidson and Chismar (1999) believed that the degree of centralisation and formalisation within an organisational structure will have a direct impact on the development of information systems in hospitals. This was also confirmed by Fitzgerald *et al.* (2008) who reported that the decision-making process in healthcare organisations involves many different multi-disciplinary stakeholders with different interests and needs making the processes of change complicated and slow. Kamal (2006) noted that innovation adoption in an

organisation requires various changes to be made to the organisational structure, such as adjustments to reward schemes, changes in authority or responsibility patterns, or the shifting of power centres. These often meet with some resistance in the public organisations, which might explain the delay or even failure of IT projects.

The negative impact of a poor organisational structure on the adoption of innovation is also seen to be exacerbated in the healthcare organisations owing to the strained relationships between medical and non-medical staff, and the power struggle between the two groups in the healthcare environment. For example, physicians generally look to monopolise the decision-making in the hospitals without involving others. This might be because the physicians, and in particular the older generation, believe that they are the main drivers in the hospitals and therefore any decisions should be taken by them. This is consistent with the findings of Pare and Trudelb (2007) who indicated that, within a hospital structure, physicians exercise a significant amount of control. This can have a negative impact on the allocation of resources to a new innovation technology. Therefore, conflict between administrators and physicians regarding their responsibilities reduces the likelihood of the new technology being a success. This was also supported by Fitzgerald *et al.* (2008) who noted that healthcare professionals are not used to working in collaboration with others and their work is often based on individualistic working practices. In this regard, Khoumbati *et al.* (2006) suggested that there is always a need for adjustments to be made to the organisational structure to maintain a close relationship between administrators and physicians in the healthcare organisations because of the autonomous role of physicians.

8.3.2.5 Lack of Adequate Policies and Procedures

This is a new factor generated from the empirical data; it refers to the lack of sufficiently well documented and detailed policies and procedures regarding the adoption of new systems. Every adoption process is treated differently and therefore the success of a project is based entirely on the qualifications of the project team. For example, the support of top management and the allocation of the required resources depend on how close the management is to the project team since there is no official documented policy in this regard. This finding might be explained by Saudi Arabian culture which still revolves around the tribal system (Al-Shehry *et al.* 2006). Another reason might be the centralised approach of

the management system in the government healthcare organisations, as explained in Section 8.3.2.4.

The literature explained that different activities and forms of support are required during the innovation adoption in an organisation. For example, top management support is a key factor in the success of such an adoption (Lin *et al.* 2010; Doebbeling *et al.* 2006; Khoumbati *et al.* 2006; Fichman 2004). The greater top management support is, the easier it is to overcome the difficulties and complexities encountered in the adoption of HIT in healthcare organisations (Li *et al.* 2005). Therefore, the major forms of top management support are showing interest, displaying a supportive attitude, and promoting the strategic value of IT-related standards (Thomas *et al.* 2008). The allocation of the required technical, human and financial resources during the adoption process is also widely recognised by other relevant studies, such as those of Zhang *et al.* (2007), Hovav *et al.* (2004) and Li *et al.* (2005). Training programmes and awareness campaigns are also necessary to provide stakeholders with the skills and confidence needed to address their concerns, thus overcoming obstacles and ensuring success (Karsh & Holden 2007, pp. 393-410; Pare & Trudelb 2007; Khoumbati *et al.* 2006; Leonard 2004). However, the empirical data showed that all the aforementioned forms of support and activities often vary from one project to another based on the perceptions of the top management toward the project team and the project itself. Therefore, and in contrast to the literature, when clear policies and procedures with regard to the adoption of HIT applications are properly set and rigorously followed up, the organisation can ensure that every necessary form of activity and support are adequately and systematically provided and allocated based on the project's needs and its value to the organisation.

8.3.2.6 Resistance to Change

The evidence from the empirical data suggested that a dedicated change management programme must be established in order to support the adoption and use of health data standards on a daily basis. The dedicated change management programme should be comprehensive to include and emphasise every change required at both an individual and organisational level. For example, such a programme should examine the implementation of technical metrics, measures of acceptance, and the use of health data standards by staff and physicians. The reason for this is that there is likely to be a high level of resistance from physicians to the use of terminology standards in their daily work. This might be for various

208

reasons. For example, there is no reward system for those who apply the standards in their daily tasks and routines. The physicians may think that the standards restrict the way they work, offering no real benefits. They may also think that using health data standards on a daily basis simply means extra work when they are already overloaded. There are no training sessions and awareness programmes to encourage physicians and expand their knowledge in the area of standardisation for health data.

This finding was supported by previous relevant studies. For example, Stablein *et al.* (2003) stated that, equally important to the support of the implementation of the medical applications in the hospitals, is the assessment of readiness for major organisational change, such as the ability to invest in change management and training, as well as in terms of the organisation's culture and processes. Doebbeling *et al.* (2006) explained that the complexity of the adoption of HIT applications not only requires significant investment of resources but, more importantly, it also involves many levels of interaction and management of both personnel and systems, representing major organisational change. Fitzgerald *et al.* (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. Lin *et al.* (2010) commented that if hospital staff were more knowledgeable about standards, there would be fewer advocator obstacles and lesser user resistance against them. The researcher suggests that there is still further work that can be done to consider a holistic approach to identifying the required changes with regard to the management of the adoption of health data standards in healthcare organisations.

8.3.2.7 Education

The empirical data explained that one of the main benefits of the adoption of health data standards is to promote medical research and education in the organisations. Every case organisation has established a vision to develop an integrated HIT infrastructure and a structured data warehouse to support the education centres and research groups with high quality data. The case organisations are seen to provide a specialised scientific environment that supports clinical research and the continuous development of diagnostic approaches and methods of treatment, in particular those genetic mutations related to the Middle East region. The reason that these hospitals are considered across the region to be centres of excellence for medical services is because of the availability of professionals and adequate financial,

209

human and technological resources. Although the education factor, which was derived from the empirical evidence, is seen as new, the literature provided support for its inclusion. For example, health data standards are the first building block in the development of a national EHR system. This will help to create a national health information network for health surveillance, for defence against bioterrorism, and for the promotion of clinical research (Spooner & Classen 2009; Jenders 2007; Hammond 2005). Ohmann and Kuchinke (2009) stated that interoperability amongst HIT applications is needed to support researchers in the biomedical and clinical fields with large numbers of patients, as well as to provide access to longitudinal clinical information.

8.3.2.8 HIT Infrastructure

The empirical evidence showed that the current HIT infrastructure must be taken into consideration whenever a new system is to be adopted as the capability of the existing infrastructure is always an important factor. Such capability means that the new system should operate within the resources that are currently available in terms of technical issues, such as platforms and networks, and human aspects, such as knowledge and skills. The reason for this is that the hospitals have made substantial investments in terms of HIT infrastructures; thus, the hospitals will not discard capital and/or equipment as a result of the requirements for adopting the new standards unless the change is strongly justified. Moreover, many cases reported by the participants, as discussed in Chapter Seven, showed that the existing infrastructure has a negative impact of the adoption of health data standards. This finding was consistent with previous studies. For example, Thomas (2006) explained that a certain amount of capital and equipment already existing in the organisation may have to be abandoned as a requirement for the new standard; this can represent a significant obstacle.

The empirical findings showed that concerns regarding the HIT infrastructure are almost always related more to the "soft", as opposed to the technical side. This soft side is related to levels of understanding, addressing technical problems and managing the adoption process of the new system (e.g. training, awareness-raising, adaptation of users, change management, etc.) within the organisation. This concern might be due to several reasons, such as the lack of expert personnel in the case organisations, difficulties in coordinating related groups and departments, resistance to change among professionals, and a fear of failure since this relates

to human life. This finding was also supported in the literature. For example, Iacovou *et al.* (1995) referred to IT infrastructures when they described organisational readiness for the adoption of EDI technology. Khoumbati *et al.* (2006) defined organisational readiness as the level of sophistication of IT usage and IT management in the organisation. Doebbeling *et al.* (2006) explained that assessing the readiness of a hospital infrastructure, in terms of features such as organisational leadership, care standardisation, order management, access to information, and the composition of the information technology, is essential before establishing any strategy for the implementation of HIT applications.

8.3.2.9 Lack of an Information Management Plan

This new reported factor was found to have a negative impact on the adoption of health data standards in the case organisations. The case organisations still lack an information management plan at the level of how data are, for example, predefined, characterised, structured, stored, exchanged, integrated, accessed and governed. This might be due to several reasons, such as a lack of experts in the area of health informatics, the absence of a national plan and a government role in this regard, and/or confusion among the authorities with regard to the function of health informatics or health information management departments. For example, the data showed that the main function of those departments is to drive the implementation of HIT applications in the hospitals, but not to develop and set up hospitals' information infrastructures. Because of the absence of an information plan, many concerns were raised by the participants, such as mapping from the old information infrastructure to the new, standardised one, the provision of the funding and commitment that would be required, and the change management that would be necessary to increase the clinical electronic content of the systems. In addition, the privacy and confidentiality of patients' information was a real concern since there is no specific health privacy legislation governing hospitals in Saudi Arabia.

Although this new finding has never been discussed in the related health informatics literature, the issues discussed surrounding it are seen to be in accordance with several relevant studies. For example, Greenhalgh *et al.* (2010) explained that the concern of clinicians, in terms of information governance controls, access to information and gaining patients' consent, was one of the barriers to the adoption of a shared electronic summary record in England. Ball and Lillis (2001) noted that the legal issues related to information

security and responsibilities are one of the challenges facing the implementation of the concept of e-health. Zhang *et al.* (2007) found that legal and ethical concerns (privacy and security) were barriers to the development of standardisation for health data in China although the government has now started to implement regulations, legal initiatives and projects for health informatics. For example, the Electronic Signatures Law was initiated in 2004 in China to allow electronic transactions to take place between related health entities. The Electronic Signatures Law aims to provide a secure environment for the increased use of electronic information in healthcare.

8.3.2.10 Accreditation

The empirical data revealed that the case organisations must follow certain health data standards in order to acquire accreditation from some leading international medical commissions. Gaining accreditation is one of the main initiatives that has been undertaken by the top management in leading Saudi hospitals. There are different means by which hospitals can be accredited, for example, the hospital might be internationally recognised as a highly standardised hospital. If accreditation is obtained, the value of the hospital will increase. This then reflects on the reputation of the top management, especially when the accreditations come from North American or European countries, as these are seen as taking the lead in the field of medical services. It might also be that the government encourages the hospitals to acquire certain accreditation in order for the health authorities to measure the performance and qualifications of the hospitals. This might be the result of the lack of national qualified medical groups and professionals in this regard.

Few studies were found in the literature to support this finding, although it was indicated by the participants as an important factor in the adoption of health data standards. For example, Johnson and Ventura (2004) noticed that using HIT systems to document and generate performance measures might facilitate the accreditation processes with these respected agencies. Furukawa *et al.* (2008) found that accreditation status has one of the strongest relationships with the adoption of HIT applications. However, the data findings revealed that accreditation status in Saudi Arabia is not being utilised effectively. In other words, the acquisition of certain accreditation does not necessarily mean that there is any real improvement in the quality of the medical services or the hospitals which actually use these standards on a daily basis. This is because the accreditation commissions look only for the

212

organisations' documentation and other physical facilities; they do not monitor, in a practical setting, how the medical services are being affected by the utilisation of HIT related standards. Therefore, the researcher suggests that further studies are needed to enhance the positive impact of the accreditation system in improving HIT infrastructures and medical services.

8.3.2.11 Data Analysis

The study's findings showed that the top managements of the case organisations attempt to acquire meaningful insights from the data by carrying out accurate statistical analysis, excluding any human bias. However, this depends on the quality of the data that are inputted, it also relies on how well the systems are integrated and how well the data are structured and predefined. Today, the case organisations are accelerating in terms of making their HIT infrastructure more integrated and constructive with rich data to support, among other things, data analysis, such as performance measuring and benchmarking. The reasons for this may well vary. For example, there is pressure on the tertiary hospitals from the government to accept more referral cases and patients owing to the small number of tertiary hospitals in Saudi Arabia and increases in the number of patients due to changes in lifestyle of most of the population. The top managements of the case organisations are looking to measure the performance of hospitals based on international KPIs and then close gaps in terms of both the cost and quality of medical services. Such benchmarking might also help the case organisations to identify best practices and provide potential targets for the relatively inefficient affiliated hospitals. In addition, such benchmarking may give considerable publicity to a hospital and its top management at an international, regional and local level.

Although data analysis was not found to be discussed in the literature as a factor having an impact on the adoption of health data standards in its own right, previous studies reported this finding as one of the benefits for healthcare organisations adopting HIT related standards. For example, Korner *et al.* (2003) stated that an integrated HIT infrastructure has the potential to facilitate benchmarking among collaborating healthcare organisations. Sequist *et al.* (2005) explained that the information systems available to healthcare organisations create a vast potential for quality improvement since they allow such organisations to measure their performance through the use of international standards and definitions, and thereafter benchmark their care against other healthcare systems. Szydlowski and Smith (2009) reported

213

that a robust HIT infrastructure could lead to competitive advantage based on timely and comprehensive clinical and financial reports for decision making, as well as facilitating the benchmarking of clinical performance against other hospitals for better patient outcomes and improved quality of care.

8.3.2.12 Lack of Clinicians' Engagement

The empirical findings revealed that effective clinical leadership, collaboration, strong communication, and commitment to adhere to the standards in tasks on a daily basis are all essential in developing electronic clinical content in healthcare organisations. However, the participants indicated that there is less interaction amongst clinicians at the level of supporting the development of the information infrastructures in the case organisations. Several reasons were reported in this regard. For example, most Saudi physicians have not undertaken any education programmes in the area of health data standards and their applications in the medical environment owing to that the subjects of medical data exchange and health data standards are new to the Saudi health community. As a result, only a few universities have recently introduced some courses in this field. The clinicians are also unaware of the benefits that standards can bring to the organisation owing to the lack of training and awareness programmes, as well as the lack of pragmatic evidence of the benefits of medical data exchange. In addition, healthcare organisations in Saudi Arabia still lack adequate policies and procedures that would offer some sort of incentive (and/or inflict certain punitive measures) to ensure the application of health data standards in hospitals on a daily basis. This might be because the case organisations are under the control of the government and so any changes to the policies or procedures must be legalised by a resolution from the King's Council; this could take years to be accomplished.

This factor was found to be consistent with previous studies. For example, Hammond (2005) stated that the engagement of clinical expertise in the process of developing health data standards is crucial since there must be a balance between the technologies required to implement and use the standards and the clinical domain of expertise in defining the data and knowledge content that are required for continuous progress in the development of the standards. Hammond (2005) continued his explanation by indicating that clinical experts create scenarios for the content of standards, giving them actors, roles and interactions through which the required data structures and data exchanges are predefined and derived.

214

Doebbeling *et al.* (2006) asserted that a team approach, where interdisciplinary medical groups are actively involved, is critical if the hospitals are to take full advantage of the existing HIT applications. Lyons *et al.* (2005) emphasised that healthcare organisations must address the needs of different medical stakeholders before the implementation of any system if a better system is to be built. Greenhalgh *et al.* (2010) reported that one of the critical success factors in the adoption of a shared of electronic summary record in England was the engagement of the key stakeholders, such as clinical user groups, in the development and implementation of the system. Rozenblum *et al.* (2011) found that one of the reasons attributed to why Canada is lagging behind other countries in the adoption of EHR is the lack of meaningful engagement on the part of clinicians.

8.3.3 Environmental-related Factors

Seven factors which influenced the adoption of HIT related standards at the decision-making stage in healthcare organisations were identified via the empirical data within the environmental context. As presented in Figure 8.3, only one factor which is National Healthcare system was new, as coloured in Figure 8.3. The remaining factors were similar to the factors presented in Chapter Six and modifications were made to some including shortage of professionals, lack of national plan for medial data exchange and lack of national regulator.
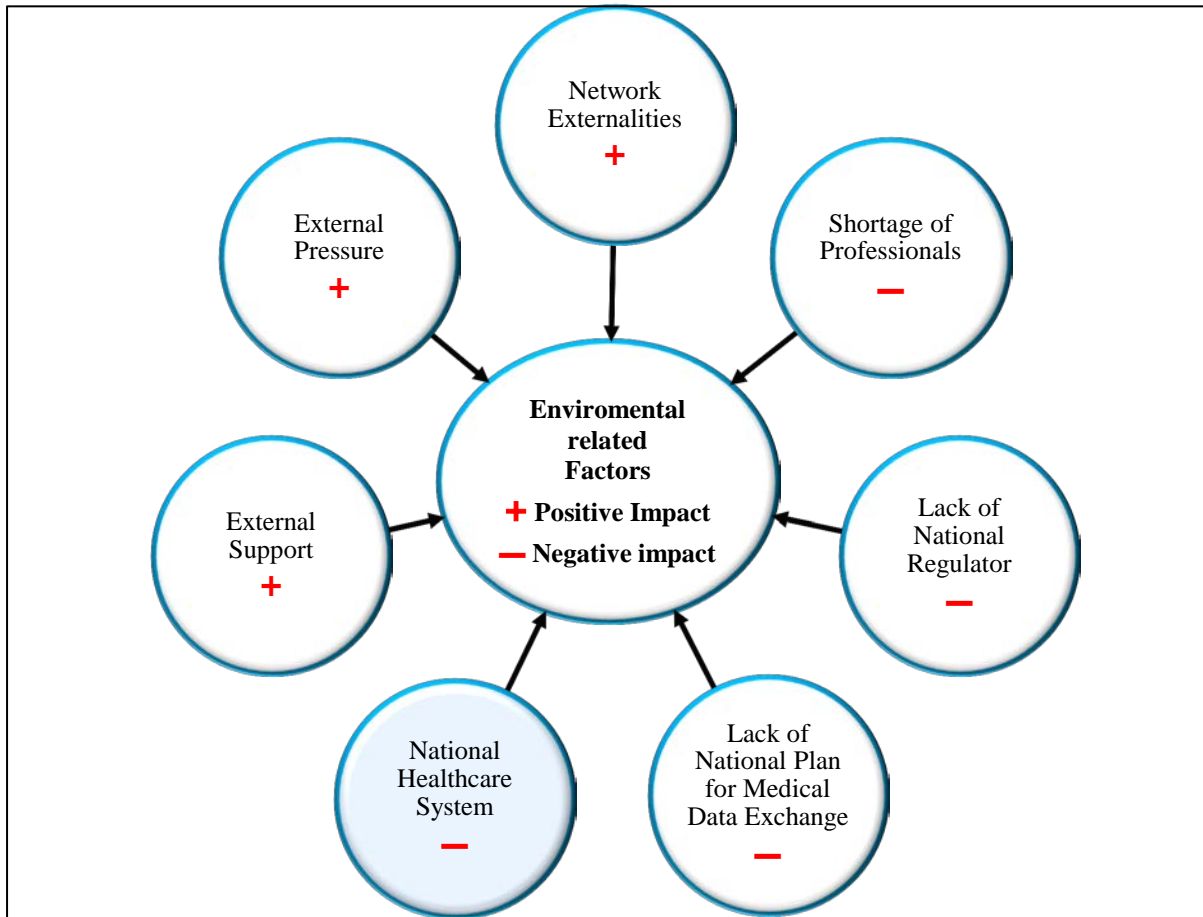
Figure 8.3: The environmental-related factors and their impact on the adoption of HIT related standards, developed by the researcher.

8.3.3.1 Network Externalities

This is one of two main theories used within the stream of economics perspective of standards and is related to the benefits created through the adoption of the new standards by the potential community of adopters (Hovav *et al.* 2004). The reason for this is that the value of the standards is increased owing to reductions in the cost of the support (due to economies of scale), as well as an increase in potential synergies through the facilitation of interactions among adopters (Hovav *et al.* 2004). The findings derived from the empirical data showed the positive impacts of this factor on the adoption of health data standards as the case organisations are always confined by market standards in order to retain market compatibility and support. In addition, the case organisations must maintain international standards in order to report certain medical information to national bodies and for them to use this information to benchmark against other national or international hospitals. This finding was consistent with the study carried out by Thomas *et al.* (2008) which found that network externalities had

216

a positive impact on the adoption of data exchange standards within the UK's Ministry of Defence. According to this study, as the user network increases in size, the benefits deriving from the support and resources surrounding the standards also increase. This was also confirmed by Wapakabulo *et al.* (2005) whose study indicated that the more people who adopt a particular standard, the value of that standard increases and therefore additional adopters are encouraged.

8.3.3.2 External Pressure

The empirical findings explained three types of external pressure on the case organisations to adopt certain health data standards in Saudi Arabia. The government on behalf of various government bodies, the market, and international trends. For example, the case organisations adopted certain terminology standards (e.g. ICD and SNOMED) in order to report annually certain medical information required by some government bodies (e.g. the MoH and the Saudi Oncology Centre) in order for them to produce medical statistics and reports concerning the health situation in Saudi Arabia in general. The case organisations also adopted some messaging standards (e.g. HL7 and DICOM) as these are one of the requirements from the vendors to facilitate the integration of the new system into the hospitals' HIT infrastructures. In addition, international trends were also shown as exerting some pressure since the case organisations are always looking to benchmark themselves against the leading international healthcare organisations; therefore they must conform to international standards in order to carry out benchmarking procedures.

The positive impact of external pressure on the adoption of health data standards was in accordance with several previous studies related to this field. For example, Khoumbati *et al.* (2006) explained that there are several stakeholders (e.g. suppliers and government) in the context of healthcare and therefore healthcare providers look for new practices and integration methods in order to coordinate more efficiently cross-enterprise business processes. Kuan and Chau (2001) argued that although organisations in Hong Kong are under pressure from the government to adopt EDI technology in order to end the manual submission of paper declarations, they are also subject to pressure from within the industry to communicate more effectively with, for example, the suppliers. Hung *et al.* (2010) found that the pressure related to competition between the hospitals in Taiwan had a positive impact on the adoption of customer relationship management systems in those hospitals while Poon *et*

al. (2004) suggested that government pressure on hospitals in the US to adopt CPOE was required in order to facilitate its adoption and to improve patient safety. Lin *et al.* (2010) noticed that environmental pressure (e.g. from government or industry) increased the likelihood of the adoption of HL7 among the hospitals in Taiwan.

