UNIVERSITY OF SOUTHAMPTON

FACULTY OF PHYSICAL SCIENCES AND ENGINEERING
Department of Electronics and Computer Science

A Model of Electronic Health Record Systems Adoption by Primary Healthcare Physicians in the Kingdom of Saudi Arabia

By
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Thesis for the degree of Doctor of Philosophy in Computer Science

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Dedicated To

My mother and my father

For raising me to believe that anything is possible

My husband

My brother Yahia and my sisters

For making everything possible

And, my son

For making everything possible incredible

WITHOUT THEIR SUPPORT THIS WORK WOULD NOT HAVE BEEN ACCOMPLISHED

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

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Over the past several decades, Electronic Health Record (EHR) systems have become a goal for many governments as a key enabler for improving healthcare quality and reducing costs. Particularly, the implementation of EHR systems in primary healthcare has been a priority for many countries. This is due to their great potentials in enhancing healthcare systems and in more efficiently managing the healthcare needs of the populations. But in developing countries, such as the Kingdom of Saudi Arabia (KSA), EHR systems are still not widely adopted. However, current policy initiatives by the Ministry of Health are attempting major reforms in primary healthcare with EHR systems as a key component. In fact, it has been estimated that between 50% and 80% of EHR projects fail, with end users' resistance usually a major contributing factor. In the KSA, many studies had identified user resistance as a major barrier to the successful implementation of EHR systems. Therefore, the aim of this research is to investigate factors that impact primary healthcare physicians' decisions regarding adopting EHR systems.

This research was conducted in two main phases. The first phase aimed at developing a framework of key factors that are important in affecting the adoption of EHR systems by primary healthcare physicians. Three major comprehensive literature reviews were performed as a basis for developing the appropriate framework: a systematic review of barriers to the adoption of EHR systems in the KSA, a review of theories and models of user adoption of IT and a review of prior theoretical models of physicians' adoption of EHR systems. As a result, an integrated framework was proposed, which was composed of eight main factors, namely: perceived usefulness, perceived ease of use, computer self-efficacy, social influence, physician participation, perceived threat to physician autonomy, attitude toward using an EHR system, and confidentiality concerns.

The proposed framework was validated and enhanced using a qualitative data triangulation methodology with two key groups of informants: (1) leaders and experts of EHR implementation in

the KSA, and (2) decision makers and physicians in primary healthcare. The findings of this phase revealed that all the proposed factors are important and influential for the adoption of EHR systems by physicians except confidentiality concerns, which appeared to be mitigated by trust. Also, an additional important factor which has not been examined in prior research was identified, namely: compatibility. Importantly, the findings from both groups were consistent with each other, providing evidence for the validity of the framework.

The second phase of the research was conducted to investigate the relationships between the identified factors in order to develop an explanatory and prediction model of EHR adoption decisions by primary healthcare physicians. In order to ensure the accuracy of measures used to examine the identified factors, a measurement instrument was developed based on both the results of the qualitative study performed in the first stage of this research and previously validated measures in the literature. The reliability of the instrument was examined using a pilot study of 32 primary healthcare physicians. The final stage of the second phase involved a nationwide survey, in which the developed instrument was used to collect data from primary healthcare physicians in the KSA. A total of 243 valid responses were received and analysed using Structural Equation Modelling (SEM). The results of SEM analysis clearly showed a good fit of both the measurement instrument and the proposed model to the collected data, implying that they are both valid in measuring and predicting EHR adoption decisions. The key outcome of the second phase of this research revealed that most of the hypothesized relationships among the factors were discovered to have a statistically significant effect in the model. The model had a large effect and was able to explain 77% of the variance in primary healthcare physicians' decisions to adopt EHR systems.

The contributions of this research are as follows: firstly, it developed an EHR systems adoption framework within the KSA context and, secondly, the framework was extended to: (1) a measurement instrument for examining EHR adoption decisions, and (2) a decision model that explains how the identified factors affect EHR adoption decisions.

Overall, the outcomes of this study are of valuable information in terms of recommendations to EHR system developers, governmental organisations, managers and policy makers. Simply put, these findings can assist in the implementation of EHR systems and encourage the spread of these systems across countries in the Middle East, particularly in the KSA.

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Declaration of Authorship

Print name: Asma Abdullah J Aljarullah Alqahtani

Title of thesis: A Model of Electronic Health Record Systems Adoption by Primary Healthcare Physicians in the Kingdom of Saudi Arabia

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:

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Glossary of Terms

Term	Definition
Barrier to adoption	A variable hindering the adoption of a particular product or service.
Determinant of adoption	A variable with a significant influence on the adoption of a particular product or service.
Dimension	Factors are often multi-dimensional. A dimension represents one face of a factor. A dimension of a factor is represented as sub-theme in the qualitative empirical investigation of this research, and as one or more measured variables in the quantitative empirical investigation of this research.
End-user	The person who uses a particular product or service.
Factor	A factor is a variable that often cannot be measured directly, but can be assessed using a number of indicators or measured variables. Factors are the key building blocks of theories such as the Theory of Reasoned Action. Factors are also discussed under other labels, such as constructs or latent variables, which are often used interchangeably in the literature.
Framework for adoption	A set of factors associated with the adoption of a particular product or service. The framework may or may not show the relationships between the factors.
Model of adoption	A set of factors associated with the adoption of a particular product or service, including the relationships between these factors.
Primary healthcare physician	A primary healthcare physician is a physician who provides the first contact for a patient with an undiagnosed health concern and who recommends secondary care physicians, medical or surgical specialists with expertise in the patient's specific health problem if further treatment is needed (Mosby, 2009). In the KSA, most primary healthcare physicians are family physicians (Ministry of Health, 2017). In the United Kingdom, the equivalent term to a primary healthcare physician is *general practitioner*.
Theme	The term used in thematic analysis to describe patterns within data. A theme captures something important within the data with regard to the research inquiry, and represents some level of meaning, through coded instances within the data. In this thesis, a theme represents a factor and a sub-theme represents a dimension of a factor.
Variable	A variable is any entity that can take on different values.

List of Abbreviations

ATT	Attitude
CC	Confidentiality Concerns
CDM	Chronic Disease Management
CDS	Clinical Decision Support
CFA	Confirmatory Factor Analysis
CIO	Chief Information Officer
CIS	Clinical Information System
COM	Compatibility
CPOE	Computerised Physician Order Entry
CSE	Computer Self-efficacy
EFA	Exploratory Factor Analysis
EHR	Electronic Health Record
EMR	Electronic Medical Record
GP	General practitioner
HIE	Health Information Exchange
HIPAA	Health Insurance Portability and Accountability Act
HITECH	The Health Information Technology for Economic and Clinical Health Act
IOM	Institute of Medicine
IS	Information System
IT	Information Technology
KFMC	King Fahad Medical City
KFSH-D	King Fahad Specialist Hospital in Dammam
KFSHRC	King Faisal Specialist Hospital and Research Centre
KKESH	King Khalid Eye Specialist Hospital
KKUH	King Khalid University Hospital
KSA	Kingdom of Saudi Arabia
MOH	Ministry of Health
NGHA	National Guard Health Affairs
OECD	Organization for Economic Cooperation and Development
NPfIT	National Programme for IT
PEOU	Perceived Ease of Use
PHC	Primary Healthcare
PP	Physician Participation
PTPA	Perceived Threat to Professional Autonomy
PU	Perceived Usefulness
SEM	Structural Equation Modelling
SHC	Saudi Health Council
SI	Social Influence
SLR	Systematic Literature Review
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology

Chapter 1 Introduction

1.1 Research Rationale

Two decades ago, the Institute of Medicine's (IOM's) report, *To Err is Human*, produced in 1999, raised the alarm about the failure of healthcare to recognize and reduce a large number of avoidable medical errors (Kohn et al., 1999). According to the report, at least 44,000, and perhaps up to 98,000, people die in hospitals each year in the United States as a result of medical errors that could have been prevented. A second report, *An Organisation with a Memory*, produced by the United Kingdom Government's Chief Medical Officer in 2000, estimated 850,000 adverse events annually in the UK's hospitals (10% of hospitals' admissions) (Chief Medical Officer, 2000). These influential reports resulted in a growing attention worldwide toward patient safety and healthcare quality (World Health Organization, 2011a).

One of the IOM's main conclusions is that medical errors are commonly caused by faulty systems, processes, or conditions that lead medical staff to make mistakes or fail to prevent them (Kohn et al., 1999). In this regard, healthcare experts and policymakers consider Electronic Health Record (EHR) systems to be transformational and integral to healthcare reform (Chaudhry et al., 2006; Dick et al., 1997; Raposo, 2015).

An EHR system is considered as the backbone integrating various information systems (e.g. computerized physician order entry, clinical decision-support, electronic prescribing, clinical documentation, laboratory information system, and diagnostic imaging system, etc.) (Gagnon et al., 2014). Advantages of EHRs have been well documented in the literature, such as increasing the availability and timeliness of information, optimizing the documentation of patient encounters, reducing errors, improving the quality of clinical decisions and improving the communication between healthcare providers (Boonstra and Broekhuis, 2010; Gagnon *et al.*, 2014). In addition to these advantages, the EHR has a particular importance in primary healthcare. For example, it improves chronic disease management programs, improves continuity of care, facilitates the reporting of population health, improves preventive care, and allows for the development of patient portals (e.g. personal health records) and adaptive educational programs for patients (Canada Health Infoway, 2006; Yamamoto and Khan, 2006; Menachemi and Collum, 2011). Therefore, applying EHRs in primary healthcare is considered as a key enabler to improving the population health, and to enhancing the overall healthcare system of the country (Menachemi and Collum, 2011).

Over the past several decades, many governments have been allocating funding and developing policies for the implementation of EHRs in order to enhance healthcare systems and to more efficiently manage the healthcare needs of the populations (AlJarullah & El-Masri, 2013). For example, in 2009, the US's Government allocated $27 billion for incentive programs that encourage hospitals and healthcare professionals to adopt EHRs. These incentives are provided through the "meaningful use" criteria, which requires that in addition to implementing a certified EHR, healthcare professionals must utilize a range of pre-specified EHR functions (Blumenthal and Tavenner, 2010). The United Kingdom's Government funds several schemes to facilitate the implementation of EHRs by healthcare providers and to connect EHR systems together. The goal is to introduce a comprehensive system of EHRs across the National Health Service (NHS) by 2020. The recent Comprehensive Spending Review of 2015 allocated £1 billion for the development of technology in the National Health Service (NHS) over the years between 2015-2020 (Parliamentary Office of Science and Technology, 2016). Particularly, the implementation of EHR in primary healthcare has been a priority in many countries. For example, a 2009 survey study (Schoen *et al.*, 2009) found that proportions of primary healthcare physicians using electronic heath records in the following countries were: United Kingdom (96%), Australia (95%), Netherlands (99%), New Zealand (97%), Norway (97%), Italy (94%) and Sweden (94%).

Developing countries such as the Kingdom of Saudi Arabia (KSA) have lagged behind significantly in this regard. In the KSA, only a small number of hospitals, most of which are large and specialised hospitals, have moved toward EHR systems (Altuwaijri, 2008, 2011; Bah *et al.*, 2011; Aldosari, 2014; Shaker, Farooq and Dhafar, 2015). Almost all primary healthcare practices under the Ministry of Health (MOH) are still completely manual (i.e. rely completely on paper-based records), and the uptake of information technology in these practices in general is rare (Altuwaijri, 2011; Almaiman *et al.*, 2014). However, recent policy initiatives in the KSA are attempting major reforms in primary healthcare with EHRs as a key component (Ministry of Health, 2011). The MOH is currently launching strategies for the implementation of EHR systems in the 2,361 primary healthcare centres across the KSA. These systems are intended to share patient information between primary healthcare centres, hospitals, regional laboratories and specialty clinics (Ministry of Health, 2011).

In fact, studies on EHR implementation have documented the difficulty of the process, with issues impeding successful implementation such as loss of productivity, disruption to patient care, and dissatisfaction among staff (Hummel and Evans, 2012). It has been estimated that between 50 and 80 percent of EHR projects fail (Cucciniello et al., 2015), with lack of end users' adoption usually a major contributing factor (Boonstra and Broekhuis, 2010). The literature reports many cases of healthcare professionals' resistance, underuse, workarounds, overrides and abandonment of e-health and EHR systems (Dowling Jr, 1980; Lawler *et al.*, 1996; Weingart *et al.*, 2003; Doolin, 2004; Lapointe and Rivard, 2006; Patterson *et al.*, 2006; Koppel *et al.*, 2008; Meigs and Solomon, 2016). The problem of user resistance to the adoption of EHR, dissatisfaction with the system, and underutilisation of core EHR functions has been raised by many studies conducted in the KSA (Nour El Din, 2007; Altuwaijri, 2008; Bah et al., 2011; Shaker and Farooq, 2013; Alharthi et al., 2014; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b). Lack of end users' adoption can have significant consequences in terms of cost, lost earnings, organizational disruption, and poor quality of care (Dowling Jr, 1980). Therefore, understanding factors affecting end-users' adoption of EHRs is essential for their successful implementation. Because physicians are the key user-group of EHRs, whether or not they accept and use EHR systems will have a great influence on other user-groups in a medical practice (Boonstra and Broekhuis, 2010).

Previous studies have looked at the factors that affect physicians' acceptance and use of EHR systems (e.g (Meade, Buckley and Boland, 2009; Rao *et al.*, 2011; Decker, Jamoom and Sisk, 2012)), however, the vast majority of these studies were performed in developed countries (Ludwick and Doucette, 2009; Boonstra and Broekhuis, 2010; Castillo, Martínez-García and Pulido, 2010; McGinn *et al.*, 2011; Gagnon *et al.*, 2012; Ajami and Bagheri-Tadi, 2013; Li *et al.*, 2013). Due to differences in their social, cultural, economic, political, legal and technological conditions, developing countries encounter a set of problems and concerns that vary considerably from those faced by developed countries (Fraser *et al.*, 2005; Al-Shorbaji, 2008). For example, developing countries are challenged by the unsuitable ICT and health IT infrastructure, lack of awareness of the benefits of health IT projects, lack of health data exchange protocols and code sets, lack of expertise and skilled personnel for complex health IT systems such as EHR systems, cultural and social challenges resulting from outsourced systems, privacy concerns and lack of legal framework (Al-Shorbaji, 2008; Hassibian, 2013). Experience with implementing EHR systems for the developing countries is scarce; and requirements, priorities and local constraints are still not well understood (Fraser *et al.*, 2005; Al-Shorbaji, 2008; Hassibian, 2013).

Furthermore, health informatics experts ascertain that the implementation of EHR systems is an uncertain and challenging task even in developed countries, calling for sensitive matching of local needs to available technologies and resources (Fraser *et al.*, 2005; Currie and Finnegan, 2011; Ammenwerth and Rigby, 2016). Hence, it cannot be suggested that a single EHR implementation and architecture will fit all environments and needs (Fraser et al., 2005). As reported by Ammenwerth and Rigby (2016), settings, health systems and clinical contexts are all different. The severe complexity of healthcare IT development and implementation is due to the fact that different professional groups (e.g. physicians, nurses) and clinical domains have different needs, which are different between primary, secondary and tertiary care. And those needs are also different between healthcare organizations that are self-contained delivery organizations and those that require networking with others involved in the care of the same patient. Those needs are also different between countries that differ in their socio-economic levels, developmental stages and cultural norms (Ammenwerth and Rigby, 2016).

Moreover, unlike IT systems in other economies, which are generally effective, efficient and '*harmless'*, healthcare IT systems are safety critical, meaning that they impact patients' safety directly or indirectly (e.g. see (Magrabi, Ong and Coiera, 2016; Marcilly, Peute and Beuscart-Zéphir, 2016)). Healthcare IT related harms have their origins in system design, implementation and use (Myers, Jones and Sittig, 2011; Magrabi, Ong and Coiera, 2016). Ammenwerth and Rigby (2016) reported that healthcare IT systems are usually imposed upon clinicians by organisations policy, or even by higher policy decisions. Clinicians are thus not users by choice, but victims of an external choice. And the cost of imperfect decisions includes user frustration in their professional work, inefficiency in use, user workarounds, waste of resources, medical errors and harms to patients, some with adverse consequences and even up to deaths (Han *et al.*, 2005; Fakler *et al.*, 2007; Westbrook *et al.*, 2013; Cheung *et al.*, 2014). This discussion and contextualisation of the problem leads to what is currently promoted by health informatics experts and international professional bodies such as the European Federation for Medical Informatics (EFMI), the International Medical Informatics Association (IMIA), the USA Agency for Health Research and Quality (AHRQ), and the World Health Organisation, that health informatics should be evidence-based (Ammenwerth *et al.*, 2004; Cusack *et al.*, 2009; World Health Organisation, 2011b; Rigby *et al.*, 2013; Rigby and Ammenwerth, 2016). Evidence based health informatics means that the "people designing, developing and implementing health information systems should be able to rely on an explicit evidence base derived from rigorous studies on what makes systems clinically acceptable, safe and effective – not on basic science or experts alone" (Wyatt, 2016). In this regard, it is generally agreed by health informatics experts that identification, testing and use of relevant theories is crucial for the development of evidence-based knowledge, which in turn leads to the future maturation of health informatics (Scott, De Keizer and Georgiou, 2019; Wyatt, 2019). There is a great demand for predictive theories to make health information systems more usable, better accepted by its users, more clinically and cost effective, and readily transferable to other settings (Wyatt, 2019). Additionally, due to their holistic investigation, and given the socio-technical nature of health information systems, mixed methods evaluations are widely regarded as essential for evidence-based health informatics (Scott, 2016).