8.3.3.3 External Support

With the absence of a government role, the empirical data showed that external support is crucial within the Saudi healthcare organisations for the adoption of health data standards. This is because health data standards are such a complex area, requiring a great deal of orientation before being adopted. This is also because Saudi Arabia is a newcomer to the area of advanced HIT applications and is therefore deficient in many areas (e.g. lack of experts) that are necessary to understand or cope with the standards. The data findings explained that there are largely two reliable external parties, consultants and vendors, who are promoting the adoption of health data standards. Owing to the availability of adequate budgets, the case organisations relied on these external entities during the adoption process of HIT related standards.

This finding was also in accordance with the literature. For example, Khoumbati *et al.* (2006) suggested that, during the integration of an HIT infrastructure, a healthcare organisation should seek external support (e.g. from consultants and/or vendors) in order to determine what available market integration solutions were suitable to address the organisation's integration problems. Lin *et al.* (2010) realised the importance of environmental support to encourage the hospitals to adopt HL7 in Taiwan while Doebbeling *et al.* (2006) explained that there is a need for a formal programme within the HIT industry to support and increase the adoption of HIT applications in hospitals. Zhang *et al.* (2007) emphasised the importance of government support for standardisation development regarding health data in China and Poon *et al.* (2004) recommended that the related government and private entities, with regard to the CPOE system, should help healthcare organisations to realise the technology's benefits. Jacucci *et al.* (2006) suggested the creation of national networks (comprising experts, vendors and hospitals, for example) to support the local adoption of standards required to develop a national health information network in South Africa.

8.3.3.4 National Healthcare System

This new factor, which was derived from the empirical evidence, indicated that the national healthcare system in Saudi Arabia is not sufficiently well organised to allow data exchange amongst healthcare providers; this might be one of the reasons that the adoption of health data standards by Saudi healthcare organisations remains frustratingly low. There are substantial variations in the management and provision of medical services in Saudi Arabia. Every healthcare provider has its own policy and procedures that usually depend on the hospital's qualifications. The reason for this is that a clear national policy is still lacking with regard to how medical services are, for example, managed, operated, structured and provided to patients. Another reason might be linked to the centralised approach of the management system in Saudi Arabia which hinders cooperation and coordination between the health communities and related entities since each one looks to have full control of the available resources. In the literature concerning developing countries and sustainable healthcare systems, this new factor has been seen to be an important issue for the development of appropriate strategies for integrating the fragmented systems.

For example, Braa *et al.* (2007) explained that healthcare systems in developing countries vary immensely between regions and geographic areas; this variation results in inequities and uneven development infrastructures which makes the integration between the fragmented areas and systems more complicated. Jacucci *et al.* (2006) stated that, while developing standardised national health information systems in developing countries is seen to be crucial to the creation of sustainable national healthcare systems, the fragmented nature of the health systems and the inequities between rural and urban regions are challenges to achieving this goal. Smith *et al.* (2008) noticed that overlap and conflict between health programmes, together with a lack of integrated health information systems in certain African countries, have led to duplications in funding, wasted resources, and a lack of coordination in terms of managerial control. The researcher suggests more work needs to be done in this area. There is a need, for example, to develop a method for identifying and representing the networks of healthcare actors in developing countries and then to examine how these actors communicate and what are the minimal data standards that are required to facilitate integration between them. This might help in developing clear policies within the healthcare systems in developing countries.

8.3.3.5 Lack of a National Plan for Medical Data Exchange

The empirical data revealed that, due to the lack of a national plan for medical data exchange between healthcare providers in Saudi Arabia, healthcare organisations prefer to invest in their IT infrastructure, in areas such as networks, platforms and other advanced clinical information systems, rather than focusing on standardisation from which they cannot benefit directly. The reason is that the hospitals still lack fundamental systems and therefore they prefer to invest in the infrastructure rather than in standardisation. This finding is consistent with the study by Zhang *et al.* (2007) which found that, due to a lack of government action, the public healthcare providers in China prefer to invest in networks rather than in standardisation for health data. Rozenblum *et al.* (2011) noticed that a lack of national policy was one of the main barriers hindering the development of clinical data exchange across the health sector. Braa *et al.* (2007) suggested that a national strategy concerning integration across health domains, together with the development of a minimal set of data standards, are important in developing countries in order at least to reduce some of the challenges facing the delivery of medical services in those countries.

Hovenga (2008) emphasised that there is a need for an agreed national plan regarding HIT related standards in order to maximise interoperability across the health sector and to decrease the risks associated with the implementation of non-standard applications. According to Williams *et al.* (2004), this is because the development of interoperable standards, not only technically defines a method of interoperation between the different systems in a network, but most importantly, represents a proposal for the future of complex socio-technical systems that form the shape of a national network. In addition, a national plan is required to maintain an integrated view of a problem area or domain, rather than each agency seeking solutions based on individual efforts. However, the researcher recommends that further research is carried out in this area, such as developing a holistic framework outlining all the actions and activities required regarding health data standards within a national plan for medical data exchange.

8.3.3.6 Lack of a National Regulator

The empirical findings revealed that, with the absence of a formal reference for health data standards in Saudi Arabia, the standards were always adopted based on the needs and expectations of the case organisations. Various reasons were identified for this problem, such

as confusion amongst the hospitals with regard to the health data standards' market, the complexity of the subject of standardisation for health data, and the high degree of drag and sunk costs associated with their adoption. Identifying this barrier is in accordance with previous studies. For example, Hammond (2005) stated that the harmonising process of standardisation for health data among different related groups has been seen to be less effective when the government does not have a role. Zhang *et al.* (2007) noted that the standardisation process for health data in China is lagging behind owing to a lack of financial support from the government. The existence of a formal national regulator is seen to be an essential factor in facilitating the acquisition of HIT applications that incorporate such standards (Zhang *et al.* 2007; Halamka *et al.* 2005; Hammond 2005).

The reason for this is that the concept of trying to define in advance all the standards that will be required for medical data exchange is not the solution. Instead, adopting "just-in-time" standards and building in blocks, with the ability to produce effective and acceptable standards quickly, is the most appropriate solution for making progress towards achieving interoperability (Hammond 2005). In addition, any interoperability gaps are likely to be difficult to identify before progress is made in the development of a national health information network (Hammond 2005). Moreover, the health data specifications and standards developed for a particular market (e.g. the North American market) cannot, in general, be applied in other markets (e.g. the European market) without modification and customisation, owing to the differences between countries regarding medical policies and procedures (Eichelberg *et al.* 2005). The literature also highlighted several other activities, alongside the development of health data standards, which should be established by a national regulator. These included market certification (Hammond 2005), fund and resources' allocation (Zhang *et al.* 2007; Hammond 2005), and training and education (Zhang *et al.* 2007); these findings are in accordance with those outlined in Chapter Seven (see Section 7.5.2.12). Nonetheless, the researcher suggests further work in this area should be undertaken, such as investigating all the functions that should be established by a national regulator in order to promote the adoption of health data standards.

8.3.3.7 Shortage of Professionals

The majority of the participants acknowledged and agreed that the shortage of national professionals is one of the main factors which is hindering the development and adoption of

health data standards by healthcare organisations. The reason for this is that standardisation for health data is a very complex field which requires many informed, interdisciplinary, experienced professionals and researchers. In addition, Saudi Arabia is newcomer in the area of advanced medical technology practices and solutions and therefore the current education and training in this regard cannot meet the need. This finding is consistent with the studies of Lin *et al.* (2010), Zhang *et al.* (2007), Braa *et al.* (2007) and Jacucci *et al.* (2006) which explained that the shortage of professionals is an important barrier facing the process of standardisation for health data. In addition, Lorence and Churchill (2005) asserted that non-uniformity between hospitals, with regard to the adoption of security standards, resulted from a lack of local expertise. There is a long-term government plan in Saudi Arabia to establish many university programmes in the field of health/medical informatics to overcome this barrier. A great deal of government funding and support is crucial in order for these programmes to be established because it will be necessary to recruit international experts and communicate with some leading international universities and institutions in the area of health/medical informatics. However, without a national regulator for health data standards there will be a slight a delay to overcome the shortage of national professional within health data standards context and therefore the application of health data standards in Saudi Arabia might be delayed for the lack of professionals. This is because the national regulator will put some pressure on the government to continue funding and supporting national health informatics programmes and their activities.

8.4 The Revised Model

Based on the research findings presented in Chapter Seven, the proposed model was revised to accommodate the required modifications. The proposed model was revised via three steps: the lifecycle phases of the pre-adoption stage, the decision control and the decision mechanism of the adoption process, and the Technology-Organizations-Environment (TOE) framework of the adoption process. The following sections discuss each step in detail.

8.4.1 Phases of the Pre-Adoption Life Cycle

The data analysis revealed that one important phase should be added to the pre-adoption lifecycle phases in the proposed model which is the organisation's needs. The need of a healthcare organisation to automate some of its work processes or procedures puts pressure

on the organisation's authorities to change. The results in the motivation of some authorities to look for suitable solutions and to gather information regarding the available systems that will meet its needs. The majority of the interviewees explained that any request for a new system is always based on the need of departments to automate some of their functions, as one manager said:

> *If we don't have clear needs and specifications, we will not reach the targeted*
> *system or the expected outcome of that system. (Participant 4)*

In addition, the same manager explained the importance of including a need phase by drawing a diagram of the three correlated dimensions for any new system project, as shown in Figure 8.4. The three dimensions are the organisation, the vendor and the outcomes of the IT project. The correlation between the organisation and the vendor is the contract, the project outcome and the vendor result in the specifications of the required system, and the organisation and the outcomes of the IT project constitute the need. The clearer the needs and project specifications of the organisation, the greater the benefits of the project outcomes. This finding is consistent with those of Cooper and Zmud (1990) and Pierce and Delbecq (1977) who stated that an IT adoption project starts with initiation; this is the result of the pressure on an organisation to change to a particular system. This then leads the organisation to gather information regarding that system. In addition, Rogers (1995, pp. 267-297) mentioned that the adoption decision process is a sequence of stages which pass from initial knowledge and ultimately finishes when the decision regarding the acquisition of an innovation is made. At the knowledge stage, the individual is exposed to an innovation but lacks information about it. According to Rogers (1995, pp. 267-297), the persuasion stage does not start until the individual begins to be interested in the innovation and so seeks information about it. This stage, described by Kamal (2006) as the motivation stage, leads the organisation to search for information and knowledge about the innovation in order to ascertain an attitude towards its adoption.

The inclusion of the need phase was also thought to make sense since the case organisations are part of the public sector in Saudi Arabia. This means that market competition is beyond their business perspectives and so they are less motivator in nature. In addition, motivator organisations tend to be venturesome, educated, rich in terms of the required resources and willing to tolerate initial risks in order to devise swift solutions to their problems. In contrast,

the organisation that is laggard tends to lack the required resources or business insight to adopt an innovation and it will adopt an innovation when it has no choice (Rogers 1995, pp. 267-297). The characteristics of the laggards are more or less identical to the characteristics of Saudi healthcare organisations, as described in Chapter Seven, where the majority of participants explained that the lack of human resources was the major barrier to the adoption of health data standards. In addition, many revealed that they still lacked business insight, as well as the policies and procedures required for the adoption of HIT related standards. They explained that they are always governed by the market and so they have no other choice but to adopt market standards.

Accordingly, five phases were suggested in the pre-adoption stage of HIT related standards within the context of Saudi healthcare organisations: need, motivation, conception, proposal and decision making. The need phase refers to the pressure from certain members, groups, divisions or departments in the organisation to change to a specific innovation. This motivates the organisation to acquire in-depth knowledge about the possible solutions to adopt the required innovation. Plans for action are then initiated in the organisation to pursue the adoption of the innovation. Following this, substantiated reasons for approval should be provided to the rest of the organisation. The decision makers are also required at this stage to analyse and assess the organisation's requirements and capabilities before adopting the innovation. The last phase is the formal decision either to adopt or reject the innovation.
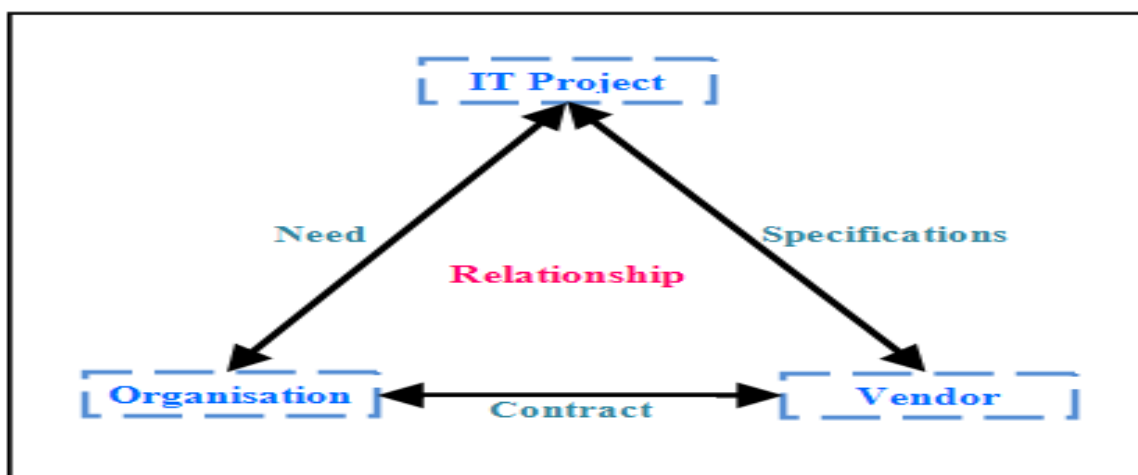
Figure 8.4: The correlation between the organisation, vendor and outcomes of the IT project during the adoption process, as drawn by participant 4.

Abdullah Ibrahim Alkraiji 2011

8.4.2 Decision Control and Mechanisms

Decision control refers to the constraints or controls on the adoption activities and these are based on criteria that vary among organisations. The findings revealed that some modifications were required to the proposed model in order to include two other criteria, educational and governmental reasoning, alongside those previously indicated such as operational, technical, strategic, managerial and organisational issues. This is because all the case organisations provide some sort of medical education and research and therefore they should adhere to certain standards in order to report medical information to such educational and research groups. Governmental reasoning also appeared to have a positive impact on the case organisations to adopt certain standards. This is because the case organisations are tertiary hospitals and, in Saudi Arabia, such hospitals are required to report some medical information annually to, for example, the MoH and the Saudi Oncology Centre in order for them to produce medical statistics and reports concerning the general health situation in the Kingdom. Therefore, the tertiary hospitals must conform to the use of certain terminology standards, such as ICD and SNOMED, to be able to report the required information.

Decision mechanisms deal with the decision making and the activities required for acquiring the new system (Whitman *et al.* 1997). The empirical findings from the case organisations illustrated that there are no special groups or departments dealing with the adoption of health data standards. Health data standards were seen as a feature of the new system and were therefore treated in a similar way to other system features. Different members and groups were involved in the decision making for the adoption of HIT related standards. However, in accordance with the organisational structure, IT and information managers, along with some senior managers, are permanent members of every committee with regards to the decision-making, purchasing and adoption of HIT applications in Saudi healthcare organisations. The decision makers were consistent with those identified in the proposed model, which suggested that various senior personnel and managers were likely to be involved in decision-making in the adoption of IT related standards, but that the most likely decision makers would be the organisation's CEO, senior and IT managers, and some other related managers (Chen 2003).

8.4.3 The Technology-Organisation-Environment (TOE) Framework

Eight new factors were identified through the analysis of the empirical data, as presented, together with their related category of the TOE framework and their impact on the decision-making in healthcare organisations (i.e. + positive impact and – negative impact), in Table 8.3. In addition, one factor was abandoned whilst four factors were modified, as explained in accordance with their related category of the TOE framework in Table 8.4. Figure 8.5 presents the big picture of the final model of the critical factors influencing the adoption of HIT related standards.

Table 8.3: Summary of the new factors based on the empirical data, together with their description and impact on the decision-making in healthcare organisations (i.e. + positive impact and – negative impact).

Factors		Factors	Impact	Description
Technological	1	Enhancing the Use of Advanced Systems	+	The hospitals in Saudi Arabia are hesitant about adopting or increasing the utilisation of advanced clinical information systems because these systems require a robust standardised information infrastructure in order to be successfully implemented.
Organisational	1	Organisation Type	+	Although the standards need to be implemented in every type of healthcare provider, the tertiary hospitals are most in need of adhering to health data standards in order to manage the complexity of their work.
	2	Lack of Adequate Policies and Procedures	-	The hospital policies and procedures are a set of guidelines that should be defined precisely; these should be developed for all the different activities when a request is made to purchase a new system and should be followed rigorously until the system is used on a regular basis.
	3	Education	+	Since the majority of the tertiary hospitals carry out some sort of education and research programmes, the hospitals must sustain high-quality medical information in order to provide these education and research centres with valuable information.
	4	Lack of Information Management Plan	-	It appears there is a lack of an information management plan in the public hospitals at the level of how data are, for example, predefined, characterised, structured, stored, exchanged, integrated, accessed and governed; this might explain why the hospitals are hesitant to change to the supported standards since they still do not have a clear vision and mission in this regard.
	5	Accreditation	+	One of the main initiatives taken by the top management in leading Saudi hospitals is the acquisition of certain accreditation from leading international medical commissions. Therefore, the hospitals must follow certain standards, including some health data standards, in order to be accredited.
	6	Data Analysis	+	The analysis of data is an important factor for healthcare organisations to help top management acquire meaningful insights from the data by carrying out accurate statistical analysis, excluding any human bias. However, this depends on the quality of the data that are inputted; it also relies on how well the systems are integrated and how well the data are structured and predefined.
Environmental	1	National Healthcare System	-	The national healthcare system is seen to be insufficiently organised to allow data exchange amongst healthcare providers and this might be one of the reasons that the adoption of health data standards by healthcare organisations remains frustratingly low where it does exist.

Table 8.4: Summary of the abandoned and modified factors, together with the reasoning behind this.

Factors		Factors	Abandoned	Modified	Reasoning
Technological	**1**	Language	✓		This factor was not an issue since English is the official medical language in Saudi hospitals. One reason is that the hospital systems in Saudi Arabia are either North American or UK based as the majority of Saudi physicians have come from the two schools. However, the technical interviewees showed that the standards must be customised to accept Arabic information and so this is a role for the future national regulator in Saudi Arabia.
Organisational	**1**	Organisational Support		✓	The empirical findings illustrated that many different organisational activities, resource allocation and various forms of support must be launched during the adoption of a new system in healthcare organisations. These vary from system to system. Therefore, if there are no adequate policies and procedures with regard to the adoption process of HIT applications in the healthcare organisations, organisational support will always be a barrier to the adoption process since it will be difficult to determine the different forms of support required in advance. So, achieving the missing support will depend on social aspects such as organisational culture, personal attitudes, organisational structure, and staff relationships and trust.
Organisational	**2**	Organisational Change		✓	The empirical data showed that, in order to promote the adoption of health data standards, a dedicated change management programme must be established owing to resistance amongst clinicians in adhering to the required standards on a daily basis. This is because clinicians lack a background in health data standards and are often unaware of the benefits that standards can bring to the organisation. Therefore the 'organisational change' factor was modified to 'resistance to change' as this is seen to be a barrier to the adoption of health data standards.
Organisational	**3**	Professional Availability		✓	The majority of the interviewees explained that the shortage of professionals with regard to standardisation for health data is the biggest barrier in Saudi Arabia and across the region. Since this barrier is not specific to certain organisations in Saudi Arabia but is across the board, the researcher thought it best to modify the name to 'Shortage of Professionals' and place it under environmental rather than organisational factors.
Environmental	**1**	Government Policy and Strategic Planning		✓	The empirical evidence from the case organisations explained that every country should launch two different initiatives in order to promote the adoption of health data standards in healthcare organisations. First, there is a need for a national regulator in order to lead and promote the development of standardisation for health data and the related activities in the country. Second, a national plan for medical data exchange should be established to set and define the standards, policies and information specifications which will be required to enable the exchange of medical data across the health sector and to establish the national health information network. Therefore, government policy and strategic planning were modified to represent the two aforementioned factors: the lack of a national regulator and the lack of a national plan for medical data exchange.