This research seeks to support current policy initiatives in the KSA by investigating factors associated with EHR adoption by primary healthcare physicians in the KSA. The study conducted in this thesis applies a mixed methods evaluation in order to identify and develop a predictive theory of EHR adoption behaviours by primary healthcare physicians. Examination of the broad literature (Chapters 3 and 4) revealed that there exists only very few predictive theories of physician adoption of EHR systems, most of them were validated in developed countries and focused on large and tertiary healthcare organisations, and none of them was developed or validated in the KSA's healthcare system. In addition, discrepancies exist in the findings of these studies. As strongly advocated in the literature, health information systems, especially those concerned with organization and delivery, need to be appropriate to their context (Ammenwerth et al., 2004; Cusack et al., 2009; World Health Organisation, 2011b; Rigby et al., 2013; Rigby and Ammenwerth, 2016). Considering the vast amount of resources being dedicated to EHR implementation in the KSA, understanding the factors associated with EHR adoption by primary healthcare physicians is essential for the successful implementation of this technology. It represents an opportunity to expand current policy initiatives to ensure EHR implementation success.

1.2 Research Aim and Objectives

As mentioned above, the aim of this thesis is to support current policy initiatives in the KSA by carrying out an investigation of EHR adoption factors by primary healthcare physicians. The objectives of this study are presented below:

- ❖ To identify factors that might influence primary healthcare physicians adoption of EHR systems in the KSA
- ❖ To develop a framework of key EHR adoption factors by primary healthcare physicians in the KSA.
- ❖ To develop a model that explains and predicts EHR adoption decisions by primary healthcare physicians in the KSA.
- ❖ To fill the gap in the existing literature and provide guidelines for healthcare organisations, EHR developers, IT managers, government and policy makers in order to increase the chances of EHR implementation success in primary healthcare practices.

1.3 Research Questions

This research seeks to answer the following research questions:

RQ1: What are the factors that are likely to influence primary healthcare physicians' adoption of EHR systems in the KSA?

RQ2: What is the appropriate framework for the adoption of EHR systems by primary healthcare physicians in the KSA?

RQ3: What is the appropriate model for explaining and predicting the adoption decisions of EHR systems by primary healthcare physicians in the KSA?

> RQ3.1: What are the most salient direct or indirect effects of the key factors identified in response to RQ2 on EHR adoption decisions?
>
> RQ3.2: What is the appropriate instrument to measure the key factors identified in response to RQ2?
>
> RQ3.3: Which relationships hypothesized in response to RQ3.1 will affect physicians' decisions to adopt EHR systems in Saudi public primary healthcare practices?

RQ4: Do the relationships between factors in the model vary between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR?

1.4 Thesis Structure

Figure 1-1 provides a summary of the stages conducted in this research to answer the research questions. Two main phases were applied for the mixed-methods investigation designed for this research (Figure 1-1). The first phase aimed at developing a framework of key factors that are important in affecting the adoption of EHR systems by primary healthcare physicians. Three major comprehensive literature reviews were performed as a basis for developing the appropriate framework: a systematic review of barriers to the adoption of EHR systems in the KSA (Chapter 3), a review of theories and models of user adoption of IT, which aimed at identifying drivers and barriers to the adoption of IT by individual users as well as the applicability of these theories in the healthcare context (Chapter 4, Sections 4.2 - 4.3), and a systematic review of prior theoretical models of physicians' adoption of EHR systems, which aimed at identifying key determinants, including both drivers and barriers, of the adoption of EHR systems by physicians (Chapter 4, Section 4.4).

As a result of the broad literature examined in Chapters 3 and 4, an integrated framework of key EHR adoption factors was proposed (Chapter 5). The proposed framework was then validated and enhanced using a qualitative data triangulation methodology with two key groups of informants (Chapter 6) : (1) leaders and experts of EHR implementation in the KSA (Chapter 7), and (2) decision makers and physicians in primary healthcare (Chapter 8). The findings of the two qualitative studies performed in Chapters 7 and 8 were then validated in a triangulation fashion to produce the validated framework of key EHR adoption factors by primary healthcare physicians (Chapter 9).

The second phase of the research was conducted to investigate the relationships between the identified factors in order to develop an explanatory and prediction model of EHR adoption decisions by primary healthcare physicians (Chapter 10). The first step in this phase involved the development of the proposed hypothesis and predictive model (Chapter 11). In this step, a further comprehensive review of the relevant academic literature was conducted and used in addition to the findings of the qualitative study performed in the first stage of this research (Chapters 6-9) to develop the proposed hypothesis about the relationships between the factors and the proposed predictive model. In order to ensure the accuracy of measures used to examine the identified factors, a measurement instrument was developed based on both the results of the qualitative study performed in the first stage of this research and previously validated measures in the literature. The reliability of the instrument was examined using a pilot study primary healthcare physicians (Chapter 12). The final stage of the second phase involved a nationwide survey, in which the developed instrument was used to collect data from primary healthcare physicians in the KSA. The field survey responses were analysed using Structural Equation Modelling (SEM) (Chapter 13).

The remainder of the thesis is structured as follows:

Chapter 2 provides background knowledge about health records and discusses limitations of paper-based health records. The chapter then defines electronic health record systems and describes their key components. Finally, the benefits of implementing EHR systems were discussed in terms of their impact on healthcare quality, safety and efficiency as well as the drawbacks of their implementation.

Chapter 3 presents a comprehensive systematic review of barriers to the adoption of EHR systems in the KSA. In this chapter, the broad literature on EHR adoption factors, both at the organisation level and at the individual user level, was reviewed in order to develop a comprehensive understanding of factors associated with EHR adoption in the KSA and to determine barriers to the adoption of these systems. As reported by Rigby and Ammenwerth (2016), systematic reviews represent the building of the evidence base of a scientific field. This chapter starts by providing a description of the healthcare system in the KSA and discussing several challenges faced by the Saudi healthcare system (Section 3.2). Then e-health initiatives in the KSA were discussed (Section 3.3). The systematic review methodology in this chapter followed the approach and steps suggested by Kitchenham and Charters (2007), which is a widely regarded methodology for systematic reviews in the field of computer science (Section 3.4). The findings of this systematic review (Section 3.5) expanded existing knowledge on what affects healthcare organisations, clinicians and other healthcare professionals' adoption of EHR systems. A discussion of the findings of this systematic review was provided in light of the findings of other international studies and systematic reviews (Section 3.6). Finally, this chapter concludes by highlighting significant research gaps, which are of great importance to academics and health informatics researchers in the KSA (Section 3.7). The findings of the study conducted in this chapter represent a key building block toward the development of evidence-based knowledge regarding factors affecting the adoption of EHR systems by physicians in the KSA, which informed the development of the proposed framework in Chapter 5.

Chapter 4 provides a comprehensive critical review of theories of user adoption of IT and previous theoretical models of physicians adoption of EHR system. This chapter starts by reviewing the broad literature of existing theories modelling what drives or inhibits individual users' acceptance and use of information technology. A critical review of these theories was conducted, investigating and discussing their applicability in the context of healthcare IT. This review critically evaluated the strengths and limitations of these theories, and led to the identification of factors, both drivers and barriers, associated with the adoption of information technology by individual users (Section 4.2). Importantly, it resulted in the identification of several limitation of these theories in the healthcare context (Section 4.3), which were addressed in this research through the systematic approach to the development of the framework (Chapter 5) and the employment of mixed methods research methodology in the complete study conducted in this thesis. The next part of this chapter (Section 4.4) presented a comprehensive systematic review of the broad literature on prior theoretical models of physician adoption of EHR systems. The systematic review conducted in this section identified and critically reviewed existing evidence on key determinants, including both drivers and barriers, to the adoption of EHR systems by physician users. The detailed review conducted in this chapter led to the identification of several important research gaps, which were highlighted and discussed in Section 4.5. The systematic reviews conducted in Chapters 3 and 4 provided a comprehensive understanding on key factors, both barriers and enablers, affecting the acceptance and use of EHR systems by physicians. The identification of these factors was guided by *theoretical constructs* from theories of user acceptance and use of technology as well as the literature of EHR adoption by physicians (see Section 3.5, Section 4.2.5, and Section 4.4), which is an approach similar to the approach followed by Venkatesh *et al.* (2003) in the development of the Unified Theory of

Acceptance and Use of Technology (UTAUT). The aim was to develop a refined, contextualised theory in the unique context of healthcare IT.

Chapter 5 presents the methodology used to develop the proposed framework of key influential factors that are likely to affect primary healthcare physicians' adoption of EHR. The broad literature examined in Chapters 3 and 4 was used as a basis to develop the proposed framework of key EHR adoption factors (Section 5.2 for the framework construction methodology). The components of the proposed framework were then defined and critically reviewed in order to provide a more holistic understanding of their dimensions in the healthcare context (Section 5.3).

Chapter 6 provides a detailed explanation of the methodology used to empirically validate the proposed framework, which included a qualitative triangulation study of EHR implementation experts and primary healthcare physicians as described previously in the present chapter. The aim was to validate factors in the proposed framework, to explore other significant factors, and to obtain an in-depth analysis on what defines these factors in the context of physician adoption of EHR systems.

Chapter 7 presents the findings of interviews with EHR implementation experts. The chapter starts by providing a detailed description of the profile of experts participated in this investigation (Section 7.2). Experts' evaluation of the proposed framework was provided and discussed in Section 7.4. Then, new factors emerged from experts' interviews were identified and discussed in Section 7.5. Finally, the findings of the thematic analysis conducted in this chapter were summarised in Section 7.6.

Chapter 8 presents the findings of interviews with primary healthcare physicians. The chapter starts by providing a detailed description of the profile of primary healthcare physicians participated in this investigation (Section 8.2). Primary healthcare physicians' evaluation of the proposed framework was provided and discussed in Section 8.4. Then, new factors emerged from primary healthcare physicians' interviews were identified and discussed in Section 8.5. Finally, the findings of the thematic analysis conducted in this chapter were summarised in Section 8.6.

Chapter 9 presents the findings of the qualitative data triangulation study conducted in the first stage of this research (see Chapter 6 for a detailed description of the methodology designed for the first stage of this research). In this chapter, the findings from the two qualitative studies conducted in Chapters 7 and 8 were compared and validated in a triangulating fashion. Based on the triangulation of the findings, this chapter presents the validated framework of key EHR adoption factors by primary healthcare physicians (Section 9.1). The findings were then discussed in light of the broad literature around (Section 9.2). These were further discussed with a more detailed critical evaluation in Chapter 14, which combines and discusses the results of the complete study conducted in this research.

Chapter 10 provides a detailed explanation of the methodology applied in the second stage of this research, which aims to develop an explanatory and prediction model of EHR adoption decisions by primary healthcare physicians. Structural Equation Modelling (SEM) was selected as the main statistical technique in the second stage of this research. A multiphase methodology was applied toward the development and validation of the model in the second stage of this research, which was described in detail in this chapter.

Chapter 11 presents the first phase in the second stage of this research. This phase was conducted to develop hypothesis about the relationships between the factors in the validated framework and to develop the proposed model of EHR adoption decisions based on these hypothesis. In this chapter, the findings of the qualitative study conducted in the first stage of this research as well as an extensive review of the broad literature informed the development of the hypothesis and the predictive model. The literature was further examined critically in this chapter in order to provide a more detailed reasoning on how the validated factors are *interconnected* in affecting EHR adoption decisions. This reasoning was also supported by seeking evidence on the relationships between the factors from the broad literature around.

Chapter 12 presents the second phase of the second stage of this research. This phase explains and presents the results of the methodology employed to develop and validate the measurement instrument to be used for the main data collection in the second stage of this research. This chapter starts by a detailed review of the literature to identify previously validated measurement items that conform to the findings of the qualitative study performed in the first stage of this research (Section 12.2). As discussed in the limitations of theories of user adoption of IT (Section 4.3) and research gaps provided in (Section 4.5, last paragraph), more contextualised measurement items are needed in order to reliably and effectively evaluate the identified factors. Therefore, the meanings and explanations provided by participants in the first stage of this research (Chapters 7-9) were used to search for and select previously validated measurement items from the broad literature. The selected measurement items were then validated for face and content validity with two expert panels (Section 12.3), and were further validated by conducting a pilot study with primary healthcare physicians (Section 12.4).

Chapter 13 presents the third phase of the second stage of this research. This chapter provides the results of measurement and structural model validation using Structural Equation Modelling (SEM) with a large sample. The chapter begins by explaining the targeted population, sampling procedure and the sample size. Then, the results of a preliminary data analysis were provided, which included:

evaluating and handling missing values, normality assessment, demographic data analysis, and internal consistency reliability analysis using Cronbach's alpha criteria. Then SEM analysis was conducted in two main phases: (1) measurement model analysis, and (2) structural model analysis. Finally, the moderating effect of EHR experience on all model relationships was evaluated using multi-group analysis.

Chapter 14 provides a detailed discussion of the results of the complete research carried out in this investigation. In this chapter, the results relevant to each factor, in addition to the practical and theoretical implications of these results, were critically discussed in relation to the broad literature and theory. In addition, discussion and implications of the results obtained relating to the moderating effect of EHR experience (RQ4) were provided with reference to the empirical literature and theory.

Chapter 15 is the conclusion chapter, which provides an overview of the research conducted in this thesis. In this chapter, the researcher articulated how this research applies to the KSA and how it can benefit researchers and practitioners outside the KSA. This chapter also outlines and discusses the main and useful theoretical and practical contributions of this research and suggests directions for future research.

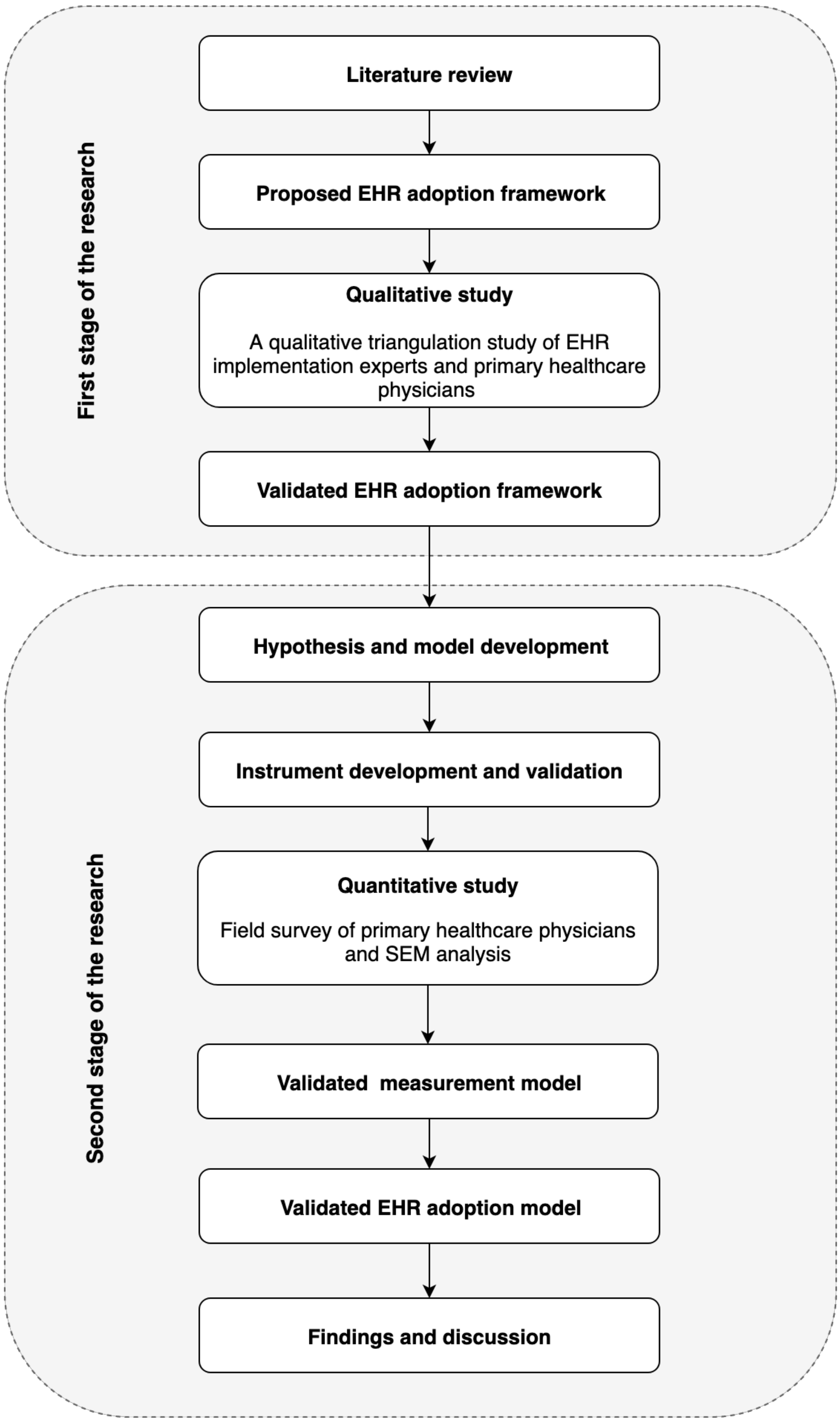


Figure 1-1 Broad overview of the main stages conducted in this research and the research process

Chapter 2 Electronic Health Record Systems

2.1 Introduction

The purpose of this chapter is to provide a background on Electronic Health Record (EHR) systems and to discuss their importance in today's healthcare. First, health records, history of health records, and limitations of paper based health records are discussed. Then, the EHR is described with its definition, key components, advantages and limitations of implementing an EHR system.