228
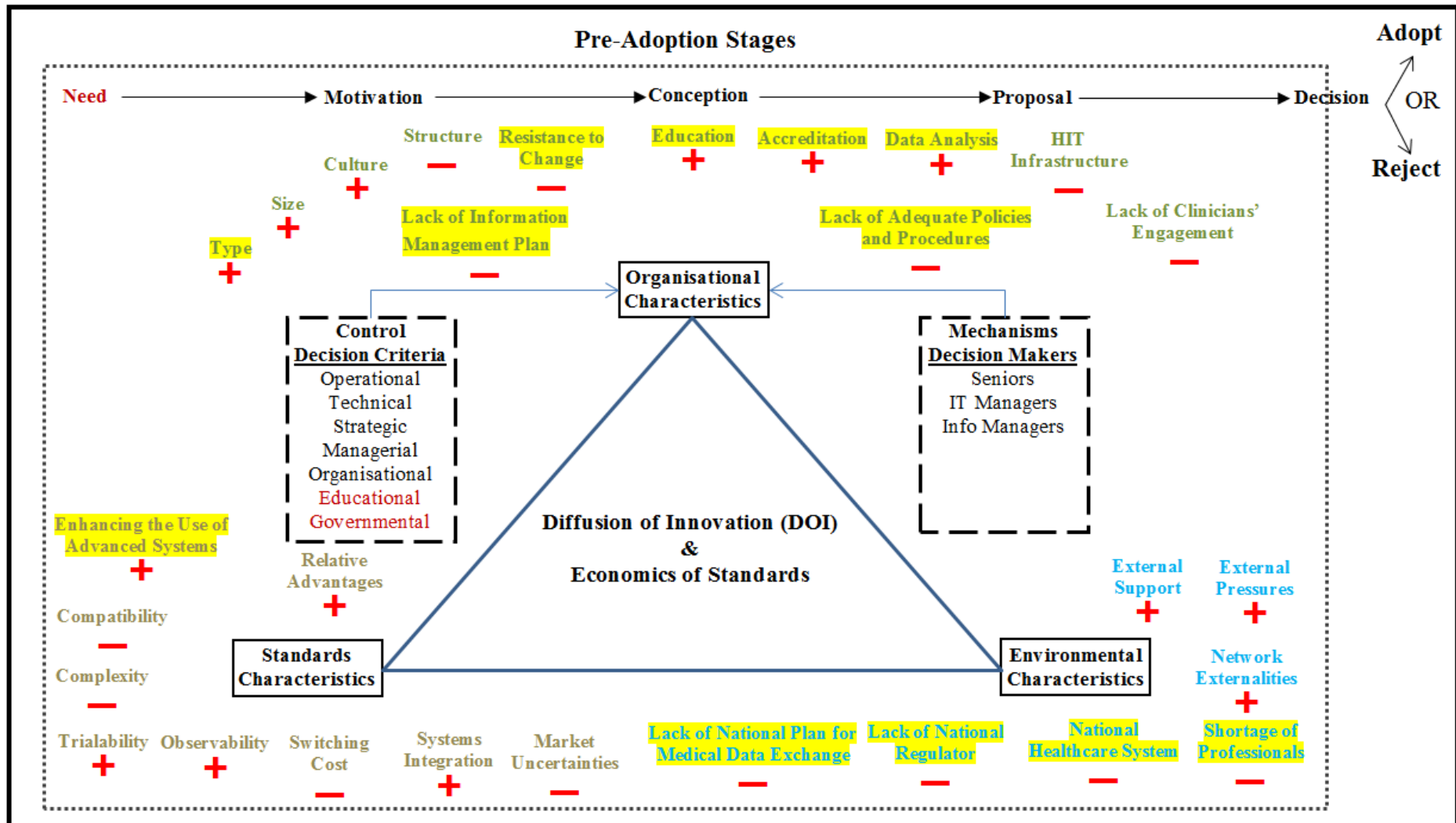
Figure 8.5: A Holistic Model of Reference for the Critical Factors Influencing the Adoption Process of HIT related Standards at the Decision-Making Stage in Healthcare Organisations, developed by the researcher.

Abdullah Ibrahim Alkraiji 2011

8.5 Summary

This chapter revised the conceptual model proposed in Chapter Six. The modifications to the proposed model were imposed by the analysis of the empirical data discussed in Chapter Seven. In addition, the lessons learned from the case organisations were thought to be helpful in the revision process. However, the researcher needed to ensure the validity of the research findings and so two phases were seen to be essential. First, the researcher sent the findings, as discussed in Chapter Seven (see also Appendix D), to five key participants to review and comment. The participants agreed on the findings and also provided the researcher with some recommendations, as presented in Chapter Nine, in order to promote the adoption of HIT related standards in healthcare organisations. Second, the researcher was required to discuss and put forward strong arguments within the findings in accordance with the literature. This was carried out in Section 8.3 where the researcher discussed each factor in the light of the literature and then offered some thoughts in this regard. Following this, revision processes were carried out in three steps. First, the phases required to be pursued in the pre-adoption stage were modified to include the need phase. Secondly, the decision criteria were also modified to take into consideration other two aspects, educational and governmental issues. Thirdly, the TOE framework was revised to abandon one factor (i.e. language), to modify four factors (i.e. Organisational Support, Organisational Change, Professional Availability, and Government Policy and Strategic Planning) and to add eight other factors (Enhancing the Use of Advanced Systems, Organisation Type, Lack of Adequate Policies and Procedures, Education, Lack of an Information Management Plan, Accreditation, Data Analysis, and National Healthcare System), as presented in Tables 8.3 and 8.4. Then, the final revision of the adoption process for HIT related standards was presented in Figure 8.5. The highlighted factors in Figure 8.5 are either new ones or have been modified based on the evidence from the case organisations.

Chapter Nine: Research Conclusions and Recommendations

9.1 Introduction

The purpose of this chapter is multiple. First is to offer an overview of the main research findings derived from the literature and the empirical studies, in relation to the aim and objectives of this research. Second is to draw recommendations from the lessons learned to promote the adoption of health data standards in healthcare organisations, and in particular those in developing countries. Third is to explain the novelty and the contribution of this research to the body of knowledge and to practice. The last is to highlight the limitations of this research whilst proposing areas for further investigation. Sections 9.2, 9.3, 9.4, 9.5 and 9.6 offer discussion based respectively on the purposes mentioned above.

9.2 Overview and Findings of the Research

Owing to interoperability barriers between clinical information systems, healthcare organisations are facing potential limitations with regard to acquiring the benefits such systems can offer, e.g. reducing the cost of medical services. However, the level of interoperability that allows a "mix-and-match" environment requires a high degree of consensus on the health data standards. Even though health data standards are expected to be the basis for solutions to interoperability, the level of adoption of these standards remains frustratingly low. One reason is that there appears to be market uncertainties surrounding the development of health data standards owing to that health data standards developed for a particular market (e.g. the North American market) cannot, in general, be applied in other markets (e.g. the European market) without modification. Given that the adoption of health data standards is an authoritative field in which the mechanisms of the marketplace do not work, many countries have launched national initiatives to develop standardised health data. Several authors (e.g. Zhang *et al.* (2007) and Hammond (2005)) have also carried out studies to map the landscape of such initiatives, as well as examining barriers which impede their progress. However, there is a lack of studies concerning the adoption of health data standards in healthcare organisations. Furthermore, these few studies, where they do exist, focus only on a specific standard and the Diffusion of Innovation paradigm to explain, using a quantitative survey methodology, broad, general factors that would predict the adoption process of that standard across the hospitals.

The outcome of these studies is limited and questionable for two main reasons. First, the application of traditional adoption theories alone, such as Rogers' paradigm (1995), to complex adoption situations produced serious deviations in the findings compared to the expected results. Second, a richer framework for understanding adoption decisions can only be developed through a qualitative study of cases adopting specific standards. This is because quantitative surveys are intended only to make a priori assumptions of what constitutes a factor, and then set out to locate, measure and observe it. The limited number of previous studies that were found treated the adoption of HIT related standards at the decision-making stage in healthcare organisations as a "black box" of aggregate-level outcomes. They did not offer a holistic view of the critical factors influencing the adoption process of HIT related standards. Therefore, both researchers and practitioners are still lacking a significant body of evidence with regard to the adoption process of such standards. In order to fill this gap in the knowledge, the researcher explored the current status of health data standards in order to identify the issues facing the development of health data standards worldwide. The reason for this was to help the researcher gain a broad view of the general industry with regard to health data standards which might explain later certain issues concerning the adoption process of those standards. The outcome of this stage satisfied Objective One of this study, "To conduct a comprehensive literature review related to health data standards."

Next, studies focussing on IT related standards needed to be reviewed owing to the lack of research surrounding HIT related standards, and also for this study to be built on a firmer foundation. The studies concerning the adoption of IT related standards also validated the importance of this research as it was found that the subject of the adoption of IT related standards was limited to a small number of empirical studies, demonstrating a need for further research. Although several theories can be employed to predict the adoption process of IT related standards, the previous studies explained that the predominant theories are Rogers' paradigm (1995), which focuses on the general characteristics of the innovation and the adopters, and the economic perspectives of standards, which examines switching costs and community effects. Using both perspectives, made the research more constructive in terms of providing a rich set of influencing factors. No single strongly predictive theory, within the IS field seemed to emerge to explain innovation adoption. The literature suggested that the adoption process should also be studied in relation to another framework, namely the Technology-Organisation-Environment (TOE). This was proposed to ensure that researchers did not ignore the temporal aspects of the adoption process or neglect other important aspects

such as the people and the organisation involved. Accordingly, in this research, the two predominant theories, Rogers' paradigm (1995) and the economic perspectives of standards were employed within the TOE framework to study the adoption process of HIT related standards. The outcomes of this stage achieved the Second Objective of this research, "To review the existing adoption models and consider how these models could be extended or modified to model the adoption process of HIT related standards at the decision-making stage."

Based on the second objective, the conceptual model was constructed. Due to the limitation of the literature concerning the adoption of HIT related standards, the researcher investigated only the literature related to the adoption of IT related standards and areas related to the adoption of medical technology for integration purposes. This was because both fields have a similar background to the adoption of HIT related standards. The literature was carefully reviewed and the final factors influencing the adoption of HIT related standards at the decision-making stage in healthcare organisations were then linked to the corresponding TOE categories. Twenty one factors were identified from the related literature and these were then used to develop the final picture of the adoption process of HIT related standards at the decision-making stage in healthcare organisations, as shown in Figure 6.6. This then accomplished the third objective of this research, "To develop a theoretical model, based on the models identified in Objective 2, of the critical factors influencing the adoption of HIT related standards in healthcare organisations at the decision-making stage."

Moving from a theoretical to an empirical setting, the proposed model had to be examined in a practical setting. The researcher's intention was not to look for a case study where the adoption of HIT related standards was compulsory and where the healthcare organisations had no option but to adopt the standards assigned by the government or national initiatives. This would have prevented the researcher gaining an holistic view of the reasons and opinions associated with the adoption process of health data standards. Therefore, developing countries were seen to be suitable cases for this research as the majority still lack government initiatives and studies related to this area. An interpretive and exploratory multiple-case study approach was undertaken in Saudi Arabia to examine the validity of the proposed model.

Through six tertiary healthcare organisations in Saudi Arabia, thirty three decision makers were interviewed face-to-face and a range of documentation was gathered to enable the researcher to ensure that rich qualitative data were collected to allow analysis that had both

233

depth and breadth. Moreover, a hybrid approach, which included both thematic and cross-case analysis, was used to analyse the collected textual materials. The results from the data analysis revealed that although several government entities and commissions speak about the standards, no one has taken the lead to develop and promote them in Saudi Arabia and therefore, only a few health data standards, including ICD, SNOMED, CPT, HL7 and DICOM, were applied in the tertiary hospitals in the Kingdom. Every healthcare organisation is at a different stage in terms of adopting these standards. They are therefore often based on the organisation's needs and expectations in terms of managerial, technical, educational and governmental purposes. The terminology standards are in limited use and most of the data were built on a proprietary format. Exchanging medical data semantically among these hospitals or related medical groups in Saudi Arabia would be impossible. In addition, obtaining meaningful insights into the medical information, through the provision of accurate statistics and reports, was also limited as a result of the inadequacy of the data. Therefore, producing medical statistics and reports, such as mortality data, concerning the health situation in Saudi Arabia in general was a real concern. The purpose of this analysis was to answer the first research question, "What is the current status of health data standards in Saudi healthcare organisations?" and to meet the fourth, fifth and sixth objectives of this research:

❐ **Objective 4:** To identify the current health data standards adopted in Saudi healthcare organisations.

❐ **Objective 5:** To assess how the current health data standards in Saudi healthcare organisations are adopted and are being supported.

❐ **Objective 6:** To examine the roles of the current health data standards adopted in Saudi healthcare organisations.

The empirical evidence also offered twenty eight factors that were thought to influence the adoption of health data standards at the decision-making stage. While fourteen factors were seen as enablers, another fourteen appeared to hinder the adoption of the standards. The resulting factors answered the second research question, "What are the critical factors that influence the adoption process of health data standards in Saudi healthcare organisations?" It also satisfied the seventh objective of this research, "To identify both the barriers and enabling factors regarding the adoption of health data standards in Saudi healthcare organisations." For the researcher to examine the validity of the proposed model, two further

234

stages were seen as essential. First, the researcher reported back the findings of this research to five key participants to review, discuss and comment on. A video-conferencing online method was used for this purpose. The participants either strongly agreed or agreed with the findings and so further modifications were not required. The researcher also needed to discuss the findings in the light of the existing literature for the results to be better grounded. Following this, the proposed model was revised by carrying out three steps: first, the phases required to be pursued in the pre-adoption stage were modified to include the need phase; second, the decision criteria were also modified to take into consideration two other aspects, educational and governmental issues; and third, the TOE framework was revised to abandon one factor (i.e. Language), to modify four factors (i.e. Organisational Support, Organisational Change, Professional Availability, and Government Policy and Strategic Planning), and to add eight other factors (Enhancing the Use of Advanced Systems, Organisation Type, Lack of Adequate Policies and Procedures, Education, Lack of Information Management Plan, Accreditation, Data Analysis, and the National Healthcare System). These modifications are presented in Figure 8.5. The purpose of this stage was to fulfil the eighth objective of this research, "To develop and validate a model of reference for the adoption of HIT related standards."

The researcher drew from the lessons learned from the case organisations and through the validation process to offer several recommendations that should be taken in account at both an organisational and national level to promote the adoption of HIT related standards. The recommendations were also developed, in accordance with the literature, to fit the context of every developing nation. The following section outlines these recommendations which fulfil the 9th Objective of this research and answer the third and fourth research questions. These are:

5. What steps should be undertaken by Saudi healthcare organisations to promote the adoption of HIT related standards?
6. How can the Saudi government help healthcare organisations to increase the adoption of HIT related standards in Saudi healthcare organisations?

Table 9.1 illustrates where each research question was answered and where each objective was fulfilled by correlating the questions and objectives with the research chapters and sections.

Table 9.1: The correlation between the research questions and objectives, and the research chapters and sections.

		Chapters (S: Section & X: Whole Chapter)								
		1	2	3	4	5	6	7	8	9
Q1	a							S 7.3		
	b							S 7.3		
	c							S 7.4		
Q2	a							S 7.5.1		
	b							S 7.5.2		
Q3									S 8.2	S 9.3
Q4									S 8.2	S 9.3
Obj-1		S 1.3 & 1.4		X						
Obj-2					X		S 67.2 & 6.3			
Obj-3							S 6.4 & 6.5			
Obj-4								S 7.3		
Obj-5								S 7.3		
Obj-6								S 7.4		
Obj-7								S 7.5.1 & 7.5.2		
Obj-8									X	
Obj-9										S 9.3, 9.4 & 9.5

9.3 Research Recommendations

This section provides those who are planning to adopt health data standards with some recommendations in order to promote the adoption rate of these standards in healthcare organisations. The recommendations, which were developed based on the empirical evidence and the literature, are offered in two parts. The first deals with the national level while the

second one concerns the healthcare organisations at organisational level. The following sections highlight these recommendations.

9.3.1 Recommendations at a National Level

From the empirical data and evidence from the literature, the researcher identified various initiatives that should be undertaken by governments at a national level in order to promote the development of standardisation and the adoption of health data standards. These are:

RECOMMENDATION 1: National Regulator - The existence of a national formal reference for health data standards is essential to lead the development of such standards in the country and to promote their adoption. Government support and funding are also seen as crucial if the activities of this national formal reference are to be effectively carried out. Such activities that should be carried out by the national regulator for health data standards are, for example:

1) The national regulator should be involved in the existing international standardisation initiatives, rather than focusing its resources on developing its own standards and then customising international ones according to local needs as this is the most appropriate approach and cost effective solution for the development of national health data standards.

2) The engagement of clinical expertise in the process of developing health data standards is also vital in order to create scenarios for the content of standards, giving them actors, roles and interactions through which the required data structures and data exchanges can be predefined and derived, as well as to ensure that health communities adhere to the standards on a daily basis.

3) An advisory group, which should monitor the activities of the international standardisation industry, will also be required to report back to national groups once the effectiveness of the new standards or versions become apparent.

4) The concept of trying to define and develop all the standards in advance is not a solution to the current interoperability issues. Instead, the most appropriate solution, offering the ability to produce effective and acceptable standards quickly, is the implementation of "just-in-time" standards and building in blocks.

5) The national regulator should monitor and govern the national market so that every system is certified before it can be marketed.

6) The national regulator should cooperate and coordinate with the Ministry of Higher Education, as well as different national universities, to redesign the curricula of medical colleges and to establish a new education programme of health informatics in order to overcome the shortage of national professionals, as discussed in section 8.3.3.7.

RECOMMENDATION_2: National Medical Data Exchange Plan - An agreed national strategic direction between the different medical entities must be established to control and govern the activities and issues associated with medical data exchange and, as part of this plan, the National Shared EHR must be taken into account in this stage. Parts of this plan roles are, for example:

1) It should examine the capabilities of the market and of the hospitals in setting and defining the necessary standards, policies and information specifications required to enable medical data exchange.

2) A continuous evaluation process is necessary as there is a need to demonstrate the usefulness of the existing standards, or to find other solutions, or to demonstrate the impact of health data standards on clinical information systems, or for the hospitals in general.

3) An on-going process of analysis and debate between related national groups will be required, not only to enhance data exchange and aggregation, but also to generate the broad feedback needed to improve the standards, to identify the precise requirements of the health sector, and to clarify the suitability of each option for those requirements.

4) A programme to offer some sorts of incentive (and/or inflict certain punitive measures) must be established to ensure the application of health data standards in the hospitals.

RECOMMENDATION_3: National Plan for Medical Information Management - There is a need for a national medical information management plan at the level of how data are, for example, predefined, characterised, structured, stored, exchanged, integrated, accessed and governed. This is the first step in the development of a national health information network. However, this plan requires the significant involvement, engagement and commitment of the hospitals' managements and clinical communities in order to place continued emphasis on developing the information infrastructure by increasing the depth and breadth of electronic clinical content. In addition, the information should follow the patient if the patient consented. This requires also the

238

national health communities to have a privacy-sensitive culture based on professional ethics and strict safeguards regarding medical data. In addition, specific health privacy legislation governing hospitals in Saudi Arabia must be developed to ensure that a high value is placed on the confidentiality of patients' information. Security and protection of patient information are not only demanded by the patient himself, but in most developed countries they are also required by law. For example, the data protection act at the European level was regulated in 1995 on the protection of individuals with regard to the processing of personal data including personal health data and on the free movement of such data (Haak et al. 2003). Therefore, aspects of patient data security and protection need to be considered carefully for every such activity in medical data exchange.

RECOMMENDATION_4: Change Management at National Level - A dedicated programme for change management must be established at a national level to ensure the national healthcare sector is redesigned to operate as an integrated, coherent system with clear policies and workflow mechanisms which would allow data to be exchanged seamlessly between the different entities within the sector. Critical to the success of this programme is the commitment of the hospitals in managing and sustaining the substantial changes that will be necessary. Other important issues that this program should encompass are, for example:

1) It should ensure that highly collaborative approaches are employed by the hospitals to regulate successfully the rate of change required for promoting the adoption of health data standards.

2) It must stress on the important role of insurance companies in the development of sustainable national HIT infrastructure as they will be the key driver for the medical data exchange between healthcare providers in Saudi Arabia.

3) It must recognise the importance of engaging clinicians in the development of a highly standardised medical information infrastructure. So, clinical leadership, collaboration, effective communication, and commitment to education, training and awareness-raising sessions, are critical success factors in maintaining the application of health data standards on a daily basis.

4) There is a need to offer incentives and forms of compensation to encourage medical staff to use terminology standards in their daily routine tasks.

RECOMMENDATION_5: National Accreditation - A national accreditation programme should be initiated to encourage healthcare providers to apply the standards on a daily basis. This programme should be developed based on international guidelines, while

channels of communication should be opened with those considered to be well recognised international institutions for them to work hand-in-hand in accrediting the national healthcare providers. The national hospitals should also be rigorously evaluated and followed up in order to assess to what extent the hospitals are conforming to the standards in practical settings, not theoretical ones, to pinpoint and investigate barriers, and to implement means for continuous improvement.

9.3.2 Recommendations at an Organisational Level

The researcher identified certain recommendations which should be taken into account at an organisational level to maximise the success of the hospitals in adopting and adhering to HIT related standards. These are as follows

RECOMMENDATION_1: Top Management Awareness - The hospital authorities must acknowledge the role of the HIT applications in the development of sustainable healthcare systems, not only from managerial, organisational and operational points of view, but also from medical and clinical perspectives. They must also acknowledge that the success of HIT implementation is never merely a matter of smoothing out technical issues. It is rather a complex balance between different types of requirement involving organisational, cultural and managerial aspects. They must also recognise the importance of achieving interoperability between the different systems as it is the key to success.

RECOMMENDATION_2: An Adequate Policies and Procedures - Clear policies and procedures with regard to the adoption of clinical information systems must be developed in alignment with the hospitals' visions in order to facilitate the development of an interoperable HIT infrastructure. Hospital policies and procedures are a set of guidelines that should be defined precisely; these should be developed for all the different activities required when a request is made to purchase a new system and should be followed rigorously until the system is used on a regular basis. These policies and procedures must stress the importance of the involvement of both top management and medical staff in the adoption process in order to increase the likelihood of the system's adoption, adherence and success.

RECOMMENDATION_3: Change management at Organisational Level - A dedicated change management programme must be established to ensure that a highly collaborative approach is undertaken by the hospital authorities, different departments and related

240

groups in order to regulate successfully the rate of change and ensure organisational change objectives are fully realised. For example:

1) The commitment of top management in supporting the implementation is a key factor in the success of every HIT related standards project.

2) The dedicated change management programme should examine the implementation of technical metrics, measures of acceptance, and the use of health data standards by staff and physicians.