2.2 Health Records

A health record is "a repository of information regarding the health of a subject of care" (European Committee for Standardization, 2000). Health records include a variety of patient information that is held within a hospital or practice including: doctor notes, nursing documentation, results of laboratory tests, radiology images, outpatient reports, and pharmacy records (Griffith and Tengnah, 2014). A health record forms the record of care and treatment a patient has received (Griffith and Tengnah, 2014). It makes it possible to monitor the progress of the patient and to develop a medical history of the patient. In addition to its clinical purpose, a health record has a very important legal purpose. It provides evidence of clinicians' involvement in patient's care. Therefore, it needs to be sufficiently detailed to demonstrate this involvement (Griffith and Tengnah, 2014).

Health records have taken various forms throughout the history; from papyrus as one of the earliest forms of health records to electronic health records in todays' healthcare (Gillum, 2013). The following subsections discuss the history of health records and the limitations of paper based health records. A detailed discussion about electronic health records is provided after that.

2.2.1 History of Health Records

Health records are as old as medicine itself. One of the oldest forms of health records is believed to be the case reports recorded in papyrus by ancient Egyptians for didactic purposes (Gillum, 2013). In the fifth century BCE, a new form of health records was developed by Hippocrates who advocated that a health record should meet two goals: it should accurately reflect the course of disease, and it should indicate the possible causes of disease (Bemmel, Musen and Helder, 1997). These two goals are still valid and appropriate for health records (Bemmel, Musen and Helder, 1997).

Historically, health records were written in the form of case histories by physicians to document the collective medical knowledge for didactic purposes (Gillum, 2013).

By the early 19th century, the modern form of health records first appeared in Paris and Berlin as loose paper files in major centres (Gillum, 2013). In 1907, health record keeping became more organized when Mayo Clinic in Rochester, Minnesota (U.S.), added patient record number to patient records. Each new patient was assigned a patient number, and all data for that patient were combined in a single record (Bemmel, Musen and Helder, 1997; Gillum, 2013). In 1918, the American College of Surgery launched a program to require hospitals to keep records on all patients, including a summary of care and outcomes, which could be used for quality improvement (Gillum, 2013). Since then, subsequent initiatives took place to improve the standardization and ordering of the contents of health records (Bemmel, Musen and Helder, 1997; Gillum, 2013).

2.2.2 Limitations of Paper-Based Health Records

For years, health records have been maintained in papers. These papers are usually handwritten by clinicians and kept in files. Handwritten notes may be illegible or too ambiguous to allow proper interpretation, and data may be incomplete (Bemmel, Musen and Helder, 1997). For patients to receive the right amount of drug at the right time, nurses, technicians and pharmacists spend a considerable time trying to guess what the doctor wrote. Misinterpretation of physician's orders has been considered as major source of serious medical errors (Edwards and Moczygemba, 2004).

Another important limitation of paper-based records is the fragmentation of patient information. The enormous growth in medical knowledge has led to an increasing number of clinical specialities. Specialization leads to multi-disciplinary care, so that multiple providers are involved in patient care. As a result, patient records are scattered between multiple providers. When clinicians need to form a complete picture of a patient's health, they may need to consult records that are maintained by other providers. Paper files can only be in one location at a time and sometimes they cannot be found at all (Bemmel, Musen and Helder, 1997). Paper-based records could only allow inefficient mechanisms for exchanging patient information such as photocopying and faxing.

A major shortcoming of paper records is that viewing a summary of patient health data over time is quite difficult. In most paper-based health records, new pages are added to the record as they are generated in chronological order, making it difficult to view the necessary information (Hersh, 1995). Accumulating paper records would result in heavy records for patients with chronic problems, and time constraints may prevent clinicians from viewing important information (Dick, Steen and Detmer, 1997).

For scientific analysis, the contents of paper records need to be transcribed, with potential errors due to handwriting problems or missing data. Conducting research or data analysis based on large numbers of paper records is extremely laborious and many data would be found missing or useless (Bemmel, Musen and Helder, 1997).

Another problem with the paper-based record is security and confidentiality. Although usually considered as a problem of the EHR, paper-records have attributes that would impose risks to the privacy of patients' data. When photocopying and faxing patients' records among providers and institutions involved in patient care, the papers could be viewed by non-privileged outsiders (Hersh, 1995). Also, patient privacy may be violated when carrying out administrative tasks at healthcare institutions (e.g., billing and accounting), the administrative staff usually has access to all contents of the record because information they need is usually mixed with other health data (Raposo, 2015).

In addition, paper-based records do not have active decision-support capabilities. For example, they cannot actively draw clinicians' attention to drug interactions or allergies of the patient (Bemmel, Musen and Helder, 1997).

Another important problem with paper-based medical records is that they accumulate over time and become bulky, requiring extensive storage facilities and staff (Roukema *et al.*, 2006). Unavailability and difficulty in accessing records are frequent problems with paper-based records (Dick, Steen and Detmer, 1997).

In summary, paper as a storage medium for patients' clinical data has many disadvantages that stand as obstacles in the development of healthcare, as outlined below:

- Contents are in handwriting, and hence are possibly illegible, ambiguous, or incomplete. (Bemmel, Musen and Helder, 1997; Edwards and Moczygemba, 2004).
- Bulky storage requirement (Roukema et al., 2006).
- Unavailability of information in due time (R. S. Dick et al., 1997).
- Fragmentation of patient's data between multiple providers (Bemmel et al., 1997).
- Poor support for fast and easy information retrieval (R. S. Dick et al., 1997; Hersh, 1995).
- Lack of active decision-support capabilities (Bemmel et al., 1997).
- Poor support for healthcare research (Bemmel et al., 1997).
- Possible security and confidentiality violations with no possibility to track access to patients' data (Hersh, 1995; Raposo, 2015).

2.3 Electronic Health Record (EHR)

The problems inherent in paper-based health records and the increasing concerns over healthcare quality, in addition to the developments in computer science, all of these have led to a great interest in the development of Electronic Health Records (EHRs) (Dick, Steen and Detmer, 1997). Early efforts to develop computer-based patient records began in 1960s and 1970s, when academic medical centres developed their own systems; Atherton (2011) provided a review of the development of EHR systems since the conception of the idea in 1960s. The Institute of Medicine (IOM) identified EHR as “an essential technology for healthcare” in 1991 (Dick & Steen, 1991). The IOM’s report of 1999 (Kohn et al., 1999), concluded that healthcare would be safer with systems such as Computerized Physician Order Entry (CPOE).

Today, EHRs have become a goal for many governments as a promising tool for improving healthcare quality and reducing costs (AlJarullah and El-Masri, 2013). Governments are allocating substantial funds to encourage the implementation and adoption of EHRs. For example, in 2009, the US Government allocated $27 billion for incentive programs that encourage hospitals and healthcare professionals to adopt Electronic Health Records (EHRs) (Blumenthal and Tavenner, 2010). These incentives are provided through the “meaningful use” criteria, which requires that in addition to implementing a certified EHR, healthcare professionals must utilize a range of pre-specified EHR functions (Blumenthal and Tavenner, 2010). The United Kingdom’s Government funds several schemes to facilitate the implementation of EHRs by healthcare providers and to connect EHR systems together. The goal is to introduce a comprehensive system of EHRs across the National Health Service (NHS) by 2020 (Parliamentary Office of Science and Technology, 2016). The recent Comprehensive Spending Review of 2015 allocated £1 billion for the development of technology in the National Health Service (NHS) over the years from 2015-2020 (Parliamentary Office of Science and Technology, 2016).