3) The hospitals must recognise the importance of engaging clinicians in the development of the highly standardised medical information infrastructure. Thus, clinical leadership, collaboration, effective communication, and commitment to education, training and awareness-raising sessions, are critical success factors in maintaining the application of health data standards on a daily basis.

4) The dedicated change management programme should assess how the hospital is structured and should examine what changes are necessary to increase success in adopting the health data standards.

5) It is necessary to have health informatics personnel and those with medical backgrounds to work closely with IT experts since medical information systems require not only technical people but also a mixture of those with business or care backgrounds in order to ensure that the needs and requirements of the stakeholders are addressed.

6) The dedicated change management programme should redefine how business processes operate and flow, how the systems are integrated, how the data are predefined and saved, and how the documentation is structured and located. This will bring about significant and potentially overwhelming changes to the flow of work and day-to-day operations.

7) The dedicated change management programme must be managed carefully and with sensitivity as it will have a considerable impact in the form of change for employees and medical staff.

9.4 The Contribution and Novelty of this Research

Although the level of adoption of health data standards remains frustratingly low, little is known about their adoption, such as their applications and roles, and the critical factors

241

influencing their adoption in healthcare organisations. In addressing this gap in the literature, an evaluation study was undertaken in Saudi healthcare organisations to examine the current status of the adoption of health data standards and the critical factors influencing their adoption in order to produce a set of recommendations to enhance the adoption of such standards in healthcare organisations. The following points summarise the main contributions made by this research, as well as outlining the novelty of this thesis.

❏ The first contribution of this thesis is the proposition of a conceptual model for the adoption process of HIT related standards in healthcare organisations, as presented in Figure 6.6. This model was based on Rogers' paradigm and the economics of standards theories. These are well-known theories in the IS field but this research has widened their applicability to the area of HIT applications. In addition, these theories were studied based on the TOE framework, a well-known and fairly comprehensive framework in the innovation adoption paradigm at an organisational level in the IS field. This provided a holistic view of the adoption process which previous studies lacked. Moreover, the constructs of the proposed model were derived from a comprehensive literature review based on the adoption of IT related standards and areas related to the adoption of medical technology for integration purposes. Due to the limitation of the literature surrounding the adoption of HIT related standards, both subjects were seen as appropriate starting points since their backgrounds were similar to the adoption of HIT related standards.

❏ Another important contribution of this thesis is the provision of the roles and reasoning perspectives, based on empirical evidence, in the adoption of health data standards, as presented in Sections 7.3 and 7.4. Although some of the perspectives reported were highlighted theoretically in previous studies, the literature still lacks empirical studies to support theoretical positions in this regard. The empirical findings concerning the roles and reasoning perspectives in the adoption of health data standards contribute in filling the knowledge gap in this area.

❏ The most important contribution of this thesis is the development of a novel model of reference for the adoption process of HIT related standards at the decision-making stage in healthcare organisations, as presented in Figure 8.5. This empirical model makes a novel contribution at two levels. First, the model was developed conceptually based on the IS theories and constructs discussed in the related normative literature and then examined in practical settings for validation based on evidence. In terms of knowledge in the IS area, this model offers an in-depth understanding of the adoption process of HIT

242

related standards which the literature still lacks. It also examines the applicability of IS theories in a new area which allows researchers to relate their experiences to those reported. Secondly, this model can be used by decision makers in the healthcare sector, and in particular those in developing countries, as a guideline while planning for the adoption of health data standards.

❑ A further contribution made by this thesis is the development of a set of recommendations which offers support to strategic planners in the health sector, particularly those in developing countries, during the development of interoperability initiatives and medical data exchange between healthcare providers.

9.5 Limitations of the Research

Although a qualitative framework was seen in carrying out this study as more appropriate than a quantitative one (as justified in Chapter Five), the results from the qualitative data were difficult to generalise to other populations. For example, the structure of the health sector varies from country to country as each health sector has its own characteristics that affect and are affected by national circumstances. Therefore, in order to be better grounded, theory resulting from a qualitative study usually requires further examination by employing quantitative studies. In addition, the qualitative data that were collected were contextually rich. This meant that the possibility of bias occurring during their interpretation cannot be ruled out, even when using triangulation. In addition, the data for triangulation were limited to only two types, from interviews and documentation reviews, owing to the restricted access the researcher was allowed to information for reasons of confidentiality. Some of the candidate participants declined to participate for personal reasons while some were not available when the data collection took place.

9.6 Further Research

This research has established a starting point for understanding the application of health data standards by developing a model of the critical factors influencing the adoption process of HIT related standards. The overall findings and the limitations of this study can guide further research in some areas that are thought to be important for academic purposes. These areas include:

Abdullah Ibrahim Alkraiji 2011

❏ The researcher suggests transforming the adoption model of HIT related standards into a large-scale survey questionnaire. This would offer the opportunity to establish generic significance to the constructs included in the model. A large-scale survey questionnaire could consider all the different types of healthcare (for example, primary, secondary and tertiary care providers) to examine the similarities and the differences between the results in relation to the type of healthcare. A large-scale survey questionnaire could also consider a mixture of countries, including both developed and developing nations, to examine to what extent the model is valid within different contexts.

❏ Another suggestion is to study in depth some of the factors in the adoption of health data standards and their impact. For example, further work could be undertaken to consider a holistic approach to identifying the change management required in the adoption of health data standards in healthcare organisations. Further studies are also needed to enhance the positive impact of the accreditation system in improving HIT infrastructures and medical services. In addition, there is a need to develop a method for identifying and representing the networks of healthcare actors in developing countries and then to examine how these actors communicate, asking what are the minimal data standards required to facilitate integration between them. Moreover, further work is needed in developing a holistic framework of the actions and activities required within a national plan for medical data exchange and of a national regulator in order to promote the adoption of health data standards.

❏ Further work could be undertaken to examine health data standards and their acceptance by users through a large-scale survey questionnaire in order to cover the perspectives of both decision makers and users, thus filling the current gaps.

9.7 Summary

This chapter highlights the main overview and findings of this thesis. The intention of this is to highlight the importance of this research and show how the thesis was developed to address a gap in the current body of knowledge. Based on the research questions and objectives, which were answered and fulfilled by different chapters and sections, this thesis has achieved its aim to fill a gap in the normative literature. A necessary part of such research is to offer recommendations and this was achieved in this chapter by putting forward a set of recommendations that were developed based on the empirical evidence and the literature to support decision makers in planning the adoption of health data standards in healthcare

organisations. To conclude, the researcher wishes to highlight the contribution and novelty of this research which is, in essence, the development of novel model of reference for the adoption process of HIT related standards at the decision-making stage in healthcare organisations. The research's limitations (a lack of generalisation, the inclusion of contextual data and restricted access to some information) are presented in this chapter, as well as suggestions for further research, such as transforming the adoption model of HIT related standards into a large-scale survey questionnaire to offer the opportunity to establish generic significance to the constructs related to the model.

Chapter Ten: References

Agarwal, R. & Prasad, J., 1998. The antecedents and consequents of user perceptions in information technology adoption. *Decision Support Systems*, **22** (1), 15-29.

Ajzen, I., 1985. From intentions to actions: A theory of planned behaviour. *In*: Kuhl, J. & Beckmann, J., eds. *Action Control: From Cognition to Behavior*, Heidelberg: Springer, 11-39.

Ajzen, I. & Fishbein, M., 1980. *Understanding Attitudes and Predicting Behavior*. USA, New Jersey: Prentice-Hall, Englewood Cliffs.

Alavi, M. & Carlson, P., 1992. A review of MIS research and disciplinary development. *Journal of Management Information Systems*, 8(4), 45-62.

AL-Gahtani, S. S., 2003. Computer technology adoption in Saudi Arabia: correlates of perceived innovation attributes. *Information Technology for Development*, **10**(1), 57-69.

ALsafadi, Y., Sheng, O. & Martinez, R., 1994. Comparison of communication protocols in medical information exchange standards. *In Proceedings of the 7th IEEE Symposium on Computer-Based Medical Systems*, 10-12 June, Winston-Salem, NC, USA, 258-263.

AlSabti, K., 2005. The Saudi Government in the Information Society, *In Proceeding of the 11th GCC e-Government Forum*, 21-25 May, Dubai, UAE.

Al-Saggaf, Y., 2004. The Effect of Online Community on Offline Community in Saudi Arabia. *EJISDC*, **16**(2), 1-16.

Al Sharif, A. I., 2008. *Big and Speedy Expected Growth in the Medical Insurance Market*. Cooperative Health Insurance, <http://www.cchi.gov.sa/sites/en/InfoCenter/Documents/Health%20Insurance%20Issue%201.pdf>, March, pp. 38-41, [Accessed 3.11.2010].

AL-Shehry, A., Rogerson, S., Fairweather & N. B., Prior, M., 2006. The motivation for change toward e-Goverment adoption: case studies from Saudi Arabia. *In Proceeding in*

e-Government Workshop '06 (eGOV06), September 11, Brunel University, London, UK.

AL-Shehry, A. M., 2008. *Transformation towards E-government in the Kingdom of Saudi Arabia: Technological and Organisational Perspectives*. PhD thesis, School of Computing, DE Montfort University, UK.

AL-Solbi, A. & Mayhew, P. J., 2005. Measuring E-readiness assessment in saudi organizations preliminary results from a survey study. *In Proceeding of the 1st European Conference on Mobile Government*, 10-12 July, University of Sussex, UK, 467-474.

Altameem, T. A., 2007. *The Critical Factors of E-Government Adoption: An Empirical Study in the Saudi Arabia Public Sectors*. PhD thesis , School of Information Systems, Computing and Mathematics, Brunel University, UK.

Altuwaijri, M. M., 2008. Electronic-health in Saudi Arabia – Just around the corner. *Saudi Medical Journal*, **29**(2), 171-178.

Al-Yousuf, M., Akerele, T. M. & Al-Mazrou, Y. Y., 2002. Organization of the Saudi health system. *Eastern Mediterranean Health Journal*, **8**(4-5), 645–653.

Amatayakul, M. & Lazarus, S. S., 2005. *The EHR Regulatory and Standards Environment: Electronic Health Records Transforming Your Medical Record*, 1st ed. USA: Medical Group Management Association MGMA, pp. 223-238.

Arthur, W. B., 1988. Computing technologies: an overview. *In*: Dos, G., Freeman, C., Nelson, R., Silverberg, G. & Soete, L., eds. *Technical Change and Economic Theory*, London: Pinter Publisher Limited, 590-607.

ASTM WK4363, 2004. *Draft Standard Specification for the Continuity of Care Record, Version 1*. ASTM International.

Attride-Stirling, J., 2001. Thematic networks: an analytic tool for qualitative research. *Qualitative Research*, **1**(3), 385-405.

Ball, M. J. & Lillis, J., 2001. E-health: transforming the physician/patient relationship. *International Journal of Medical Informatics*, **61**(1), 1-10.

Bandura, A., 1986. *Social Foundations of Thought and Action: A Social Cognitive Theory*. USA, New Jersey: Prentice-Hall, Englewood Cliffs.

Braa, J., Hanseth, O., Heywood, A., Mohammed, W. & Shaw, V., 2007. Developing Health Information Systems in Developing Countries: The flexible standards strategy. *MIS Quarterly*, **31**(2), 381-402.

Basole, R. C., 2008. Enterprise adoption of ICT innovations: multi-disciplinary literature analysis and future research opportunities. *In Proceedings of the 41st Annual Hawaii International Conference on System Sciences*, IEEE Computer Society, Washington, DC, USA.

Beale, T., 2002. Archetypes: Constraint-based domain models for future-proof information systems. *In Proceeding of the 11th OOPSLA Workshop on behavioral semantics serving the customer*.

Becker, S.W. & Whisler, T.L., 1967. The innovative organization: A selective view of current theory and research. *The Journal of Business*, **40**(4), 462-469.

Begoyan, A., 2007. An overview of interoperability standards for electronic health records. *In Proceeding of the 10th World Conference on Integrated Design and Process Technology (IDPT)*, Society for Design and Process Science, June, Antalya, Turkey, 3-8.

Benbasat, I., Goldstein, D. K. & Mead, M., 1987. The Case Research Strategy in Studies of Information Systems. *MIS Quarterly*, **11**(3), 369-386.

Berler, A., Tagaris, A., Angelidis, P. & Koutsouris, D., 2006. A roadmap towards healthcare information systems interoperability in Greece. *Journal of Telecommunications and Information Technology*, **2**, 59-73.

Bird, C.M., 2005. How I stopped dreading and learned to love transcription. *Qualitative Inquiry*, **11**(2), 226-248.

Blobel, B. & Pharow, P., 2008. Analysis and evaluation of EHR approaches. *Methods of Information in Medicine*, **48**, 162–169.

Boonstra, A., & Broekhuis, M., 2010. Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC Health Services Research*, **10**(231), 1–17.

Bott, O. J. & Braunschweig, G., 2004. The Electronic Health Record: Standardization and Implementation. *In Proceeding of the 2nd OpenECG Workshop*, Institute for Medical Informatics, Berlin.

Brancheau, J.C. & Wetherbe, J. C., 1990. The adoption of spreadsheet software: testing innovation diffusion theory in the context of end-user computing. *Information Systems Research*, **1**(2), 115-143.

Braun, V. & Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, **3**(2), 77–101.

Brender J., Ammenwerth, E., Nykänen, P. & Talmon, J., 2006. Factors influencing success and failure of health informatics systems. *Methods of information in Medicine*, **45**(1), 125–136.

Bretschneider, S., 1990. Management information systems in public and private organizations: An empirical test. *Public Administration Review*, **50**(5), 536-545.

Brooke, C., 2002. Editorial: Critical Research in Information Systems. *Journal of Information Technology*, **17**(1), 45-47.

Burrell, G. & Morgan, G., 1979. *Sociological Paradigms and Organizational Analysis: Elements of the Sociology of Corporate Life*. UK, London: Heinemann Educational Books.

Byrne, B.M. & Golder, P. A., 2002. The diffusion of anticipatory standards with particular reference to the ISO/IEC information resource dictionary system framework standard. *Computer Standards & Interfaces*, **24**(5), 369-379.

Call for Papers, 2011. Special Issue on Standards in Practice – Translating Standards into Practice: Experiences and Lessons Learned in Biomedicine and Health Care. *Journal of Biomedical Informatics*, **44**, 181-182.

Carr, C.D. & Moore, S. M., 2003. IHE: A model for driving adoption of standards. *Computerized Medical Imaging and Graphics*, **27**(2-3), 137-146.

Cavaye, A. L. M., 1996. Case Study Research: A Multi-Faceted Research Approach for IS. *Information Systems Journal*, **6**(3), 227-242.

Chang, I. C., Hwang, H. G., Yen, D. C. & Lian, J. W., 2006. Critical factors for adopting PACS in Taiwan: Views of radiology department directors. **Decision Support Systems**, **42**(2), 1042-1053.

Chaudhry, B., Wang, J., WU, S., Maglione, M., Mojica, W., Roth, E., Morton, S. C. & Shekelle, P. G., 2006. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine*, **144**(10), 12-22.

Chen, M., 2003. Factors affecting the adoption and diffusion of XML and Web services standards for E-business systems. *International Journal of Human-Computer Studies*, **58**(3), 259-279.

Chheda, N. C., 2007. *Standardization & Certification: The truth just sounds different (MS in MIS)*. Application of Healthcare Governance, January 2007, Electronic Medical Records Inc. <http://www.nainil.com/research/whitepapers/Standardization_and_Certification.pdf>, [Accessed 9.4.2009].

Chua, W. F., 1986. Radical developments in accounting thought. *The Accounting Review*, **61**(4), 601-632.

Chwelos, P., Benbasat, I. & Dexter, A. S., 2001. Research report: Empirical test of an EDI adoption model. *Information Systems Research*, **12**(3), 304-321.

Cooper, R. B. & Zmud, R. W., 1990. Information technology implementation research: a technological diffusion approach. *Management Science*, *36*(2), 123-139.

Cooper T., 2002. ISO/IEEE 11073 Standards for Medical Device Communication. *In Proceeding of the 2nd Joint EMBS-BMES Conference*, Houston, TX.

Cornford, T. & Smithson, S., 2006, *Project Research in Information Systems: A Student's Guide*, 2nd ed. New York: Palgrave Macmillan.

Council of Health Services, 2010a. *Decision and Activities*. <http://www.chs.gov.sa/COHS/Templates/standard.aspx?NRId=2018&NRMode=PresentationPublished>, [Accessed 6.6.2009].

Council of Health Services, 2010b. *Health Associations*. <http://www.chs.gov.sa/COHS/Templates/standard.aspx?NRId=2185&NRMode=PresentationPublished>, [Accessed 20.10.2010].

Darmawan, I. G. N., 2001. Adoption and implementation of information technology in Bali's local government: a comparison between single level path analyses using PLSATH 3.01 and AMOS 4 and multilevel path analyses using MPLUS 2.01. *International Education Journal*, **2**(4), 100-123.

Davidson, E. J. & Chismar, W. G., 1999. Planning and managing computerized order entry: a case study of IT-enabled organizational transformation. *Topics in health information management*, **19**(4), 47-61.

Davis, F. D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, **13**(3), 319-340.

Dedrick, J. & West, J., 2003. Why firms adopt open source platforms: A grounded theory of innovation and standards adoption. *In Proceedings of the MISQ Special Issue Workshop on Standard Making: A Critical Frontier for Information Systems*, December, 236-257.

Department of States, 2010. *United States, Diplomacy in Action, Background Note: Saudi Arabi*a. <http://www.state.gov/r/pa/ei/bgn/3584.htm>, [Accessed 20.10.2010].

Abdullah Ibrahim Alkraiji 2011

Depietro, R., Wiarda, E. & Fleischer, M., 1990. The context for change: Organization, technology and environment. *In*: Tornatzky, L.G. & Fleischer, M., eds. *The processes of technological innovation*, Lexington, Mass: Lexington Books, 151-175.

Deutsch, E., Duftschmid, G. & Dordaa, W., 2010. Critical areas of national electronic health record programs: Is our focus correct?. *International Journal of Medical Informatics*, **79**(3), 211-222.

DICOM Standard Committee, 2006. *DICOM Part 8: Network Communication Support for Message Exchange*. NEMA/The DICOM Standard.

Dixon, D. R., 1999. The behavioral side of information technology. *International Journal of Medical Informatics*, **56**(1-3), 117-123.

Doebbeling, B. N., Chou, A. F. & Tierney, W. M., 2006.Priorities and strategies for the implementation of integrated informatics and communications technology to improve evidence-based practice. *Journal of General Internal Medicine*, **21**(2), S50-S57.

Dorda, W., Duftschmid, G., Gerhold, L., Gall, W. & Gambal, J., 2005. Introducing the electronic health record in Austria. *Studies in Health Technology and Informatics*, 116, 119-124.

Dyer, W. G. J. & Wilkins, A. L., 1991. Better Stories, Not Better Constructs, To Generate Better Theory: A Rejoinder to Eisenhardt. *Academy of Management Review*, 16, 3, pp. 613-619.

Eichelberg, M., Aden, T., Riesmeier, J., Dogac, A. & Laleci, G.B., 2005. A survey and analysis of Electronic Healthcare Record standards. *ACM Computing Surveys*, **37**(4), 277-315.

Eisenhardt, K. M., 1989. Building theories from case study research. *Academy of Management Review*, **14**(4), 532-550.

Egyedi, T. M., & Loeffen, A. G., 2002. Succession in standardization: Grafting XML onto SGML. *Computer Standards & Interfaces*, *24*(4), 279-290.

Abdullah Ibrahim Alkraiji 2011

Elkin, P. L., Brown, S. H., Husser, C. S., Bauer, B. A., Wahner-Roedler, D., Rosenbloom, S. T. & Speroff, T., 2006. Evaluation of the content coverage of SNOMED CT: ability of SNOMED clinical terms to represent clinical problem lists. *Mayo Clinic Proceedings*, **81**(6), 741-748.

Farrell, J. & Saloner, G., 1985. Standardization, compatibility, and innovation, The RAND Journal of Economics, 16(1), 70-83.

Feldbaum, E. G. & Dick, R. S., 1997. *Electronic patient records, smart cards and confidentiality*. USA: FT Pharmaceuticals & Healthcare Publishing.

Ferranti, J., Musser, C., Kawamoto, K. & Hammond, E., 2006. The Clinical Document Architecture and the Continuity of Care Record: A Critical Analysis. *Journal of the American Medical Informatics Association*, **13**(3), 245-252.

Fichman, R. G., 2004. Going beyond the dominant paradigm for information technology innovation research: Emerging concepts and methods. *Journal Associated Information System*, **5**(8), 314–355.

Fichman, R.G., 2001. The role of aggregation in the measurement of IT-related Organisational innovation. *MIS Quarterly*, 25(4), 201-429.

Fichman, R. G., 1992. Information technology diffusion: a review of empirical research. *In Proceeding of the 13th international conference on information systems*, Society for Information Management, 195-206.

Fichman, R. G. & Kemerer, C. F., 1997. The assimilation of software process innovations: An organizational learning perspective. *Management Science*, **43**(10), 1345-1363.

Fichman, R. G. & Kemerer, C. F., 1994. Toward a theory of the adoption and diffusion of software process innovations, *In Proceedings of the IFIP TC8 Working Conference on Diffusion, Transfer and Implementation of Information Technology*, Elsevier Science, 23-30.

Fitzgerald, G., Piris, L. & Serrano, A., 2008. Identification of benefits and barriers for the adoption of e-health information systems using a socio-technical approach. *In*

253

Proceedings of the ITI 30th International Conference on Information Technology Interface, 23-26 June, Cavtat, Croatia.

Frambach, R. T. & Schillewaert, N., 2002. Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research. *Journal of Business Research*, **55**(2), 163-176.

Frey, J. H. & Fontana, A., 1991.The group interview in social research. *Social Science Journal*, **28**(2), 175-187.

Furukawa, M. F., Raghu, T. S., Spaulding, T. J. & Vinze, A., 2008. Adoption of health information technology for medication safety in U.S. Hospitals. *Health Affairs*, **27**(3), 865-875.

Gable, G. G., 1994, Integrating Case Study and Survey Research Methods: An Example in Information Systems, *European Journal of Information Systems*, **3**(2), 112-126.

Galliers, R. D., 1992. Choosing information systems research approaches. *In*: Galliers, R. D., ed. *Information systems research: Issues, methods, and practical guidelines*, UK, Oxford: Blackwell Scientific Publications, 144-162.

Gallivan, M. J., 2001. Organizational adoption and assimilation of complex technological innovations: development and application of a new framework, *The Data Base for Advances in Information Systems*, **32**(3), 51-85.

Gorman, G.E. & Clayton, P., 1997. *Qualitative Research for the Information Professional: A Practical Handbook*. England, London: Library Association.

Grechenig, T., Tappeiner, B. & Wujciow, A., 2008. Challenging interoperability and bandwidth issues in national e-Health strategies by a bottom-up approach: Establishing a performant IT infrastructure network in a Middle East State. *In Proceeding of the 10th International Conference on e-health Networking, Applications and Services*, 7-9 July, Singapore, 148-155.

Abdullah Ibrahim Alkraiji 2011

Greenhalgh, T., Stramer, K., Bratan, T., Byrne, E., Russell, J. & Potts, H., 2010.
Adoption and non-adoption of a shared electronic summary care record in England: A mixed-method case study. *BMJ*, **340**, c3111, 1-11.

Grimson, J., Grimson, W. & Hasselbring, W., 2000. The SI challenge in health care, *Communications of the ACM*, **43**(6), 49-55.

Grix, J., 2002. Introducing students to the generic terminology of social research. *Politics*, **22**(3), 175–86

Haak, M., Wolf, A. C., Bradner, R., Drings, P., Wannenmacher, M. & Wetter, T., 2003. Data security and protection in cross-institutional electronic patient records. *International Journal of Medical Informatics*, **70** (2-3), 117–130.

Halamka, J., Overhage, J. M., Ricciardi, L., Rishel, W., Shirky, C. & Diamond, C., 2005. Exchanging health information: Local distribution and national coordination. *Health affairs*, **24**(5), 1170-1179.

Hammond, W.E., 2005. The making and adoption of health data standards. *Health affairs*, **24**(5), 1205-1213.

Hammond, W. E. & Cimino, J. J., 2006. Standards in Biomedical Informatics, *In*: Shortliffe, E. H. & Cimino, J. J., eds. *Biomedical Informatics: Computer Applications in Health Care and Biomedicine*, 3rd ed. United States: Springer, 265-311.

Haux, R., 2006. Health information systems – past, present, future. *International journal of Medical Informatics*, **75**(3-4), 268-281.

HL7, 2008. *A basic overview of Clinical Document Architecture*, <http://www.hl7.org.uk/version3group/cda.asp>, [Accessed 7.11-2010].

HL7 CDA Release 2.0, 2005. *The HL7 Version 3 Standard: Clinical Data Architecture*. ANSI Standard.

Holloway, I. & Todres, L., 2003. The status of method: flexibility, consistency and coherence. *Qualitative Research*, **3**(3), 345-357.

Hovav, A., Patnayakuni, R. & Schuff, D., 2004. A model of internet standards adoption: The case of IPv6. *Information Systems Journal*, **14**(3), 265-294.

Hovenga, E. J. S., 2008. Importance of achieving semantic interoperability for national health information systems. *Texto & Contexto-Enfermagem*, **17**(1), 158-167.

Hu, P. J. H., Chau, P. Y. K. & Sheng, O. R. L., 2002. Adoption of telemedicine technology by health care organizations: an exploratory study. *Journal of Organizational Computing and Electronic Commerce*, **12**(3), 197-221.

Hu, P. J., Chau, P. Y. K. & Sheng, O. R. L., 2000. Investigation of factors affecting healthcare organization's adoption of telemedicine technology, *In Proceeding of the 33rd Annual Hawaii International Conference on System Sciences*, 4-7 January, Maui, Hawaii.

Hung, S., Hung, W., Tsai, C. & Jiang, S., 2010. Critical factors of hospital adoption on CRM system: Organizational and information system perspectives. *Decision Support Systems*, **48**(4), 592-603.

Hyde, K. F., 2000. Recognizing deductive processes in qualitative research. *Qualitative Market Research: An International Journal*, **3**(2), 82-90.

Iacovou, C. L., Benbasat, I. & Dexter, A. S., 1995. Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology. *MIS Quarterly*, **19**(4), 465-485.

Iakovidis, I., Dogac, A., Purcarea, O., Comyn, G. & Laleci, G. B., 2007. Interoperability of eHealth Systems–selection of recent EU's Research Programme. *In Proceeding of the International of e-Health: Combining Health Telematics, Telemedicine, Biomedical Engineering and Bioinformatics to the Edge*.

Iakovidis, I., 1998. Towards personal health record: current situation, obstacles and trends in implementation of electronic healthcare record in Europe. *International journal of medical informatics*, **52**(1-3), 105-115.

Indrajit, I. K. & Verma, C. B. S., 2007. DICOM, HL7 and IHE: A basic primer on Healthcare Standards for Radiologists. *Indian Journal of Radiology and Imaging*, **17**(2), 66-68.

Irani, Z., 1998. *Investment Justification of Information Systems: A Focus on the Evaluation of MRPII*. PhD thesis, Department of Manufacturing and Engineering, Brunel University, UK.

Irani, Z., Ezingeard, J. N., Grieve, R. J. & Race, P., 1999. Case study approach to carrying out information systems research: A critique, *International Journal of Computer Applications in Technology*, **12**(2), 190-198.

Irani, Z., Ezingeard, J. N. & Grieve, R. J., 1997. Integrating the costs of a manufacturing IT/IS infrastructure into the investment decision-making process. *International Journal of Technological Innovation, Entrepreneurship and Technology Management*, **17**(11-12), 695-706.

ISO/IEC Guide 2, 1996. *Standardization and related activities -- General vocabulary*.

ISO/TC 215 Technical Report, 2003. Electronic Health Record Definition, Scope, and Context, Second Draft. <http://secure.cihi.ca/cihiweb/en/downloads/infostand_ihisd_isowg1_mtg_denoct_cont extdraft.pdf>, [accessed 15.9.2009].

ISO/TR 20514, 2005. Health informatics -- Electronic health record -- Definition, scope and context. <http://www.iso.org/iso/catalogue_detail.htm?csnumber=39525>, [Accessed 15.9.2009].

Jackson, T. W., 2001. *The Cost Effectiveness of Electronic Communication*. PhD thesis, Department of Computer Science, Loughborough University, UK.

Jacucci, E., Shaw, V., & Braa, J., 2006. Standardization of health information systems in South Africa: The challenge of local sustainability. *Information Technology for Development*, **12**(3), 225-239.

Janesick, V., 2000. The Choreography of Qualitative Research Design. *In*: Lincoln, Y. S., ed. *Handbook of Qualitative Research*, USA, CA, Thousand Oaks: SAGE Publications, 379-399.

Jenders, R. A., 2007. Standards in Health Information Technology: Promise and Challenges. *In Proceeding of the American Medical Informatics Association (AMIA) Annual Symposium*, 10-14 November, 1179-1180.

Jeyaraj, A., Rottman, J. W. & Lacity, M. C., 2006. A review of the predictors, linkages, and biases in IT innovation adoption research. *Journal of Information Technology*, **21**(1), 1-23.

Johnson, T. & Ventura, R., 2004. Applied informatics for quality assessment and improvement. *Journal of Nursing Care Quality*, **19**(2), 100–104.

Kalra D., 2006. Electronic Health Record standards. *Methods of Information in Medicine*, **45**, 136-144.

Kamal, M. M., 2006. IT innovation adoption in the government sector: identifying the critical success factors. *Journal of Enterprise Information Management*, **19**(2), 192-222.

Kaplan, B. & Maxwell, J. A., 1994. Qualitative Research Methods for Evaluating Computer Information Systems. *In*: Anderson, J. G. & AYDIN, C. E., eds. *Evaluating the Organizational Impact of Healthcare Information Systems*, 2nd ed. USA, New York: Springer, 30-55.

Karahanna, E., Straub, D. W. & Chervany, N. L., 1999. Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, **23**(2), 183-213.

Karsh, B. & Holden, R. J., 2007. New technology implementation in healthcare, *In*: Carayon, P., ed. *Handbook of Human Factors and Ergonomics in Patient Safety*, Mahwah, NJ: Lawrence Erlbaum, 393-410.

Katz, M. L. & Shapiro, C., 1986. Technology adoption in the presence of network externalities. *The Journal of Political Economy*, **94**(4), 822-841.

Abdullah Ibrahim Alkraiji 2011

Khoumbati, K., Themistocleous, M. & Irani, Z., 2006. Evaluating the adoption of enterprise application integration in health-care organizations. *Journal of Management Information Systems*, **22**(4), 69-108.

Kim, K., 2005. *Clinical Data Standards in Health Care: Five Case Studies*. <http://www.kathykim.com/sitebuildercontent/sitebuilderfiles/ClinicalDataStandardsIn HealthCare.pdf>, [Accessed 6.5.2009].

Kimberly, J. R. & Evanisko, M. J., 1981.Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal*, **24**(4), 689-713.

King, J. L. & Lyytinen, K., 2003. Special issue workshop on standard making: A critical frontier for information systems - call for papers. *MISQ*, <http://www.si.umich.edu/misq-stds/MISQ/CFP.pdf>, [Accessed: 26.6.2009].

Klein, H. K. & Myers, M. D.,1999. A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, **23**(1), 67-93.

Korner, E. J., Oinonen, M. J. & Browne, R. C., 2003. The power of collaboration: using internet-based tools to facilitate networking and benchmarking within a consortium of academic health centres. *Journal of Medical Systems*, **27**(1), 47–56.

Kuan, K. & Chau, P., 2001. A perception-based model for EDI adoption in small businesses using a technology–organization– environment framework. *Information and Management*, **38**(8), 507–521.

Kvasny, L. & Richardson, H., 2006. Critical research in information systems: looking forward, looking back. *Information Technology & People*, **19**(3), 196-202.

Kwon, T. H. & Zmud, R. W., 1987. *Unifying the fragmented models of information systems implementation*. USA, New York: John Wiley & Sons, 227-251.

Leonard, K. J., 2004. Critical success factors relating to healthcare's adoption of new technology: a guide to increasing the likelihood of successful implementation. *Electronic Healthcare*, **2**(4), 72-81.

Lewin, K., 1952. Group decision and social change, *In*: Newcomb, T. M. & Hartley, E. L., eds. *Readings in Social Psychology*, USA, New York: Henry Holt and Company.

Li, Y. C., Chang, I. C., Hung, W. F. & Fu, H. K., 2005. The critical factors affecting hospital adoption of mobile nursing technologies in Taiwan. *In Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS'05) – Track*, 6, 3-6 January, Big Island, Hawaii, 157b-167b.

Lin, C., Lin, I., Roan, J. & Yeh, J., 2010, Critical Factors Influencing Hospitals' Adoption of HL7 Version 2 Standards: An Empirical Investigation, *Journal of Medical Systems*, DOI: 10.1007/s10916-010-9580-2, 1-10.

Lorence, D. P. & Churchill, R., 2005. Incremental adoption of information security in health-care organizations: implications for document management. *IEEE Transactions on Information Technology in Biomedicine*, **9**(2), 169-173.

Luic, L. & Striber-Devaja, D., 2006. The significance of information standards for development of integrated health information system. *Archive of Oncology*, **14**(1-2), 64-66.

Lyons, S. S., Tripp-Reimer, T., Sorofman, B. A., Dewitt, J. E., Bootsmiller, B. J.,Vaughn, T. E. & Doebbeling, B. N., 2005. VA QUERI informatics paper: information technology for clinical guideline implementation: perceptions of multidisciplinary stakeholders. *JAMIA*, **12**(1), 64–71.

Markus, M.L. & Robey, D., 1988. Information technology and organizational change: causal structure in theory and research. *Management Science*, **34**(5), 583-598.

Markus, M. L., Steinfield, C. W. & Wigand, R. T., 2003. The evolution of vertical IS standards: Electronic interchange standards in the US home mortgage industry. *In Proceedings of the MISQ Special Issue Workshop on Standards Making: A Critical Research Frontier for Information Systems*, Citeseer, 80-91.

Ministry of Communication and Information Technology, 2009. *The Development of ICT Sector, Sectors Indictors*.
<http://www.mcit.gov.sa/english/Development/SectorIndices/>, [Accessed 1.11.2010].

Ministry of Economy and Planning, 2010a. *Geography*.
<http://www.mep.gov.sa/index.jsp;jsessionid=7A201C0E5A1953075E18ADE5D6DD9
763.alfa?event=ArticleView&Article.ObjectID=14>, [Accessed 28.10.2010].

Ministry of Economy and Planning, 2010b. *Population*.
<http://www.mep.gov.sa/index.jsp;jsessionid=7A201C0E5A1953075E18ADE5D6DD9
763.alfa?event=ArticleView&Article.ObjectID=15>, [Accessed 28.10.2010].

Ministry of Economic and Planning, 2010c. *Why Saudi Arabia*.
<http://www.mep.gov.sa/index.jsp;jsessionid=E561D33991A80E77B88E3D1BA2E1D
48C.alfa?event=ArticleView&Article.ObjectID=22>, [Accessed 28.10.2010].

Ministry of Foreign Affairs, 2006. *The kingdom: site and geographical Position*.
<http://www.mofa.gov.sa/Detail.asp?InSectionID=4084&InNewsItemID=46466>,
[Accessed 25.10.2010].

Ministry of Health, 2007. *Health Statistics Book*.
<http://www.moh.gov.sa/statistics/stats2007/2007.html>, [Accessed 2.11.2010].

Ministry of Health, 2009. *Health Statistics Book*.
<http://www.moh.gov.sa/statistics/s2009/ch20000.pdf>, [Accessed 2.11.2010].

Moore, G.C. & Benbasat, I., 1991. Development of an instrument to measure the
perceptions of adopting an information technology innovation. *Information Systems
Research*, **2**(3), 192-222.

Mustonen-Ollila, E., 1999. Methodology choice and adoption: Using the diffusion of
innovations theory (DOI) as the theoretical framework. *In Proceedings of the 22nd
Information Systems research Seminar in Scandinavia (IRIS22): Enterprise
Architectures for Virtual Organizations*, 7-10 August.

Myers, M. D., 1997. Qualitative research in information systems. *MIS Quarterly*, **21**(2), 241-242.

Mykkänen, J. A. & Tuomainen, M. P., 2008. An evaluation and selection framework for
interoperability standards. *Information and Software Technology*, **50**(3), 176-197.

Abdullah Ibrahim Alkraiji 2011

NEHTA, 2007. *Standards for E-Health Interoperability: An E-Health Transition Strategy*. National E-Health Transition Authority (NEHTA), Sydney, Australia, <http://www.nehta.gov.au/index.php?option=com_file_index&key=33016274702&name=Standards for Interoperability in E-Health v1 0.pdf>, [Accessed: 5.5.2009].

NEHTA, 2006. *Review of Shared Electronic Health Record Standards*. National E-health Transition Authority (NEHTA), Sydney, Australia, <http://www.nehta.gov.au/index.php?option=com_file_index&key=330197274702&name=SEHR Standards Report v1 0 public release.pdf>, [Accessed: 5.5.2009].

Nelson, M. L. & Shaw, M. J., 2003. The adoption and diffusion of inter-organizational system standards and process innovation. *In Proceedings of the MISQ Special Issue Workshop on Standard Making: A Critical Frontier for Information Systems*, 12-14 December, 258-301.

Nilakanta, S. & Scamell, R. W., 1990. The effect of information sources and communication channels on the diffusion of innovation in a data base development environment. *Management Science*, **36**(1), 24-40.

Nogeste, K., 2007. Research strategy development for dummies: define a framework of research options and then use it. *In Proceeding of the 6th European Conference on Research Methodology for business and Management Studies (ECRM 2007)*, 9-10 July, 215-228.

Ohmann, C & Kuchinke, W., 2009. Future developments of medical informatics from the viewpoint of networked clinical research. *Methods of Information in Medicine*, **48**(1), 45–54.

Orlikowski, W. J. & Baroudi, J. J., 1991. Studying information technology in organizations: Research approaches and assumptions. *Information Systems Research*, **2**(1), 1-28.

Paré, G. & Trudel, M., 2007. Knowledge barriers to PACS adoption and implementation in hospitals. *International journal of medical informatics*, **76**(1), 22-33.

Abdullah Ibrahim Alkraiji 2011

Park, H. & Hardiker, N., 2009. Clinical Terminologies: A Solution for Semantic Interoperability. *Journal of Korean Society of Medical Informatics*, **15**(1), 1-11.

Patton, M. Q., 1991. *Qualitative evaluation and research methods*. 2nd ed. CA, Newbury Park: Sage Publications.

Phillips, E. M. & Pugh, D. S., 2000. *How to get a PhD: A handbook for students and their supervisors*. 3rd ed. Philadelphia, Buckingham: Open University Press.

Pierce, J. L. & Delbecq, A. L., 1977. Organization structure, individual attributes and innovation. *Academy of Management Review*, **2**(1), 27-37.

Pirnejad, H., Bal, R. & Berg, M., 2008. Building an inter-organizational communication network and challenges for preserving interoperability. *International Journal of Medical Informatics*, **77**(12), 818-827.

Plsek, P. E. & Greenhalgh, T., 2001. Complexity science: The challenge of complexity in health care. *British Medical Journal (BMJ)*, **323**, 625–628.

Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W. & Kaushal, R., 2004. Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Health Affairs*, **23**(4), 184–90.

Premkumar, G. & Ramamurthy, K., 1995. The role of inter-organisational and organisational factors on the decision mode for adoption of inter-organisational systems. *Decision Sciences*, **26**(3), 303-36.

Qurban, M. H. & Austria, R. D., 2008. Public perception on e-health services: implications of preliminary findings of KFMMC for military hospitals in KSA. *In Proceeding of the European and Mediterranean Conference on Information Systems (EMCIS2008)*, 25-26 May, Dubai, UAE.

Remenyi, D., 1991. *The formulation and implementation of strategic information systems*. London: Henley Management College, Brunel University.

Remenyi, D., Williams, B., Money, A. & Swartz, E., 2005. *Doing research in business and management: An introduction to process and method*. London: SAGE Publications.

263

Robson, C., 1993. *Real world research: a resource for social scientists and practitioner researchers*. Oxford: Blackwell.

Rogers, E. M., 1995. *Diffusion of Innovations*. 4th ed. New York: The Free Press.

Rozenblum, R., Jang, Y., Zimlichman, E., Salzberg, C., Tamblyn, M., Buckeridge, D., Forster, A., Bates, D. & Tamblyn, R., 2011. A qualitative study of Canada's experience with the implementation of electronic health information technology. *Canadian Medical Association Journal*, **183**(5), 281-288.

Ryan, G. W. and Bernard, H. R., 2000. Data management and analysis methods. *In*: Denzin, N. K. and Lincoln, Y. S., eds. *Handbook of qualitative research*, 2nd ed. Sage, 769-802.

Saudi Commission for Health Specialists, 2010. *About us*. <http://english.scfhs.org.sa/index.php?option=com_content&view=article&id=100&Itemid=4378>, [Accessed 22.10.2010].

Saudi e-Health, 2010. *Saudi e-Health 2010 Conference, Speakers*. <http://www.saudiehealth.org/index.php?option=com_content&view=category&layout=blog&id=23&Itemid=44>, [Accessed 15.5.2010].

Saunders, M., Lewis, P. & Thornhill, A., 2003. *Research Methods for Business Students*. 3rd ed. England, Harlow: Pearson Education Limited.

Schraffenberger, L. A., 2006. *Basic ICD-9-CM Coding*. USA, Illinois, Chicago: American Health Information Management Association.

Sequist, T., Cullen, T. & Ayanian, J., 2005. Information technology as a tool to improve the quality of American Indian Health Care. *American Journal of Public Health*, **95**(12), 2173-2179.

Shang, S. & Seddon, P. B., 2002. Assessing and managing the benefits of enterprise systems: The business manager's perspective. *Information Systems Journal*, **20**(12), 271-299.

Abdullah Ibrahim Alkraiji 2011

Shaw, T. & Jarvenpaa, S., 1997. Process models in information systems. *In Proceedings of the IFIP TC8 WG 8.2 International Conference on Information Systems and Qualitative Research*, 31 May –3 June, Springer, Philadelphia, Pennsylvania, USA, 70-100.

Sittig, D., Wright, A., Osheroff, J., Middleton, B., Teich, J., Ash, J., Campbell, E., Bates, D., 2008. Grand challenges in clinical decision support. *Journal of Biomedical Informatics*, **41**(2), 387–92.

Smith, D., 2009. *Committee E31 on Healthcare Informatics, The American Society for Testing and Materials (ASTM).*
<http://www.astm.org/COMMIT/COMMITTEE/E31.htm>, [Accessed: 18-6-2009].

Smith, M., Madon, S. & Anifalaje, A., 2008. Integrated health information systems in Tanzania: experience and challenges. *The Electronic Journal on Information Systems in Developing Countries*, **33**(1), 1-21.

Soh, C. & Markus, M. L., 1995. How IT creates business value: a process theory synthesis. *In Proceedings of the 16th International Conference on Information Systems*, Amsterdam, the Netherlands, 29–41.

Spooner, S. A. & Classen, D. C., 2009. Data standards and improvement of quality and safety in child health care, *Pediatrics*, **123**(Supplement), S74-S79.