2.3.1 Definition of Electronic Health Record (EHR)

Although there is no consensus on an exact definition of EHR, the International Organization for Standardization (2003) defines the primary purpose of an EHR as follows:

> “The primary purpose of the EHR is to provide a documented record of care which supports present and future care by the same or other clinicians. This documentation provides a means of communication among clinicians contributing to the patient’s care.”

The primary generic EHR is defined by the International Organization for Standardization (2005) as follows:

> "A repository of information regarding the health of a subject of care, in computer processable form."

According to the US President's Council of Advisors on Science and Technology (2010), an Electronic Health Record (EHR) refers to an electronic record of health-related information of a patient that contains information captured in clinical visits, lab and image studies, and other important information related to the medical history and condition. This record can be stored and exchanged securely and is accessible by different levels of authorized users (Hayrinen et al., 2008). The Healthcare Information Management Systems Society (n.d.) further defines an EHR identifying its content, context, primary and secondary purpose, as follows:

> "A longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports - the EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter as well as supporting other care-related activities directly or indirectly via interface including evidence-based decision support, quality management, and outcomes reporting."

According to the National Institutes of Health (2006), an EHR is created and maintained within a healthcare organization, such as a hospital, an integrated delivery network, a clinic, or a physician office. It is not a longitudinal record of all care provided to the patient in all institutions over time. Longitudinal records may be kept in a national or regional health information system (National Institutes of Health, 2006).

The terms Electronic Health Record (EHR) and Electronic Medical Record (EMR) have been used synonymously/interchangeably throughout the literature; however, according to the National Alliance for Health Information Technology (2008) the term EMR describes an outdated mode of electronic patient records. The principal difference between EHR and EMR is that EMR does not allow for the exchange of health information outside of the originating organization. The patient's record might have to be printed out and delivered in paper format to specialists and other members involved in patient's care (Garrett and Seidman, 2011).

The goal of EHR is comprehensiveness of patient care and that health information moves with the patient from facility to facility (Garrett and Seidman, 2011). Therefore, a basic attribute of EHR is interoperability, the ability of different systems to communicate and exchange information (National Alliance for Health Information Technology, 2008). To achieve interoperability, an EHR must conform to a commonly recognized interoperability standards (National Alliance for Health Information Technology, 2008).

2.3.2 Key Components and Functionalities of an EHR System

An EHR system is defined as the software platform used by hospitals and physician practices to create, store, update, and maintain EHRs for patients (Angst and Agarwal, 2009). The Institute of Medicine (2003) has identified eight main functionalities of an EHR system as outlined in Figure 2-1. These functionalities are requirements of the "meaningful use" criteria set forth in the HITECH Act of 2009 (Blumenthal and Tavenner, 2010). The following subsections briefly describe each of these functionalities.

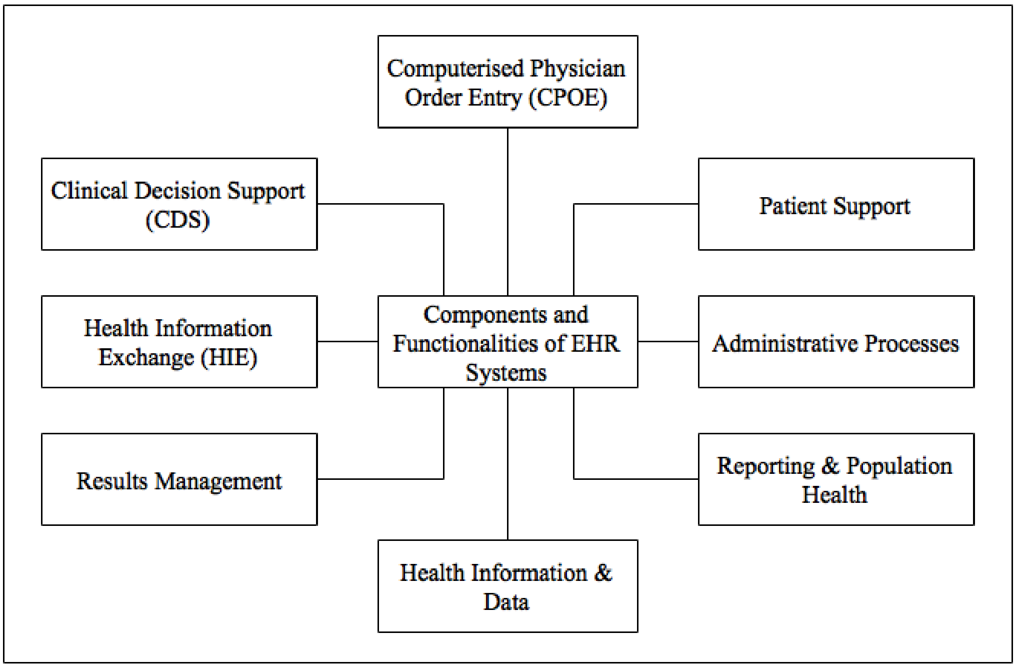


Figure 2-1 Key components and functionalities of EHR systems – adapted from the Institute of Medicine (2003)

2.3.2.1 Computerized Physician Order Entry (CPOE)

CPOE systems allow physicians to enter orders, for example, for drugs, laboratory tests, or radiology, electronically rather than doing so on paper (Menachemi & Collum, 2011). This eliminates potentially dangerous medical errors caused by illegible or ambiguous handwriting of physicians. It also ensures that the physician orders adhere to the clinical guidelines. Therefore, nursing and pharmacy staffs do not need to seek clarification or to solicit missing information from illegible or incomplete orders (Institute of Medicine, 2003)

2.3.2.2 Clinical Decision Support (CDS)

The CDS system assists the physician in making decisions with regard to patient care (Menachemi and Collum, 2011). It has a great potential in improving patient safety and healthcare quality. It supplements care planning through performing checks in real time, cross-referencing a patient allergy to a medication, alerting the physician for drug interactions and for other potential adverse events based on the patient information contained within the system (Institute of Medicine, 2003).

2.3.2.3 Health Information Exchange (HIE)

HIE is defined as “the electronic movement of health-related information among organizations according to nationally recognized standards” (National Alliance for Health Information Technology, 2008). By allowing secure and potentially real-time movement of patient information, HIE can improve the quality and efficiency of patient care and reduce costs associated with redundant tests. Historically, providers rely on faxing or mailing each other the needed information, which makes it difficult to access data in “real time” when and where it is needed. HIE facilitates the exchange of this information via EHRs (Menachemi and Collum, 2011).

2.3.2.4 Results Management

This functionality manages results of all types, including laboratory test results and radiology reports results electronically. This ensures timely and easy access to results by providers, prevents redundant and additional tests, and allows for easier detection of abnormalities. Therefore, this functionality holds the potential to improving care quality and efficiency and reducing costs (Institute of Medicine, 2003).

2.3.2.5 Health Information and Data

An EHR system should hold certain data about patient’s health and care, including such items as, medical and nursing diagnoses, a medication list, allergies, demographics, clinical narratives, and laboratory test results. The purpose is to ensure improved access by healthcare providers to the needed information (Institute of Medicine, 2003).

2.3.2.6 Reporting and Population Health

This feature automates the process of generating safety and quality reports at the local, regional, and national levels. Thus, reducing the labour-intensive and time consuming processes associated with paper-based records and ensuring the accuracy of the data reported (Institute of Medicine, 2003).

2.3.2.7 Administrative Processes

Electronic scheduling systems for hospital admissions, inpatient and outpatient procedures and visits improves the efficiency of heath care organizations and provides better, more timely service to patients (Institute of Medicine, 2003).

2.3.2.8 Patient Support

Various forms of patient support functionalities have demonstrated significant effectiveness in healthcare, particularly in improving control of chronic diseases. Examples include computer-based patient education, home telemonitoring and telehealth (Institute of Medicine, 2003).

2.4 Benefits of implementing an EHR system

The benefits of implementing EHR have been well documented in the literature (Yamamoto & Khan, 2006; Menachemi & Collum, 2011; Pare et al., 2014). Although these advantages are highly related, they can be categorized into three main categories: quality-related advantages, safety-related advantages, and efficiency-related advantages. The following subsections discuss major advantages of EHR in each category.

2.4.1 Benefits to Healthcare Quality

Healthcare quality has been defined by the US Department of Health and Human Services as "doing the right thing at the right time in the right way to the right person and having the best possible results" (US Department of Health and Human Services, 2004). Eight main advantages of EHR related to improvement of healthcare quality have been reported, as follows:

- **Optimizing the documentation of patient encounters** – handwriting problems such as illegibility, ambiguity and incompleteness are eliminated in EHR. Every step of the patient care process is time documented (Yamamoto and Khan, 2006). The information may be presented in different forms and statistically analysed to produce various documents, such as discharge notes (Pare *et al.*, 2014).