Spyrou, S., Bamidis, P., Chouvarda, I., Gogou, G., Tryfon, S. & Maglaveras, N., 2002. Healthcare information standards: comparison of the approaches. *Health Informatics Journal*, **8**(1), 14-19.

Stablein D., Welebob E., Johnson E., Metzger J., Burgess R. & Classen D., 2003. Understanding hospital readiness for computerized physician order entry. *Joint Commission Journal on Quality and Patient Safety*, **29**(7), 336–344.

Szydlowski, S., & Smith, C., 2009. Perspectives from nurse leaders and chief information officers on health information technology implementation. *Hospital Topics*, **87**(1), 3-9.

Tessier C., 2004. *The Continuity of Care Record*.
<http://www.astm.org/COMMIT/E31_CCRJuly04.ppt.Accessed 05/25/05>, [Accessed 8.11.2010].

The World Factbook, 2010. *Regional Maps, Middle East*.
<https://www.cia.gov/library/publications/the-world-factbook/maps/refmap_middle_east.html>, [Accessed 26.10.2010].

Themistocleous, M., 2004. Justifying the decisions for EAI implementations: a validated proposition of influential factors. *Journal of Enterprise Information Management*, **17**(2), 85-104.

Themistocleous, M. G., 2002. *Evaluating the Adoption of Enterprise Application Integration in Multinational Organizations*. PhD thesis, Department of Information Systems and Computing, Brunel University, UK.

Thompson, T. & Brailer, D., 2004. *The Decade of Health Information Technology: Delivering Consumer-centric and Information-rich Health Care - Framework for Strategic Action*. Department of Health and Human Services,
<http://www.providersedge.com/ehdocs/ehr_articles/The_Decade_of_HIT-Delivering_Customer-centric_and_Info-rich_HC.pdf>, [Accessed 21.9.2010].

Thomas, J. W., 2006. *The Adoption and Diffusion of Data-exchange Standards*. PhD thesis, Department of Information Science, Loughborough University, UK.

Thomas, J. W. Probets, S., Dawson, R. & King, T., 2008. A step towards the adoption of standards within the UK Ministry of defence. *Journal of IT Standards & Standardization Research*, *6*(1), 55-69.

Thong, J. Y. L. & Yap, C. S., 1995. CEO characteristics, organizational characteristics and information technology adoption in small businesses. *International Journal of Management Science*, **23**(4), 429–442.

Tornatzky, L. G., & Fleischer, M., 1990. *The process of technological innovation: Reviewing the literature*. Washington, DC: National Science Foundation.

Trauth, E. M. & Howcroft, D., 2006. Critical research on gender and information systems. In: Trauth, E. M. ed. *Encyclopedia of Gender and Information Technology*, USA, Pennsylvania, Hershey: Idea Group, 141-145.

Venkatesh, V. & Davis, F. D., 2000. A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management science*, **46**(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B. & Davis, F. D., 2003. User acceptance of information technology: Toward a unified view, *MIS Quarterly*, **27**(3), 425-478.

Vishwanath, A. & Scamurra, S. D., 2007. Barriers to the adoption of electronic health records: Using concept mapping to develop a comprehensive empirical model. *Health Informatics Journal*, **13**(2), 119-134.

Walker, J., Pan, E., Johnston, D., Adler-Milstein, J., Bates, D.W. & Middleton, B., 2005. The value of health care information exchange and interoperability. *Health Affairs, Suppl Web Exclusives*, **10**(1377), 5w-10-5w-18.

Walker, J. H. & Whetton, S. G., 2002. The diffusion of innovation: factors influencing the uptake of telehealth. *Journal of Telemedicine and Telecare*, **8**(3), 73-75.

Walsham, G., 1995. The emergence of interpretivism in IS research, *Information Systems Research,* **6**(4), 76-394.

Walsham, G., 1993. *Interpreting information systems in organizations*. USA, New York: John Wiley & Sons.

Wapakabulo, J., Dawson, R., Probets, S. & King, T., 2005. A step towards the adoption of data-exchange standards: A UK defence community case study. *In Proceeding of the 4th Conference on Standardization and Innovation in Information Technology*, 21-23 Sept, IEEE Xplore, 242-253.

West, J., 2004. The role of standards in the creation and use of information systems. *In Proceeding of the Special Issue Workshop on Standard Making: A Critical Research Frontier for Information Systems*, MISQ, 314-326.

267

West, J., 1999. Organizational decisions for IT standards adoption: Antecedents and consequences. *In Proceeding of the 1st IEEE Conference on Standardization and Innovation in Information Technology*, 15-17 September, 13-18.

Whitman, L., Huff, B. & Presley, A., 1997. Structured models and dynamic systems analysis: The integration of the IDEF0/IDEF3 modelling methods and discrete event simulation. *In the Proceedings of the Winter Simulation Conference*, IEEE, December 07-10, 518-524.

Williams, R., Bunduchi, M., Graham, I., Pollock, R., Procter, R. & Voss, A., 2004. Understanding the evolution of standards: alignment and reconfiguration in standards development and implementation arenas. *In Proceedings of the 4S/EASST Conference*, August 27-29, Paris,

Wu, C., 2004. A readiness model for adopting web services. *Journal of Enterprise Information Management*, **17**(5), 361-371.

Yao, J. & Warren, S., 2005. Applying the ISO/IEEE 11073 standards to wearable home health monitoring systems. *Journal of clinical monitoring and computing*, **19**(6), 427-436.

Yin, R. K., 2003. *Case Study Research Design and Methods*, 3rd ed. USA, CA, Thousand Oaks: SEGA Publication.

Yiu, E. N. & Yiu E. N., 2007. *Network Management for Picture Archiving and Communication Systems*. MA dissertation, School of Engineering Science, Simon Fraser University.

Zaltman, G., Duncan, R. & Holbek, J., 1973. *Innovation and Organizations*. USA: John Wiley & Sons.

Zhang, Y., Xu, Y., Shang, L. & Rao, K., 2007. An investigation into health informatics and related standards in China. *International journal of medical informatics*, **76**(8), 614-620.

268

Zmud, R.W., 1982. Diffusion of modern software practices: influence of centralization and formalization. *Management Science*, **28**(2), 1421-1431.

Appendix A: Scientific Medical Associations in Saudi Arabia

Table A.1: List of scientific medical associations in Saudi Arabia (Council of Health Services 2010b).

NO	Society's Name	Foundation	Affiliated By	Location
1	Saudi Orthodontic Society	2006	Saudi Commission for Health Specialists	Riyadh
2	Saudi Stroke Association	2006	Saudi Commission for Health Specialists	Riyadh
3	Society of Critical Care Medicine	2007	Saudi Commission for Health Specialists	Riyadh
4	Saudi Oncology Society	2007	Saudi Commission for Health Specialists	Riyadh
5	Saudi Society of Emergency Medicine	2007	Saudi Commission for Health Specialists	Riyadh
6	Saudi Pharmaceutical Society	1987	King Saud University	Riyadh
7	Saudi Society for Food and Nutrition	2001	King Saud University	Riyadh
8	Saudi Society for Educational and Psychological Sciences	1980	King Saud University	Riyadh
9	Saudi Paediatric Association	1981	King Saud University	Riyadh
10	Saudi Heart Association	1988	King Saud University	Riyadh
11	Saudi Ophthalmology Society	1985	King Saud University	Riyadh
12	Saudi Association of Gastroenterology	1988	King Saud University	Riyadh

13	Saudi Otolaryngology Society	1988	King Saud University	Riyadh
14	The Saudi Association of Anaesthesia Practitioners	1989	King Saud University	Riyadh
15	Saudi Society of Nephrology	1995	King Saud University	Riyadh
16	Saudi Society of Dermatology and Venereology	1989	King Saud University	Riyadh
17	Saudi Thoracic Society	2002	King Saud University	Riyadh
18	Saudi Orthopaedic Association	2005	King Saud University	Riyadh
19	Saudi Dental Society	1981	King Saud University	Riyadh
20	Saudi Physical Therapy Association	2001	King Saud University	Riyadh
21	Saudi Society of Obstetrics and Gynaecology	1989	King Abdulaziz University	Jeddah
22	Saudi Society of Thalassemia and Sickle Cell Anaemia	1990	King Abdulaziz University	Jeddah
23	Saudi General Surgery Society	2000	King Abdulaziz University	Jeddah
24	Saudi Society for Medical Laboratories	2001	King Abdulaziz University	Jeddah
25	Saudi Society for Plastic Surgery	2001	King Abdulaziz University	Jeddah
26	Saudi Society for Internal Medicine	2002	King Abdulaziz University	Jeddah
27	Saudi Scientific Association for Nursing	2002	King Abdulaziz University	Jeddah

271

28	Saudi Radiological Society	2003	King Abdulaziz University	Jeddah
29	Saudi Paediatric Surgical Association	2005	King Abdulaziz University	Jeddah
30	Saudi Urological Association	2005	King Abdulaziz University	Jeddah
31	Saudi Society for Vascular Surgery	2005	King Abdulaziz University	Jeddah
32	Saudi Society for Nuclear Medicine	2006	King Abdulaziz University	Jeddah
33	Saudi Society of Haematology	2006	King Abdulaziz University	Jeddah
34	Saudi Diabetes & Endocrine Association	2006	King Abdulaziz University	Jeddah
35	Saudi Society of Family and Community Medicine	1991	King Faisal University	Al-Khobar
36	Saudi Veterinary Medical Society	2001	King Faisal University	Al-Ahsa
37	Saudi Psychiatric Association	2001	King Faisal University	Jeddah
38	Saudi Neurology Association	2005	King Faisal University	Dammam
39	Saudi Society for Respiratory Care	2005	King Faisal University	Dammam
40	Saudi Society of Medical Microbiology and Infectious Diseases	2006	King Faisal University	Jeddah
41	Saudi Society for Medical Education	2002	King Khalid University	Abha
42	Saudi Association for Health Informatics	2005	King Saud University for Health Sciences	Riyadh

Appendix B: Some Common Health Data Standards

B.1 Introduction

The intention of this part is not to cover all the health data standards that are available, but rather to present some illustrated examples with regard to the standards that were shown in Table 3.2, Chapter 3. Thus, this part offers such examples in some detail in order to simplify these standards so that they may be better understood.

B.2 Terminology Standards

Terminology standards are the basic elements required for semantic medical data exchange. According to Hammond and Cimino (2006, pp. 265-311), terminology standards can serve two purposes: they can save developers of HIT applications from having to create their own standards and can also facilitate medical data exchange between the different systems since each system uses the same coding scheme. Hammond and Cimino (2006, pp. 265-311) described the two different levels required for encoding medical data as abstraction and representation. The abstraction level is used to label a long and complex course of treatment for a patient: for example, myocardial infarction may be represented as a single code for billing purposes. The representation level, on the other hand, is used to code the details required for a patient's medical records; for a patient who has suffered a myocardial infarction, for example, the representation might consist of codes for each physical finding that was noted, each laboratory test performed, and all medication administered.

However, three considerations should be taken into account in discussing such terminology standards: these are the domain of discourse, the content of the standard itself and the methods by which the terminology is maintained. The domain of discourse refers that the terms for any subject matter must be harmonised with other standards used for the same purpose. The content of the standards refers to many issues, such as the degree to which the standard covers the terminology of the intended domain, the degree to which data are coded by assembling terms into a description, the overall structure of the terminology, the availability of synonyms, and the possibility of redundant terms (i.e. more than one way to encode the same information). The methods by which the terminology is maintained means that every standard terminology must have an ongoing maintenance process so the old

273

version must be maintained and integrated into the new version (Hammond & Cimino 2006, pp. 265-311). The following section presents, together with some examples, the most common terminology standards currently available.

B.2.1 International Classification of Diseases (ICD)

ICD is the best known terminology standard used throughout the world today for disease and diagnosis terms. It was first published by the Statistical International Institute and has latterly been maintained by the WHO. While ICD-9 is still being used in the US, with some modifications required for detailed information, there has been a major split in the European countries, many of which have moved to ICD-10. ICD contains up to 10,000 codes representing the names of diseases and different families of terms for medical-specialty diagnoses, health status, disablements, procedures, and reasons for contact with healthcare providers. The ICD coding system consists of three-digit codes, with one digit after the decimal place (e.g. 000.0) which provides an additional level of detail. The codes are tied in a hierarchy based on the digits in the code (Hammond & Cimino 2006, pp. 265-311; Feldbaum & Dick 1997, pp.59-77). However, ICD-9 was perceived as inadequate in the US for the level of detail desired for statistical reporting and so the National Centre for Health Statistics published a set of clinical modifications in 1999 known as ICD-9-CM; this provides extra levels of detail by adding fourth- and fifth-digit codes (Schraffenberger 2006, pp 1-15). For example, Figure B.1 shows the classification of bacterial pneumonias in ICD-9 in the Clinical Modification (CM) American version. In addition, Figure B.2 shows how the bacterial pneumonias are classified in the American version of ICD-10; however, this version is still under clinical modification and a review has not yet been published. As shown by the figures, ICD-10 provides more detail; for example, while ICD-10-CM classifies mycoplasma pneumonia as a bacterium, ICD-9-CM does not.

274

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003 Other salmonella infections
        003.2 Localized salmonella infections
            003.22 Salmonella pneumonia
020 Plague
        020.3 Primary pneumonic plague
        020.4 Secondary pneumonic plague
        020.5 Pneumonic plague, unspecified
021 Tularemia
        021.2 Pulmonary tularemia
022 Anthrax
        022.1 Pulmonary anthrax
481 Pneumococcal pneumonia
482 Other bacterial pneumonia
        482.0 Pneumonia due to Klebsiella pneumoniae
        482.1 Pneumonia due to Pseudomonas
        482.2 Pneumonia due to Hemophilus influenzae
        482.3 Pneumonia due to Streptococcus
                482.30 Pneumonia due to Streptococcus, unspecified
                482.31 Pneumonia due to Group A Streptococcus
                482.32 Pneumonia due to Group B Streptococcus
                482.39 Other streptococcal pneumonia
        482.4 Pneumonia due to Staphylococcus
                482.40 Pneumonia due to Staphylococcus, unspecified
                482.41 Pneumonia due to Staphylococcus aureus
                482.49 Other Staphylococcus pneumonia
        482.8 Pneumonia due to other specified bacteria
                482.81 Pneumonia due to anaerobes
                482.82 Pneumonia due to Escherichia coli
                482.83 Pneumonia due to other Gram-negative bacteria
                482.84 Legionnaires' disease
                482.89 Pneumonia due to other specified bacteria
        482.9 Bacterial pneumonia, unspecified
483 Pneumonia due to other specified organism
        483.0 Mycoplasma pneumoniae
484 Pneumonia in infectious diseases classified elsewhere
        484.3 Pneumonia in whooping cough
        484.5 Pneumonia in anthrax
```

Figure B.1: ICD-9 CM showing how Bacterial Pneumonia Terms are coded, together with the use of an extra fifth digit in the decimal place to support billing requirements (Hammond & Cimino 2006, p. 281).

275

```
A01 Typhoid and paratyphoid fevers
      A01.0 Typhoid Fever
            A01.03 Typhoid Pneumonia
A02 Other salmonella infection
      A02.2 Localized salmonella infections
            A02.22 Salmonella pneumonia
A20 Plague
      A20.2 Pneumonic plague
A22 Anthrax
      A22.1 Pulmonary anthrax
A37 Whooping cough
       A37.0 Whooping cough due to Bordetella pertussis
            A37.01 Whooping cough due to Bordetella pertussis with pneumonia
       A37.1 Whooping cough due to Bordetella parapertussis
            A37.11 Whooping cough due to Bordetella parapertussis with
pneumonia
       A37.8 Whooping cough due to other Bordetella species
            A37.81 Whooping cough due to other Bordetella species with
pneumonia
       A37.9 Whooping cough, unspecified
            A37.91 Whooping cough, unspecified species with pneumonia
A50 Congenital syphilis
      A50.0 Early congenital syphilis, symptomatic
            A50.04 Early congenital syphilitic pneumonia
A54 Gonococcal infection
      A54.8 Other gonococcal infection
            A54.84 Gonococcal pneumonia
J13 Pneumonia due to Streptococcus pneumoniae
J14 Pneumonia due to Hemophilus influenzae
J15 Bacterial pneumonia, not elsewhere classified
      J15.0 Pneumonia due to Klebsiella pneumoniae
      J15.1 Pneumonia due to Pseudomonas
      J15.2 Pneumonia due to staphylococcus
            J15.20 Pneumonia due to staphylococcus, unspecified
            J15.21 Pneumonia due to Staphylococcus aureus
            J15.29 Pneumonia due to other staphylococcus
      J15.3 Pneumonia due to streptococcus, group B
      J15.4 Pneumonia due to other streptococci
      J15.5 Pneumonia due to Escherichia coli
      J15.6 Pneumonia due to other aerobic Gram-negative bacteria
      J15.7 Pneumonia due to Mycoplasma pneumoniae
      J15.8 Other bacterial pneumonia
      J15.9 Bacterial pneumonia, unspecified
P23 Congenital pneumonia
      P23.2 Congenital pneumonia due to staphylococcus
      P23.3 Congenital pneumonia due to streptococcus, group B
      P23.4 Congenital pneumonia due to Escherichia coli
      P23.5 Congenital pneumonia due to Pseudomonas
      P23.6 Congenital pneumonia due to other bacterial agents
```

Figure B.2: ICD-10 (American Version) showing how Bacterial Pneumonia Terms are coded (Hammond & Cimino 2006, p. 282).

B.2.2 Systemised Nomenclature of Medicine (SNOMED)

Drawing from SNOP, the Systematized Nomenclature of Medicine (SNOMED) was published in 1975, evolving beyond an abstracting scheme to become a comprehensive coding system. It was then revised as SNOMED II in 1979. In 1996, SNOMED was adapted to become a more logic-based structure with a Reference Terminology to resolve the encoding problems that had occurred when dealing with sophisticated terms, as well as some other problems encountered in the earlier version. In 1999, SNOMED's name was changed to SNOMED Clinical Terms (SNOMED-CT) with strong participation from the NHS. Although SNOMED CT is a comprehensive coding system in its own right, and contains terms for over 350,000 concepts, it can map to other medical terminologies, such as ICD, to avoid duplicate data capture. It can also support other medical requirements, such as enhanced health reporting, billing and statistical analysis (Hammond & Cimino 2006, pp. 265-311). Figure B.3 shows how the term 'bacterial pneumonia' is coded in SNOMED-CT through the use of different attributes. Table B.1 explains each attribute in Figure B.3 while Figure B.4 shows some of the hierarchical relationships among bacterial pneumonia terms in SNOMED-CT. For example, "Congenital group A hemolytic streptococcal pneumonia" is presented under multiple parent terms; in contrast, "Congenital staphylococcal pneumonia" is not listed under all possible parent terms.

Table B.1: An explanation of some of the different attributes used in SNOMED-CT in representing medical terms (Hammond & Cimino 2006, p. 286).

Attribute	Function
Is a	Defines bacterial pneumonia's position in SNOMED-CT's multiple hierarchy.
Causative Agent and Finding Site	Provide definitional information.
Onset and Severities	Indicate ways in which bacterial pneumonia can be post-coordinated with other terms, such as Acute Onset or any of the descendants of the term Severities.
Descriptions	Refers to various text strings that serve as names for the term.
Legacy Codes	Provide backward compatibility to SNOMED and Read Clinical Terms.

```
Concept: Bacterial pneumonia
        Concept Status Current
                Fully defined by ...
                        Is a
                                Infectious disease of lung
                                Inflammatory disorder of lower respiratory tract
                                Infective pneumonia
                                Inflammation of specific body organs
                                Inflammation of specific body systems
                                Bacterial infectious disease
                        Causative agent:
                                Bacterium
                        Pathological process:
                                Infectious disease
                        Associated morphology:
                                Inflammation
                        Finding site:
                                Lung structure
                        Onset:
                                Sub-acute onset
                                Acute onset
                                Insidious onset
                                Sudden onset
                        Severity:
                                Severities
                        Episodicity:
                                Episodicities
                        Course:
                                Courses
                        Descriptions:
                                Bacterial pneumonia (disorder)
                                Bacterial pneumonia
                        Legacy codes:
                                SNOMED: DE-10100
                                CTV3ID: X100H
```

Figure B.3: The "Bacterial Pneumonia" description-logic representation encoded in SNOMED-CT (Hammond & Cimino 2006, p. 286).