- **Supporting continuity of care and facilitating the exchange of up-to-date information among healthcare providers in distinct locations** – an EHR facilitates timely sharing and access to patient information between healthcare providers involved in patient care. Primary healthcare staff can access the EHR record during follow-up care (Yamamoto and

Khan, 2006).

- **Availability and timeliness of information** - the speed in accessing patient's information is one of the main features of an EHR. EHR allows the medical team to have access to information that otherwise would go unnoticed, with the additional benefits of easily filtering that information according with the chosen criteria of research (by episodes, by date, by drugs) (Raposo, 2015). Also, data entered about laboratory and radiology results become immediately available to physicians (Yamamoto and Khan, 2006).

- **Improved communication between the healthcare team** – EHR allows immediate exchanges of notes and consultations between physicians. Consultations regarding diagnostic images can be made through EHRs. Laboratory results are made available to physicians through EHR rather than papers (Yamamoto and Khan, 2006). Also, physician orders to laboratory, radiology, pharmacy, or other clinicians are made electronically through EHR rather than papers.

- **Chronic Disease Management (CDM)** – there is a consensus that the EHR is a necessary tool to improve CDM (Canada Health Infoway, 2006). Evaluations of telehealth home care and chronic disease management programs have shown among users of the services: 34% to 40% fewer emergency room visits, over 32% fewer hospitalizations and up to 60% fewer hospital days (Canada Health Infoway, 2006).

- **Supporting preventive care and improving population health** – EHR can be used to more efficiently report, track, and aggregate health data in local, regional, and national levels (Office of the National Coordinator for Health Information Technology, 2013). It can be used to track the delivery of preventive care recommendations across primary care practices (De Leon and Shih, 2011). Also, EHR can be used to monitor disease outbreaks, resulting in improved population health (Office of the National Coordinator for Health Information Technology, 2013).

- **Empowering patients to actively take part in decision regarding their own health** – EHR can empower individuals to become active participants in their own care, resulting in better care management. Providing patients access to information such as laboratory results and prescriptions has the potential to improve self-care, especially important for chronic disease management (Canada Health Infoway, 2006).

- **Supporting healthcare research** – EHR forms a data repository for research and quality improvement (Yamamoto and Khan, 2006), resulting in improved population health (Menachemi and Collum, 2011).

2.4.2 Benefits to Patient Safety

Patient safety has been defined by the IOM as "avoiding injuries to patients from the care that is intended to help them" (Institute of Medicine, 2001). Two important benefits of EHR associated with improved patient safety have been documented in the literature, as follows:

- **Improved quality of clinical decisions** – EHR provides real-time assistance in decision making for physicians (Pare *et al.*, 2014; Raposo, 2015). For example, it provides accurate calculation regarding the dose of the prescribed drug, it warns the physician about possible drug-interactions as well as potential risks to the patient such as drug allergies (Raposo, 2015). Also, EHR provides reminders of missing events such as missing immunizations, important laboratory tests, and screening examination (Yamamoto & Khan, 2006). In addition, EHR increases clinicians' awareness of potential medication errors and drug interactions (Office of the National Coordinator for Health Information Technology, 2013).
- **Reduction of errors –** EHR reduces errors caused by: unavailable information in due time, illegible physician handwriting, missing information in physician orders, drug-interactions, inappropriate drug dosage, and patient allergies (Yamamoto and Khan, 2006). Evaluation studies suggests that serious medication errors can be reduced by as much as 55% when a CPOE system is used alone (Bates *et al.*, 1998), and by 86% when coupled with a CDS system (Bates *et al.*, 1999).

2.4.3 Benefits to Healthcare Efficiency

Efficiency refers to "the avoidance of wasting resources, including supplies, equipment, ideas, and energy" (Institute of Medicine, 2001). Two important advantages of EHR related to the improvement of healthcare efficiency have been reported in the literature, as follows:

- **Reduction of redundant tests –** A frequent form of wasted medical resources is redundant diagnostic testing (Menachemi and Collum, 2011). The study by Tierney et al., (1990) found that EHR decreased the number of diagnostic tests in outpatient settings by up to 14%. Moreover, the communication of information between multiple care providers prevents patient submission to repeated examinations, sometimes dangerous and painful (Raposo, 2015).
- **Reduction of cost –** EHR can make substantial cost savings at the healthcare system level. The study conducted by Hillestad et al., (2005) estimated efficiency savings of up to $77 billion per year to the USA healthcare system at a 90-percent level of EHR adoption. In Canada, the Ontario Telehealth Network saved $5.2 million in travel grants alone in 2005-2006 by avoiding 20 million kilometres of travel (Canada Health Infoway, 2006).

2.5 Drawbacks of Implementing an EHR system

Despite the growing literature on advantages of EHRs, some authors have identified several potential drawbacks and shortcomings associated with these systems, as follows:

- **High financial cost** – financial costs including start-up implementation costs, ongoing maintenance costs, and loss of revenue due to temporary loss of productivity are frequently reported drawbacks of EHR implementation (Menachemi and Collum, 2011). Start-up implementation costs are those associated with purchasing and installing hardware and software, converting paper-records into electronic ones, and training end users. Ongoing maintenance costs are those associated with upgrading the software system, replacing the hardware (and possibly storage migration), and ongoing training and support for end-users (Menachemi and Collum, 2011). These costs create a major barrier to the adoption and implementation of EHR systems. The study conducted by Boonstra & Broekhuis, (2010) listed implementation and maintenance costs as the most frequently cited barrier to the adoption of EHRs.

- **Temporary loss of productivity** – A major drawback of EHR is the changes it makes to the routine workflow of the medical staff, resulting in temporary loss of productivity. The time needed by the end-users to learn a new system and to prepare for the use of the system in clinical encounters leads to temporary loss of clinical productivity and thus to loss of revenue, which may stand as a major barrier to the adoption of EHR (Menachemi and Collum, 2011).

- **Privacy and security concerns** – Laws around the world have put strict regulations to protect the privacy of patient's medical data, and impose several penalties; not only to the ones who unlawfully view the data, but also to the ones in charge of protecting them; in the case of EHR, these are the healthcare institutions (Raposo, 2015). EHRs store personal, health and genetic data, which are very attractive for many industries, so hackers may try to access the system in order to get these data (Raposo, 2015). In the USA, the Health Insurance Portability and Accountability Act (HIPAA) (Gostin, 2001) have put rigorous requirements to ensure the security and privacy of electronic patient information. One of HIPAA legislations is that EHR systems should include audit functions, which allow system administrators to identify each individual who accessed every part of a given medical record. However, as EHRs are not 100% secure, privacy and security concerns may stand as a major barrier to the adoption of EHRs (Menachemi and Collum, 2011).

- **Unintended consequences** – unintended consequences such as increased medical errors and overdependence on technology have been cited as drawbacks of EHR in the literature (Menachemi and Collum, 2011). Studies have found a relationship between the use of CPOE and increased medical error due to poorly designed user interface or lack of adequate training for end-users (Campbell et al., 2006). Also, EHR may lead to overdependence on technology by healthcare providers. The more widely and deeply the technology is diffused, the more difficult it becomes to work without it. Therefore, organizations need to take appropriate procedures to ensure that the basic medical care can still be provided in the absence of technology (Menachemi and Collum, 2011). Using paper records as a secondary solution would be easy for the current generation. However, when a future generation makes EHR the norm, and paper records become unfamiliar, it is unlikely that using paper records as a secondary solution would be easy (Yamamoto and Khan, 2006).

2.6 Summary and Conclusion

Health records are an integral part of patient care. Certain attributes of paper-based health records have been identified by many studies as a major reason for medical errors. An EHR system has many advantages to the healthcare system in terms of improved healthcare quality, improved patient safety, and increased healthcare efficiency. Although some drawbacks have been reported in the literature with regard to EHR implementation, when balancing the advantages and disadvantages of this technology, it is beneficial, at both the individual and the population health levels.

Chapter 3 A Systematic Review of Barriers to the Adoption of EHR Systems in the KSA

3.1 Introduction

In the Kingdom of Saudi Arabia (KSA), most of the implemented systems in healthcare organizations are administrative systems rather than patient-care focus (Altuwaijri, 2010, 2011). Only few hospitals have moved toward the EHR (Bah *et al.*, 2011; Shaker, Farooq and Dhafar, 2015). In primary care centers, the uptake of IT in general is rare (Almaiman *et al.*, 2014). Understanding barriers to the widespread adoption of EHR systems in the KSA is crucial for their successful implementation.