```
Pneumonia
        Bacterial pneumonia
                Proteus pneumonia
                Legionella pneumonia
                Anthrax pneumonia
                Actinomycotic pneumonia
                Nocardial pneumonia
                Meningococcal pneumonia
                Chlamydial pneumonia
                        Neonatal chlamydial pneumonia
                        Ornithosis
                                Ornithosis with complication
                                Ornithosis with pneumonia
                Congenital bacterial pneumonia
                        Congenital staphylococcal pneumonia
                        Congenital group A hemolytic streptococcal pneumonia
                        Congenital group B hemolytic streptococcal pneumonia
                        Congenital Escherichia coli pneumonia
                        Congenital pseudomonal pneumonia
                Chlamydial pneumonitis in all species except pig
                        Feline pneumonitis
                Staphylococcal pneumonia
                Pulmonary actinobacillosis
                Pneumonia in Q fever
                Pneumonia due to Streptococcus
                        Group B streptococcal pneumonia
                        Congenital group A hemolytic streptococcal pneumonia
                        Congenital group B hemolytic streptococcal pneumonia
                        Pneumococcal pneumonia
                                Pneumococcal lobar pneumonia
                                AIDS with pneumococcal pneumonia
                Pneumonia due to Pseudomonas
                        Congenital pseudomonal pneumonia
                Pulmonary tularemia
                Enzootic pneumonia of calves
                Pneumonia in pertussis
                AIDS with bacterial pneumonia
                Enzootic pneumonia of sheep
                Pneumonia due to Klebsiella pneumoniae
                Hemophilus influenzae pneumonia
                Porcine contagious pleuropneumonia
                Pneumonia due to pleuropneumonia-like organism
                Secondary bacterial pneumonia
        Pneumonic plague
                Primary pneumonic plague
                Secondary pneumonic plague
        Salmonella pneumonia
                Pneumonia in typhoid fever
        Infective pneumonia
                Mycoplasma pneumonia
                        Enzootic mycoplasmal pneumonia of swine
        Achromobacter pneumonia
        Bovine pneumonic pasteurellosis
        Corynebacterial pneumonia of foals
        Pneumonia due to Escherichia coli
        Pneumonia due to Proteus mirabilis
```

Figure B.4: SNOMED-CT and the hierarchical relationships among Bacterial Pneumonia Terms (Hammond & Cimino 2006, p. 287).

Abdullah Ibrahim Alkraiji 2011

B.2.3 Logical Observations, Identifiers, Names and Codes (LOINC)

LOINC was initiated for the purpose of exchanging clinical data between laboratories which produce the results of tests and other clinical procedures, and other medical entities (e.g. hospitals, physicians' offices and payers) that request such results for clinical care and management purposes. This standard not only specifies the names of tests and observations, it also specifies structured and coded semantic information about each test, such as the substance measured and the analytical method used. LOINC has also been extended to include other non-laboratory observations, such as vital signs and electrocardiograms. Moreover, LOINC allows users to create their own LOINC terms or names for new tests which can be recognised and used by other users (Hammond & Cimino 2006, pp. 265-311). Figure B.5 shows examples of some common laboratory observations encoded in LOINC. Each observation name is separated by ":" and consists of the substance measured, such as the property (e.g., MCNC = mass concentration; SCNC = substance concentration; NFR = numeric fraction; and NCNC = number concentration), the time (PT = point in time), the specimen, and the method (SQ = semiquantitative; QN = quantitative; QL = qualitative).

Blood glucose	GLUCOSE:MCNC:PT:BLD:QN:
Plasma glucose	GLUCOSE:MCNC:PT:PLAS:QN:
Serum glucose	GLUCOSE:MCNC:PT:SER:QN:
Urine glucose concentration	GLUCOSE:MCNC:PT:UR:QN:
Urine glucose by dip stick	GLUCOSE:MCNC:PT:UR:SQ: TEST STRIP
Glucose tolerance test at 2 hours	GLUCOSE^2H POST 100 G GLUCOSE PO:MCNC:PT:PLAS:QN:
Ionized whole blood calcium	CALCIUM.FREE:SCNC:PT:BLD:QN:
Serum or Plasma ionized calcium	CALCIUM.FREE:SCNC:PT:SER/PLAS:QN:
24-hour calcium excretion	CALCIUM.TOTAL:MRAT:24H:UR:QN:
Whole blood total calcium	CALCIUM.TOTAL:SCNC:PT:BLD:QN:
Serum or plasma total calcium	CALCIUM.TOTAL:SCNC:PT:SER/PLAS:QN:
Automated hematocrit	HEMATOCRIT:NFR:PT:BLD:QN:AUTOMATED COUNT
Manual spun hematocrit	HEMATOCRIT:NFR:PT:BLD:QN:SPUN
Urine erythrocyte casts	ERYTHROCYTE CASTS:ACNC:PT:URNS:SQ:MICROSCOPY.LIGHT
Erythrocyte MCHC	ERYTHROCYTE MEAN COPRUSCULAR HEMOGLOBIN CONCENTRATION:MCNC:PT:RBC:QN:AUTOMATED COUNT
Erythrocyte MCH	ERYTHROCYTE MEAN COPRUSCULAR HEMOGLOBIN:MCNC: PT:RBC:QN: AUTOMATED COUNT
Erythrocyte MCV	ERYTHROCYTE MEAN COPRUSCULAR VOLUME:ENTVOL:PT: RBC:QN:AUTOMATED COUNT
Automated Blood RBC	ERYTHROCYTES:NCNC:PT:BLD:QN:AUTOMATED COUNT
Manual Blood RBC	ERYTHROCYTES:NCNC:PT:BLD:QN:MANUAL COUNT
ESR by Westergren method	ERYTHROCYTE SEDIMENTATION RATE:VEL:PT:BLD:QN: WESTERGREN
ESR by Wintrobe method	ERYTHROCYTE SEDIMENTATION RATE:VEL:PT:BLD:QN: WINTROBE

Figure B.5: Example of some common laboratory observations encoded in LOINC (Hammond & Cimino 2006, p. 290).

Abdullah Ibrahim Alkraiji 2011

B.3 Messaging Standards

The conceptualisation stage of the need to interconnect healthcare applications began in 1980 when discussions took place amongst individuals in an organisation called the American Association for Medical Systems and Informatics (AAMSI). In 1983, AAMSI established a task force to develop standards covering a wide range of medical information and related activities. At that time, the main objective for the task force was to encourage others to participate in activities to develop standards for data exchange between commercial laboratories and health care providers. As a result, many members joined together to form various groups to develop standards, each with a slightly different emphasis. For example, the American College of Radiology (ACR), together with the National Electronic Manufacturers' Association (NEMA), were assigned to develop standards for medical image data exchange (Hammond & Cimino 2006, pp. 265-311). The following section gives examples of the most commonly used messaging standards worldwide.

## B.3.1 Digital Imaging and Communications in Medicine (DICOM)

DICOM is the foundation of Picture-Archiving and Communication Systems (PACS). Every transaction between an image modality and PACS uses DICOM standards to communicate (Yiu & Yiu 2007). In 1983, the American College of Radiology (ACR) joined forces with the National Electrical Manufacturers' Association (NEMA) to be responsible for creating the required standards for exchanging radiographic images. Following this, the collaboration between ACR and NEMA became an international organisation with ACR becoming simply a member of the organisation. DICOM standards were created to serve three purposes: first, to promote the development of a generic digital-image communication protocol between image systems; secondly, to support the evolution and expansion of PACS systems; and thirdly, to allow the development of diagnostic databases to enhance integration between the PACS systems and different HIT applications. In 1985, DICOM version 1.0 was published to support only point-to-point communications; it comprised hardware interface specifications, a data dictionary and a set of commands. In 1988, DICOM was upgraded to version 2.0. This version introduced a message structure consisting of a command segment for display devices, a new hierarchy scheme to identify an image, and a data segment for increased specificity in the description of an image (e.g., the details of how the image was made and of the settings). In 1992, DICOM version 3.0, an object-oriented data model version, was published

282

(Hammond & Cimino 2006, pp. 265-311). Many features were added to this version. For example, explicit information objects for images, graphics and text reports were introduced while specifying image-related management information exchange, with the potential to interface to different HIT applications such as hospital and radiology information systems.

The data elements in DICOM are defined in a data dictionary and are organised into groups. DICOM syntax uses three variables to represent data elements: a data tag, a data length specification and a data value. The data set is a structured set of attributes and values related to an information object that consists of three types: images, graphics and text. In addition, DICOM standards include structured reports, as well as web access to, and presentation of, DICOM persistent objects. Figure B.6 illustrates the communication protocol for point-to-point integration in DICOM 3.0. The communication protocol architecture identifies the upper-layer services and protocols required to support communication between the different image systems. The upper-layer services conform to OSI protocols through the use of a choice of physical networks such as Ethernet, FDDI, ISDN, X.25 and dedicated digital circuits, as well as other local area network (LAN) and wide area network (WAN) technologies; it can also be used in combination with TCP/IP transport protocols. Figure B.7 shows how the upper-layer protocol can act as a bridge between image systems and TCP/IP protocols. Figure B.8 illustrates the interaction between the radiology modalities and the PACS system in the radiology information system, and also between the radiology information system and the hospital information system.
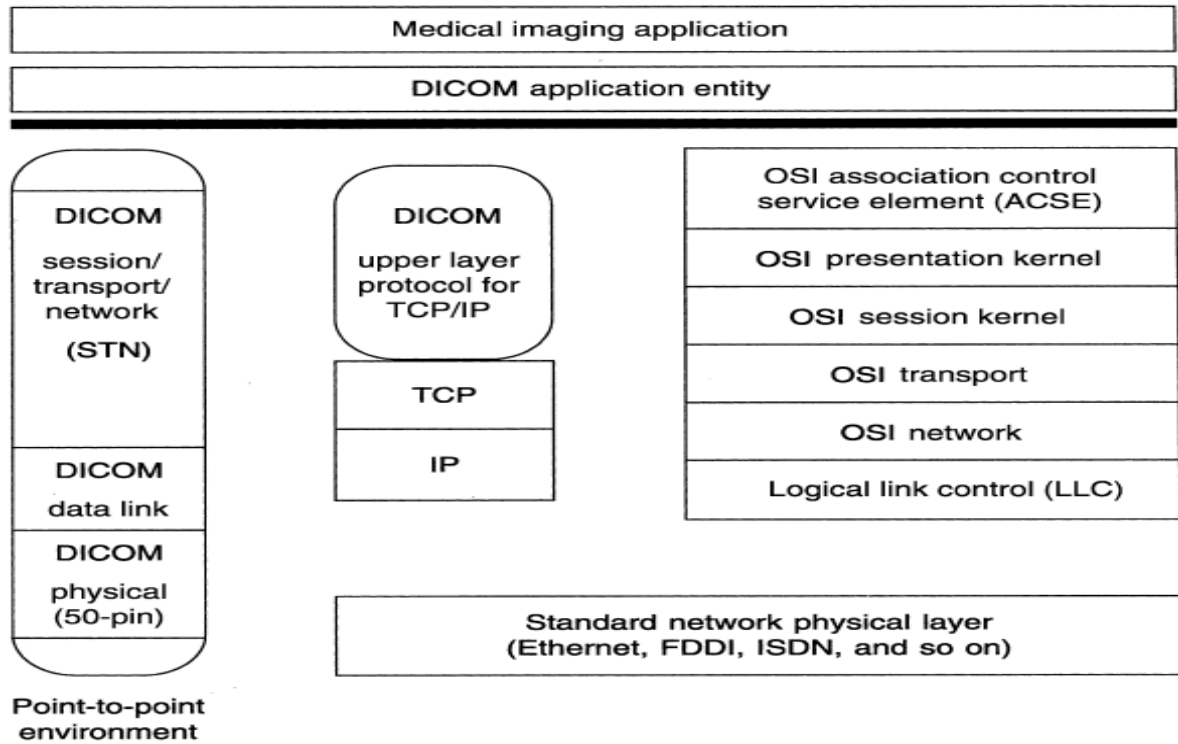
Figure B.6: DICOM Communications-Protocol Architecture stacks on top of the OSI Reference Model Communication and the TCP/IP Network (Hammond & Cimino 2006, p. 299).
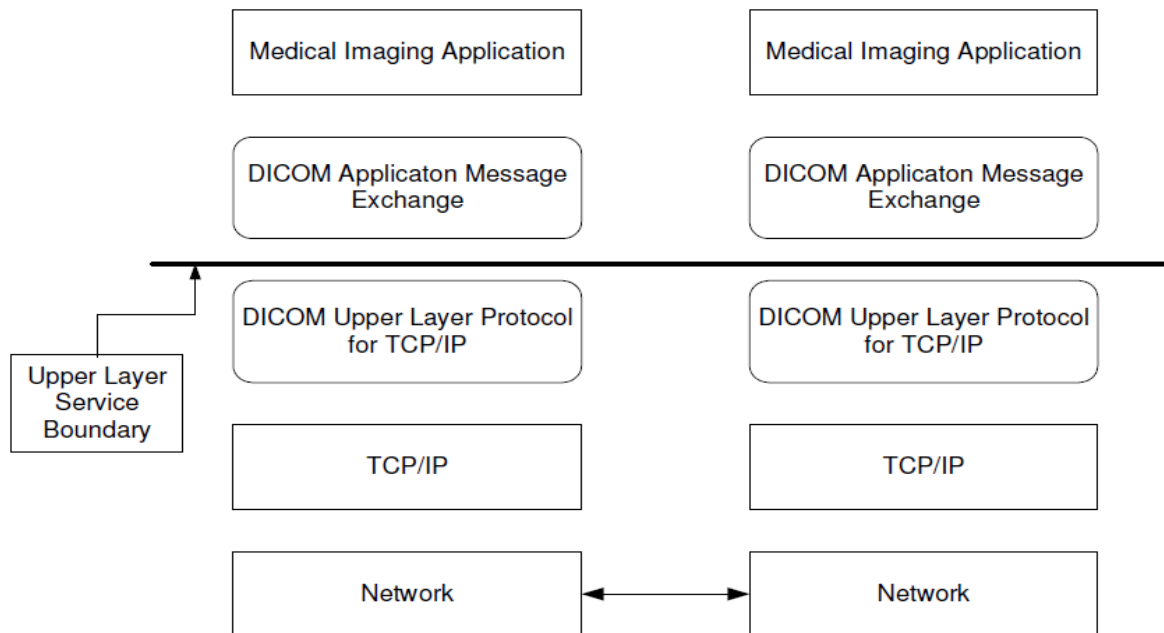
Figure B.7: DICOM Communication-Protocol stack on top of the TCP/IP Network (DICOM Standard Committee 2006).
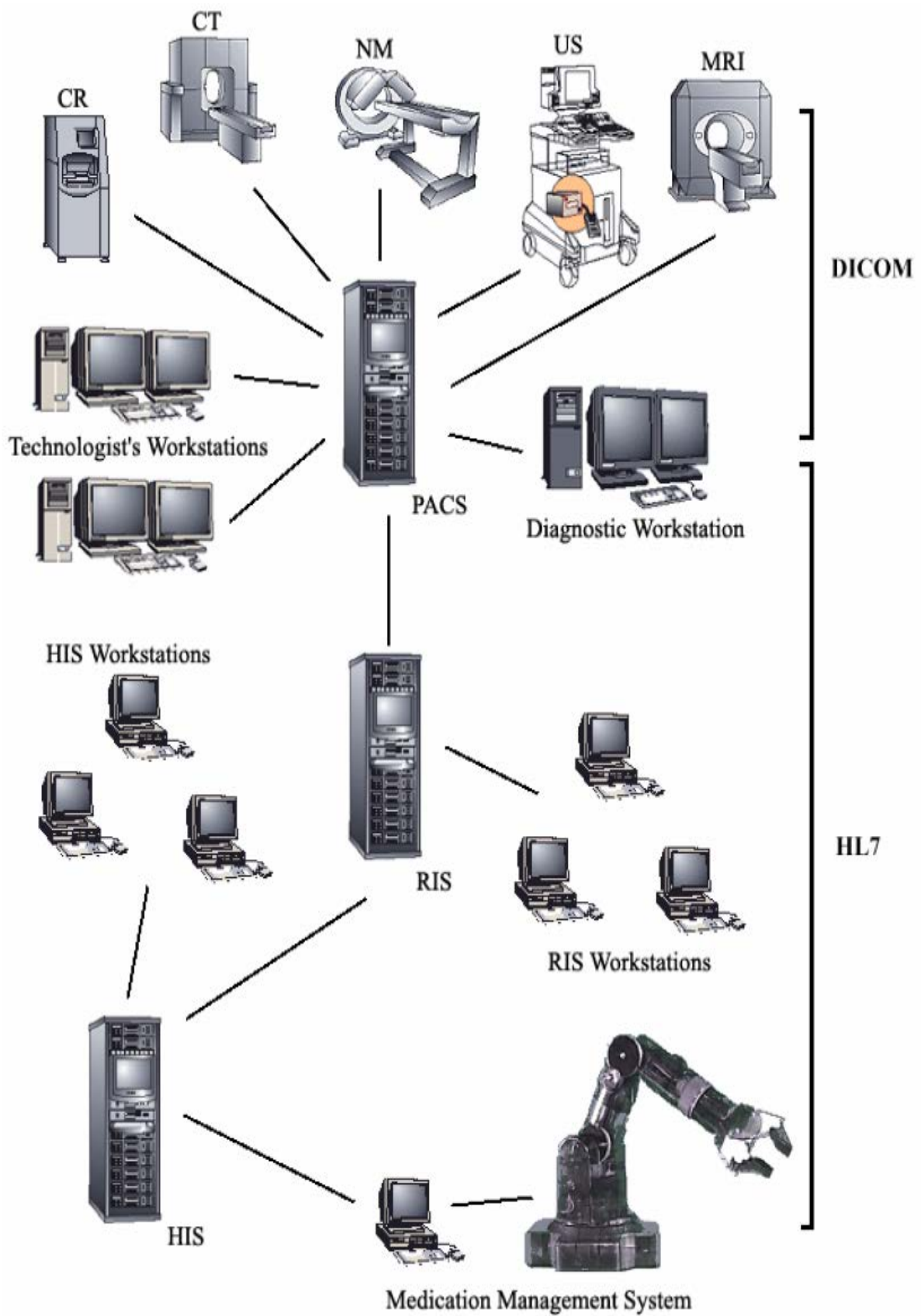
Figure B.8: The interactions between image modalities, PACS, RIS and HIS (Yiu & Yiu 2007, p. 4).

285

B.3.2 Health Level 7 (HL7 2.x)

HL7 was formed in 1987 to provide a standard for the exchange of clinical application data in order to eliminate or substantially reduce the interface programming and maintenance required at that time. In September 1988, version 2.0 was released as the basis for several data-interchange demonstrations. In June 1990, version 2.1 was published and was soon widely implemented across the world. In 1991, HL7 became a charter member of the American National Standards Institute (ANSI) and later, in 1994, it became an ANSI-accredited standard development organisation. Following this, version 2.2 was published in December 1994. In March 1997, version 2.3 was released to provide standards for the interchange of data relating to managerial issues while, in October 2000, version 2.4 introduced conformance query profiles and some additional features, such as messages for laboratory automation, application management, and personnel management. In 2003, version 2.5 was released to support more functionality and lately, ANSI approved the HL7 version 2.0 Extensible Markup Language (XML) Encoding Syntax to make messages Web-enabled (Hammond & Cimino 2006, pp. 265-311). Figure B.9 illustrates the ADT (Admission, Discharge and Transfer) transaction message that occurs when a patient is transferred from the operating room to a surgical intensive-care unit. This message includes a heading segment, the EVN segment specifying the type of event contained within the PID (patient-identification) segment, the PV1 (patient-visit) segment, the OBR (general-order) segment and several OBX result segments (observations).

```
MSH|^~&\|DHIS|OR|TMR|SICU|199212071425|password|ADT|16603529|P|2.1<cr>

EVN|A02|199212071425||<cr>

PID|||Z99999^5^M11||GUNCH^MODINE^SUE|RILEY|19430704 |F||C|RT. 1, BOX
97^ZIRCONIA^NC^27401 |HEND|(704)982-1234|(704)983-1822||S|C||245-33-
9999<cr>

PV1|1|I|N22^2204|||OR^03|0940^DOCTOR^HOSPITAL^A||| SUR|||||A3<cr>

OBR|7|||93000^EKG REPORT|R|199401111000|199401111330|||RMT||||19940111
11330|?|P030||||||199401120930||||||88-126666|A111|VIRANYI^ANDREW<cr>

OBX|1|ST|93000.1^VENTRICULAR RATE(EKG)||91|/MIN|60-100<cr>

OBX|2|ST|93000.2^ATRIAL RATE(EKG)||150|/MIN|60-100<cr>

 . . .

OBX|8|ST|93000&IMP^EKG DIAGNOSIS|1|^ATRIAL FIBRILATION<cr>
```

Figure B.8: HL7 ADT Transaction Message between an Operating Room System and an Intensive-care Unit System (Hammond & Cimino 2006, p. 302).

B.4 Document Standards

Clinical notes are the historical form of patient records which include a mixture of discrete data and free-flowing narratives which are built using handwritten and loosely structured medical documents. This is because there are no specific rules as such governing the paper-based, clinical notes of healthcare providers although rough guidelines might impose a general format for such notes (Ferranti *et al.* 2006). As described in Chapter 3, several SDOs are working to develop the standards required for representing and exchanging the contents of EHR systems. In the following section, two of the most prominent medical document standards are presented.

B.4.1 Clinical Document Architecture (CDA)

CDA is an XML-based markup standard that defines the structure and semantics of medical documents for the purpose of exchange. Its content is based on the object-oriented concept that can exist outside of a message. CDA documents derive their meaning from HL7 RIM. However, the CDA standard does not specify how documents should be exchanged and so

287

CDA documents can be transferred using any available communication mechanisms such as HL7 v2.x, HL7 v3 and DICOM. CDA is organised into a three-level architecture, as shown in Figure B.10, with each higher level adding more clinical content to the document (Begoyan 2007; Iakovidis *et al.* 2007; Eichelberg *et al.* 2005; Bott & Braunschweig 2004). A CDA document can be any form of medical document, such as a discharge summary, referral, clinical summary report, history and/or physical examination account, diagnostic reports, medication prescription and public health report, as in the discharge letter shown in Figure B.11. Figure B.12 presents part of the body of the CDA three-level document in XML language. For example, the "section" element is coded using LOINC and the "observation" element is coded using SNOMED-CT to describe a "Skin _finding" in a manner that is machine-processable (HL7 2008).

Figure B.10: The Three-level Architecture of a CDA Document (HL7 2008, p. 4).

288

Figure B.11: An Example of a Discharge Letter in CDA format (HL7 2008, p. 3).
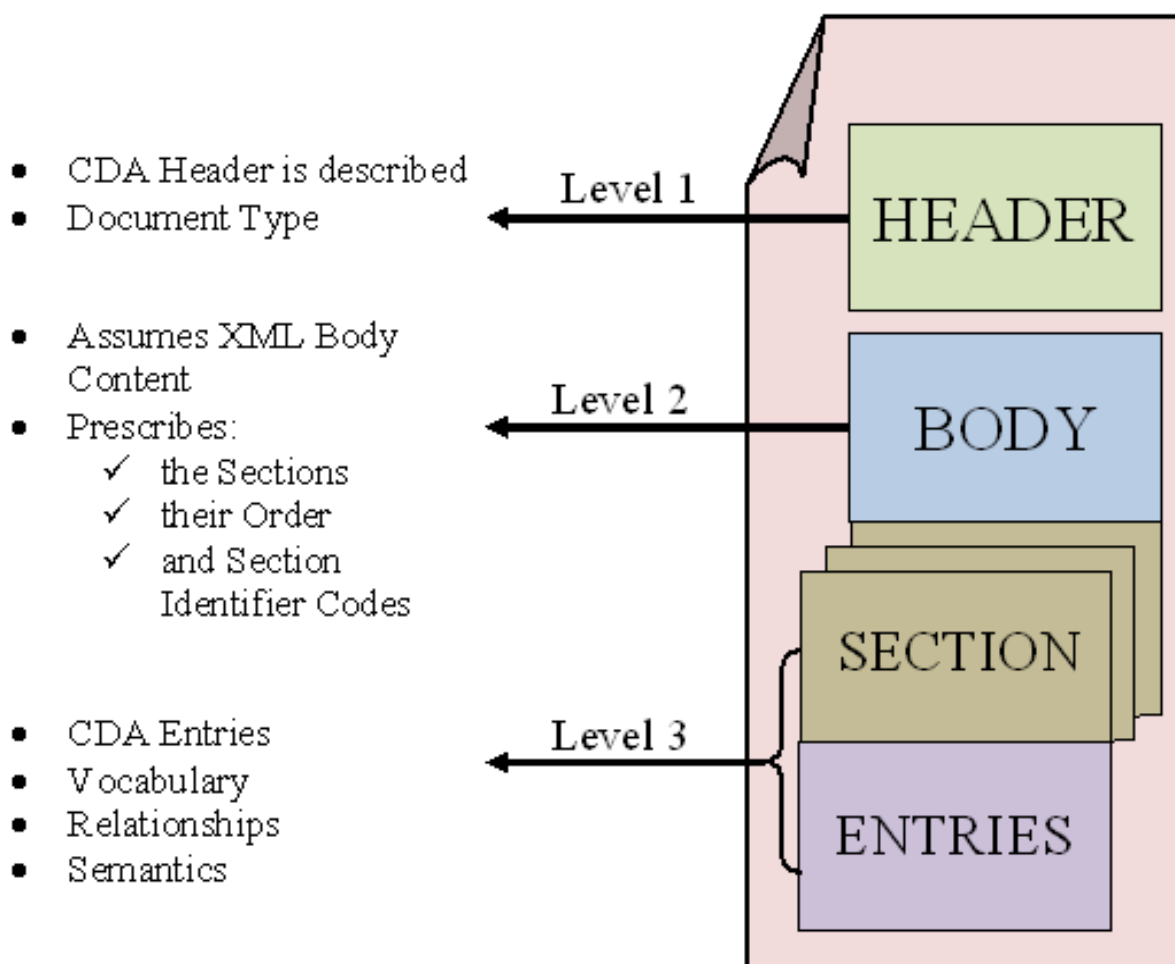
```
<section>
  <code code="8709-8" codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC"/>
  <title>Skin Exam</title>
    <text>Erythematous rash, palmar surface, left index finger.
      <renderMultiMedia referencedObject="MM2"/>
    </text>
  <entry>
    <Observation>
      <code code="106076001" codeSystem="2.16.840.1.113883.6.96"
        codeSystemName="SNOMED CT" displayName="Skin finding"/>
      <value xsi:type="CD" code="271807003"
        codeSystem="2.16.840.1.113883.6.96"
        codeSystemName="SNOMED CT" displayName="Rash"/>
      <targetSiteCode code="48856004"
        codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT"
        displayName="Skin of palmer surface of index finger">
        <qualifier>
          <name code="78615007" codeSystem="2.16.840.1.113883.6.96"
            codeSystemName="SNOMED CT" displayName="with laterality"/>
          <value code="7771000" codeSystem="2.16.840.1.113883.6.96"
            codeSystemName="SNOMED CT" displayName="left"/>
        </qualifier>
      </targetSiteCode>
      <entryRelationship typeCode="SPRT">
        <RegionOfInterest MMID="MM2">
          <id root="10.23.4567.4489"/>
          <code code="ELLIPSE"/> <value>3 1 3 7 2 4 4 4</value>
          <entryRelationship typeCode="SUBJ">
            <ObservationMedia> <id root="10.23.4567.345"/>
              <value xsi:type="ED" mediaType="image/jpeg">
              <reference value="lefthand.jpeg"/> </value>
            </ObservationMedia>
          </entryRelationship>
        </RegionOfInterest>
      </entryRelationship>
    </Observation>
  </entry>
</section>
```

Figure B. 12: Part of the CD Three-level Body in XML (HL7 CDA Release 2.0 2005).

B.4.2 Continuity of Care Record (CCR)

Many different groups of clinicians and related organisations joined together to form a task force with ASTM International in order to develop the standards required for collecting a nucleus of medical data relevant to patients' care status in a standardised format for the purpose of medical data exchange. The result of this collaboration was the development of the ASTM CCR. CCR was defined by ASTM (2004) as "a summary of the patient's health status (e.g., problems, medications, allergies) and basic information about insurance, advance directives, care documentation, and care plan recommendations." However, CCR was not intended to replace the EHR system, but rather to help in managing some medical procedures such as medication errors, drug–drug interactions, duplicate prescriptions and redundant laboratory testing (Ferranti *et al.* 2006). Figure B.13 shows the ASTM CCR conceptual model.
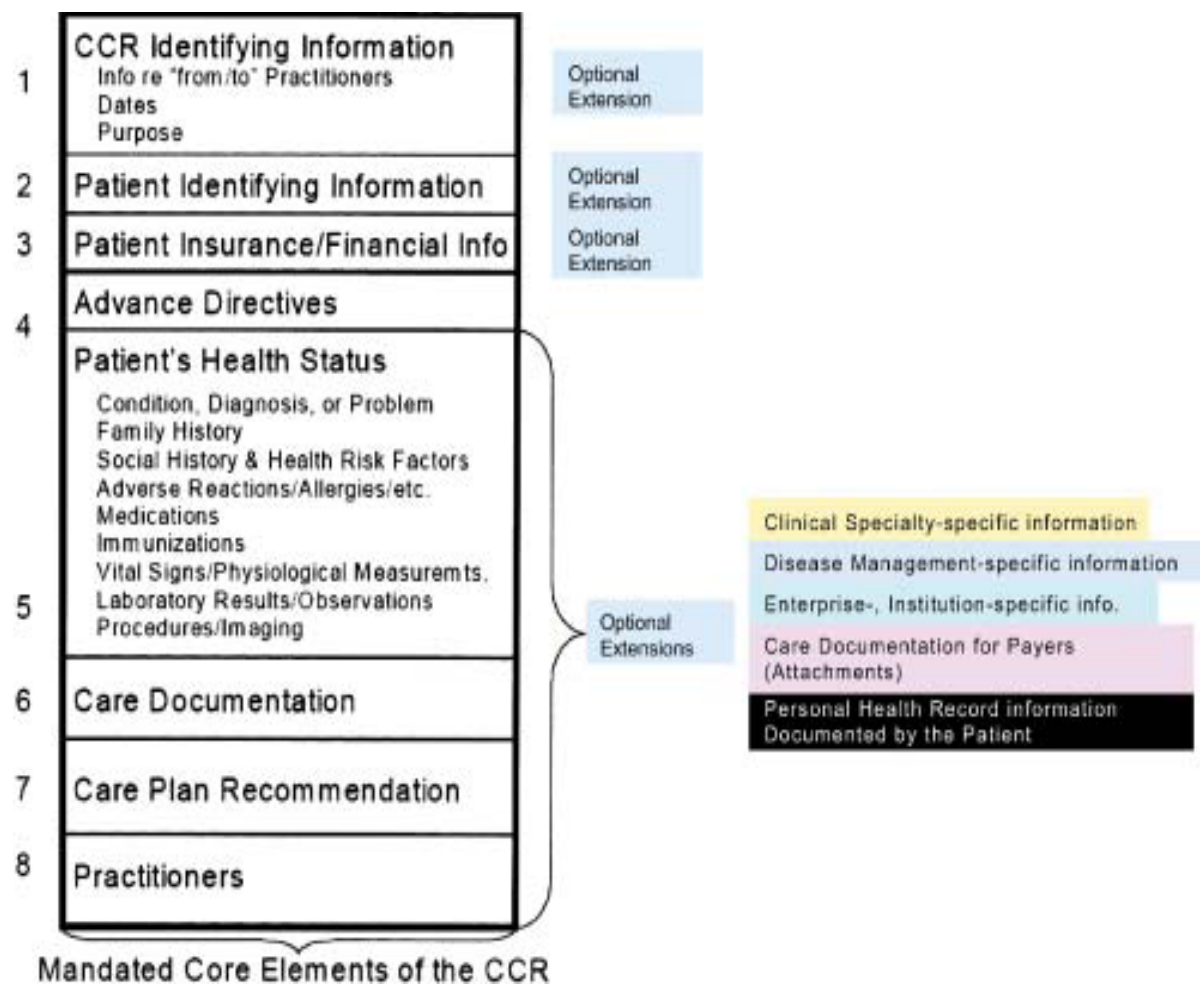

Figure B.13: Conceptual Model of the Continuity of Care Record Version 1 (Tessier 2004).

291

Appendix C: Interview Agenda

A. General Hospital Information

A.1　How many subsidiaries or branches does the hospital have?

    a. If there are subsidiaries or branches, are there close links administratively between the hospital and the other branches? Please explain.

A.2　What is the hospital policy with regard to the purchasing, adoption and implementation of IT applications?

A.3　What are the rules imposed by the IT department regarding this policy?

A.4　Do you have a specific department concerning health informatics issues?

    a. If yes, what rules are imposed by this department regarding the purchasing, adoption and implementation of IT applications?

A.5　Are there any interest in the health informatics field and/or participation in related national and international activities? Please explain.

B. Technological Factors

B.1　Did you use any evaluation tools for HIT related standards before the adoption process? Please explain.

B.2　Have you carried out any pilots or viewed any demonstrations regarding HIT related standards? Please specify the name of the system and the names of the supported health data standards. What available sources are being used to explore the area of health data standards?

B.3　How does the actual state of affairs regarding health data standards impact on the adoption of HIT-related standards in the organisation?

B.4　What is the overall cost of the adoption and implementation of health data standards?

    a. What are the main costs (e.g. hardware, software, development, maintenance, consultancy, employees' training, business process re-engineering, organisational restructuring, standard body membership … etc) associated with the adoption of health data standards?

    b. Were the costs expected or were there hidden costs? Please explain.

    c. What impact does prior knowledge of these costs have on the adoption of health data standards?

B.5   What are the main characteristics or aspects of HIT related standards that must be taken into consideration before the adoption process?

    a. In your opinion, how can healthcare organisations predict and respond to these aspects effectively and efficiently before the adoption process?

B.6   In your opinion, what other technological factors are likely to influence the adoption process of HIT-related standards in the organisation?

C. Organisational Factors

C.1   How is your HIT infrastructure organised?

    a. Is there any central integrated infrastructure or does each subsidiary have its own infrastructure? Please explain.

    b. What is the big picture of the integrated IT infrastructure in your hospital?

C.2   Could you specify the name of health data standards that are implemented in your organisation?

C.3   What were the main business problems the organisation faced before adopting HIT related standards?

C.4   What are the main motivations for adopting HIT related standards?

C.5   Who initiated the idea of adopting health data standards?

C.6   What are your rules in the adoption and implementation process?

C.7 Were there any concerns about the current IT infrastructure before adopting HIT related standards?

C.8 How are the selected standards being supported?

C.9 What was the impact of the adoption of HIT related standards?

C.10 What benefits are derived from HIT related standards in the organisations?

    a. Were the benefits realised within the expected time frame? Please explain.

    b. Do the benefits outweigh the costs? Please explain.

C.11 What barriers derived from HIT related standards in the organisations?

    b. What solutions are being introduced to overcome these barriers?

C.12 In your opinion, what other organisational factors are likely to influence the adoption process of HIT related standards in the organisation?

D. Environmental Factors

D.1 Have any activities (e.g. promotion and awareness-raising, pilots and demonstrations, sponsorship, information and technical support, resource allocation, vendor support, consultant support and government support … etc) been carried out by the government and/or other parties to encourage and support the uptake of HIT related standards? Please explain.

D.2 Have you carried out any consultations with regard to health data standards?

    a. If yes, what impact did the consultants have on the adoption of health data standards?

D.3 What are the roles of the vendors in supporting the adoption of HIT related standards? Please explain.

D.4 How does participation in health data standards activities, either at a national or international level, impact on the adoption of the standards? Please explain.

Abdullah Ibrahim Alkraiji 2011

D.5   In your opinion, what other environmental factors are likely to influence the adoption

process of HIT-related standards in the organisation?

    a.   In your opinion, what solutions can overcome other environmental barriers to

the adoption of HIT related standards?

Appendix D: Validation of the Research Findings

Dear Participant,

First of all, I appreciate your time, cooperation and effort in providing me with valuable information during the process of my data collection, undertaken from 12 April 2010 to 12 July 2010, to investigate the adoption process of HIT related standards at the decision-making stage in Saudi healthcare organisations. Because of the valuable information that you have given me, I was able to draw conclusions concerning the critical factors influencing the adoption process of HIT related standards. For part of the conclusion, I am required to validate these findings by reporting back to some key participants. You have been selected in the validation process because you are seen as a key player in the adoption process of HIT applications in your organisation. This interview will take approximately one hour. All the critical factors, together with their meanings and descriptions, are attached in the tables below. Your views and comments regarding these factors, based on the five-variable scale (strongly disagree, disagree, neutral, agree and strongly agree) are required to enhance the validity of the research findings. In addition, your recommendations for overcoming the negative factors, enhancing the positive factors or offering other recommendations, are also essential in this research. Once again, I appreciate your time and your cooperation. I look forward to hearing from you.

Sincerely,

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Table D.1: Description of critical factors influencing the adoption process of HIT related standards at the decision-making stage in Saudi healthcare organisations.

Category		Factors	Description
Standards Factors	1	Relative Advantage	This is the degree to which HIT related standards have clear benefits over others in meeting the existing functionality requirements based on five categories of benefits: organisational, strategic, managerial, technical and operational.
	2	Complexity	The Saudi health community is a newcomer to advanced HIT practices such as health data standards and so the concept of health data standards was seen as complex to understand and cope with.
	3	Compatibility	This is the degree to which HIT related standards are consistent with the experiences, resources, practices, values, skills and the IT infrastructure of the Saudi health community.
	4	Trialability	This refers to pilots, demonstrations or other methods used by the organisations in order to test out the new system and its conformity to the required standards.
	5	Observability	This refers to the information that is available regarding health data standards and general industry knowledge. Different methods can be used for locating the required information, such as searching the internet and attending conferences.
	6	Switching Cost	This refers to the costs required for converting to the new standards which might result in creating a high degree of drag and sunk costs.
	7	Market Uncertainties	This refers to the market confusion surrounding health data standards which, in turn, hampers market transparency and leads to a confused situation amongst Saudi hospitals.
	8	Systems Integration	The main technical benefit of adopting HIT related standards for the hospitals is to facilitate the integration and exchange of data between systems.
	9	Enhancing the Use of Advanced Systems	The hospitals in Saudi Arabia are hesitant about adopting or increasing the utilisation of certain advanced clinical information systems because those systems require a robust standardised information infrastructure in order to be successfully implemented.
Organisation Factors	1	Type of Healthcare Organisation	Although the standards need to be implemented in every type of healthcare provider, the tertiary hospitals are most in need of adhering to the health data standards in order to manage the complexity of their work.
	2	Size of Healthcare Organisation	The large healthcare organisations are seen to be most in need of increasing interoperability between systems as this is more complicated across the sites due to the distributed nature of their organisational systems.
	3	Organisational Culture	This refers to the attitude (e.g. the opinions and beliefs) of top management and staff towards change and the advantages brought by standards.
	4	Organisational Structure	It appears there is a high degree of politics and bureaucracy in the public hospitals which means there are numerous faults in terms of drafting and proposing the specifications and requirements for a new system owing to the unclear organisational structure.
	5	Lack of Adequate Policies and Procedures	The hospital policies and procedures are a set of guidelines that should be defined precisely; these should be developed for all the different activities when a request is made to purchase a new system and should be followed rigorously until the system is used on a regular basis.
	6	Resistance to Change	There appears to be resistance to change and so a dedicated change management programme must be established to ensure that a highly collaborative approach is undertaken by the hospital authorities and different departments and related groups. This should be done in order to regulate successfully the rate of change and ensure that organisational change objectives are fully realised during the adoption of health data standards.

297

Category		Factors	Description
	7	Education	Since the majority of the tertiary hospitals carry out some sort of education and research programmes, they must sustain high-quality medical information in order to provide these education and research centres with valuable information.
	8	HIT Infrastructure	This refers to the amount of capital and equipment already existing in the organisation which may have to be abandoned as a requirement for the new standard because of incompatibility issues and/or other obstacles.
	9	Lack of Information Management Plan	There appears to be a lack of an information management plan in the public hospitals at the level of how data are, for example, predefined, characterised, structured, stored, exchanged, integrated, accessed and governed. This might explain why the hospitals are hesitant to change to the supported standards since they still do not have a clear vision and mission in this regard.
	10	Accreditation	One of the main initiatives taken by the top management in leading Saudi hospitals is the acquisition of certain accreditation from leading international medical commissions. Therefore, the hospitals must follow certain standards, including some health data standards, in order to be accredited.
	11	Data Analysis	The analysis of data is an important factor for healthcare organisations to help top management acquire meaningful insights from the data by carrying out accurate statistical analysis, excluding any human bias. However, this depends on the quality of the data that are inputted; it also relies on how well the systems are integrated and how well the data are structured and predefined.
	12	Lack of Clinicians' Engagement	There is less engagement on the part of clinicians in adhering to health data standards since most Saudi physicians have not undertaken any education programmes with regard to health data standards and their applications in the medical environment; thus, they are unaware of the benefits that standards can bring to the organisation.
Environmental Factors	1	Network Externalities	The adopted standards are imposed because they are the current market standards and so hospitals cannot choose other standards if they want to retain market compatibility and support.
	2	External Pressure	There appears to be external pressure on the Saudi hospitals to adhere to certain standards. The sources of pressure are the government, the market and international trends.
	3	External Support	Due to the absence of a government role in the adoption of health data standards, healthcare organisations look for support from reliable external parties, such as vendors and consultants, to understand and cope with health data standards.
	4	National Healthcare System	The national healthcare system is seen to be insufficiently well organised to allow data exchange amongst healthcare providers and this might be one of the reasons that the adoption of health data standards by healthcare organisations remains frustratingly low where do they exist.
	5	Lack of National Plan for Medical Data Exchange	Because of the lack of a national plan for medical data exchange between healthcare providers in Saudi Arabia, healthcare organisations prefer to invest in their IT infrastructure (i.e. in areas such as networks, platforms and other advanced clinical information systems), rather than focusing on standardisation from which they cannot benefit directly.
	6	Lack of National Regulator	Owing to the lack of a formal reference for health data standards, there is confusion amongst the hospitals in Saudi Arabia about which standards they should pay attention to, which they should embrace, and those which they should adopt. Although several government entities and commissions have spoken about the standards, no one has taken the lead in developing and promoting such standards in Saudi Arabia.
	7	Shortage of Professionals	Since Saudi healthcare organisations are newcomers in the area of advanced HIT applications, there is a shortage of national experts who are knowledgeable about this subject; this is hindering improvement and development in the field of health informatics in general.

298

Table D.2: List of the critical factors and their impacts on the adoption process of HIT related standards at the decision-making stage in Saudi healthcare organisations.

Category			Factors	Impact	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Comments
Standard Factors	1		Relative Advantage	+	1	2	3	4	5	reason
	2		Complexity	-	1	2	3	4	5	reason
	3		Compatibility	-	1	2	3	4	5	reason
	4		Trialability	+	1	2	3	4	5	reason
	5		Observability	+	1	2	3	4	5	reason
	6		Switching Cost	-	1	2	3	4	5	reason
	7		Market Uncertainties	-	1	2	3	4	5	reason
	8		Systems Integration	+	1	2	3	4	5	reason
	9		Enhancing the Use of Advanced Systems	+	1	2	3	4	5	reason
Organisation Factors	1		Organisation Type	+	1	2	3	4	5	reason
	2		Organisation Size	+	1	2	3	4	5	reason
	3		Organisational Culture	+	1	2	3	4	5	reason
	4		Organisational Structure	-	1	2	3	4	5	reason
	5		Lack of Adequate Policies and Procedures	-	1	2	3	4	5	reason
	6		Resistance to Change	-	1	2	3	4	5	reason
	7		Education	+	1	2	3	4	5	reason
	8		IT Infrastructure	-	1	2	3	4	5	reason
	9		Lack of Information Management Plan	-	1	2	3	4	5	reason
	10		Accreditation	+	1	2	3	4	5	reason
	11		Data Analysis	+	1	2	3	4	5	reason
	12		Lack of Clinicians' Engagement	-	1	2	3	4	5	reason
Environmental Factors	1		Network Externalities	+	1	2	3	4	5	reason
	2		External Pressure	+	1	2	3	4	5	reason
	3		External Support	+	1	2	3	4	5	reason
	4		National Healthcare System	-	1	2	3	4	5	reason
	5		Lack of National Plan for Medical Data Exchange	-	1	2	3	4	5	reason
	6		Lack of National Regulator	-	1	2	3	4	5	reason
	7		Shortage of Professionals	-	1	2	3	4	5	reason