The aim of the study in the present chapter is to identify barriers to the implementation and widespread adoption of EHR systems in the KSA using a systematic literature review. The results of the study presented in this chapter will be of great potential to policy makers and practitioners in the KSA, and will assist in developing the proposed framework of key EHR adoption factors by primary healthcare physicians in the KSA (Chapter 5).

In the following sections, a discussion of the need for EHR in the KSA is provided, followed by a review of e-health initiatives in the KSA. Following this, the methodology used for the systematic literature review is described, including: information sources, study selection criteria, study selection process, and data extraction and analysis. Then, the results of the review are illustrated, including details of the included studies, barriers, and their frequency of occurrence in the literature. Finally, a discussion on the results is provided along with highlights on limitations of the study conducted in the present chapter as well as research gaps.

3.2 Challenges to the Healthcare System in the KSA

The Ministry of Health (MOH) is the major government provider of healthcare services in the KSA, providing 60% of healthcare services, through 282 hospitals (43,080 beds) and 2361 primary healthcare centres. The remaining 40% of provision is divided between other governmental institutions, including military hospitals (e.g. National Guard Health Affairs), university hospitals (e.g. King Khalid University Hospital), and referral hospitals (e.g. King Faisal Specialist Hospital and Research Centre) (combined total of 47 hospitals, 12,279 beds), and the private sector with 158 hospitals (17,622 beds) (Ministry of Health, 2017). There are three levels of healthcare services in the KSA: primary, secondary, and tertiary. Primary healthcare is the first point of contact for healthcare for patients, and is provided by primary healthcare centres. Cases that require more advanced care are referred by primary healthcare centres to public hospitals (the secondary level of healthcare), and cases that require more complex levels of care are transferred by public hospitals to central or specialized hospitals (the tertiary level of healthcare) (Almalki, Fitzgerald and Clark, 2011).

Although the MOH was established in 1950, the healthcare system in the KSA has made tremendous improvements in a short time because of extensive investments. In 2000, the World Health Organization ranked the healthcare system in the KSA as 26th among 190 healthcare systems in the world. It appeared before many other healthcare systems, for example, Australia was ranked 32th, Canada 30th, New Zealand 41st. It also appears before several systems in the Middle East region, such as Qatar 44th, and the United Arab Emirates 27th (World Health Organization, 2000).

However, in addition to the potential benefits of EHR, the healthcare system in KSA has specific challenges that make the movement toward EHRs even a more promising solution. These are related to the rapid population growth, shortage of medical workforce and maldistribution of healthcare services. A brief description of these challenges is provided below:

- **Rapid population growth** – according to the General Authority for Statistics, the Saudi population was 34 millions in 2019, an increase from 22.6 millions in 2004 (i.e. population growth ratio from 2004 to 2019 was 50.4%) (General Authority for Statistics in Saudi Arabia, 2020). This rapid population growth imposes tremendous financial pressures on the healthcare system in the KSA (Almalki, Fitzgerald and Clark, 2011; Balkhair, 2012). It is suggested that the EHR would make substantial cost savings to the healthcare system, for example according to a RAND study (Hillestad *et al.*, 2005), it was estimated that the EHR would make a potential efficiency savings of $77 billion per year in the US healthcare at a 90-percent level of adoption. Adding the value for safety and health could double these saving.

- **Shortage of medical workforce** – a major challenge the Saudi healthcare system is facing is the shortage of Saudi healthcare professionals. The majority of healthcare professionals are expatriates which leads to high levels of turnover and instability in the health workforce (Almalki, Fitzgerald and Clark, 2011). As of 2017, the total number of physicians in the KSA, including dentists, is 98,074; only 29.5% of them were Saudis (Ministry of Health, 2017). Total number of nurses was 185,693; and only 36.7% of them were Saudis, and pharmacists were 28,312, 22.2% of whom were Saudis (Ministry of Health, 2017). Evaluation studies have shown that the EHR systems improved clinicians' productivity (Adler-Milstein and Huckman, 2013), and decreased time spent per patient visit by physicians (Pizziferri *et al.*, 2005), which is a good sign for the KSA and other developing countries with a shortage of clinicians.

- **Maldistribution of healthcare services** – the KSA covers a large and diverse geographical area, with over 2,150,000 square kilometers – about one quarter the size of the US, with more than 150 cities and 2000 villages separated by large distances, which complicates the delivery of healthcare services (Balkhair, 2012). Recent MOH statistics indicated that there is an uneven distribution of healthcare services and healthcare professionals across geographical areas (Ministry of Health, 2017). This has resulted in long waiting lists for people to access many healthcare services and facilities, particularity those living in remote and border areas (Almalki, Fitzgerald and Clark, 2011). EHR can improve the delivery of healthcare services to those medically underserved areas through various forms of telemedicine (Raposo, 2015).

3.3 E-Health Initiatives in the KSA

Recently, there have been several e-health initiatives in the KSA. In 2010, the MOH initiated strategic plans to transform the healthcare delivery in the KSA through the National EHR project. One the most important initiatives was allocating 5 Billion Saudi Riyals (1 Billion GPB) toward the development of the project. The project aims to implement EHRs in all hospitals and primary healthcare centers all over the kingdom with a vision to allow future integration and sharing of information across the nation's healthcare system. The MOH expects that the project will improve the quality of care, increase patient safety, reduce healthcare costs and improve healthcare policies (Ministry of Health, 2011). Additionally, several policy initiatives have taken place to improve e-health programs and to enhance health informatics workforce. For example, an applied health informatics master program, which is considered to be the first of its kind in the Middle East region, has been launched by King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) in 2005 (Altuwaijri, 2010). Many other universities have incorporated similar programs into their curriculums to address the barrier of lack of national professionals in health informatics (Alkraiji, Jackson and Murray, 2013). The Saudi Association for Health Informatics (SAHI) was also established in 2005 to promote scientific thinking in the field of health informatics in the KSA (Altuwaijri, 2008). One of the main initiatives undertaken by SAHI is the Saudi e-Health conference, which was established in 2006, since when it has been held at roughly 2- yearly intervals in the capital, Riyadh (Alkraiji et al., 2013; Altuwaijri, 2010). The conference is considered the largest e-health conference in the region, aiming to promote regional cooperation on e-health development.

Therefore, investigating barriers to EHR adoption and implementation in the KSA is a relevant and timely topic. It is crucial to understand such barriers so that possible interventions can be taken.

3.4 The Systematic Literature Review Methodology

The aim of this study is to identify reported barriers to widespread adoption EHRs in the KSA by analyzing current academic literature. A Systematic Literature Review (SLR) is a defined as methodological way of identifying, assessing and analyzing published primary research for investigating a specific research question. Systematic reviews differ from ordinary reviews in being formally planned and methodically executed. They are considered to be essential tools for summarizing evidence published in primary research, and may provide a greater level of validity in the findings than might be possible in any one of the included primary studies (Kitchenham and Charters, 2007).

Kitchenham and Charters (2007) identified three main steps for conducting systematic literature reviews: planning the review, conducting the review, and reporting on the results. The same approach was followed in this study, and the researcher followed the same steps applied by many systematic reviews (Boonstra and Broekhuis, 2010; Khan, Niazi and Ahmad, 2011; Kruse and Goetz, 2015), as follows: i) Locating research resources, ii) Study selection, iii) Data extraction and synthesis, and iv) Reporting the results.

3.4.1 Information Sources

Studies on barriers to the adoption of electronic health records may come from various distinct disciplines including medical and biomedical sciences, computer and information systems sciences, and social sciences; therefore, in order for this study to reflect all relevant studies and be up-to-date and comprehensive, six relevant search engines were selected ("PubMed", "EBSCO", "Web of Science", "ACM", "IEEE", and "Google Scholar") to be used for the search. Moreover, in order to increase the likelihood of identifying all studies conducted in the KSA, two general search terms, separated by the "OR" operator, were used: "Electronic Health Record" AND" Saudi Arabia" OR "Electronic Medical Record" AND "Saudi Arabia".

3.4.2 Study Selection Criteria

In order to make sure that information used as the basis for this study are reliable, accurate and pertinent, the following selection criteria were used to qualify articles for eligibility and inclusion:

1) Articles published in scientific journals – as such conference articles and unpublished work were excluded.
2) Articles focusing solely on EHR or EMR, and not other electronic systems used in healthcare (for example on IT systems, or Personal Health Records (PHRs)).
3) Articles assessing barriers to the implementation and/or adoption of EHR/EMR, and not other issues (such as software engineering issues).
4) Articles based on empirical studies, and
5) Articles where the country of data collection is the KSA.

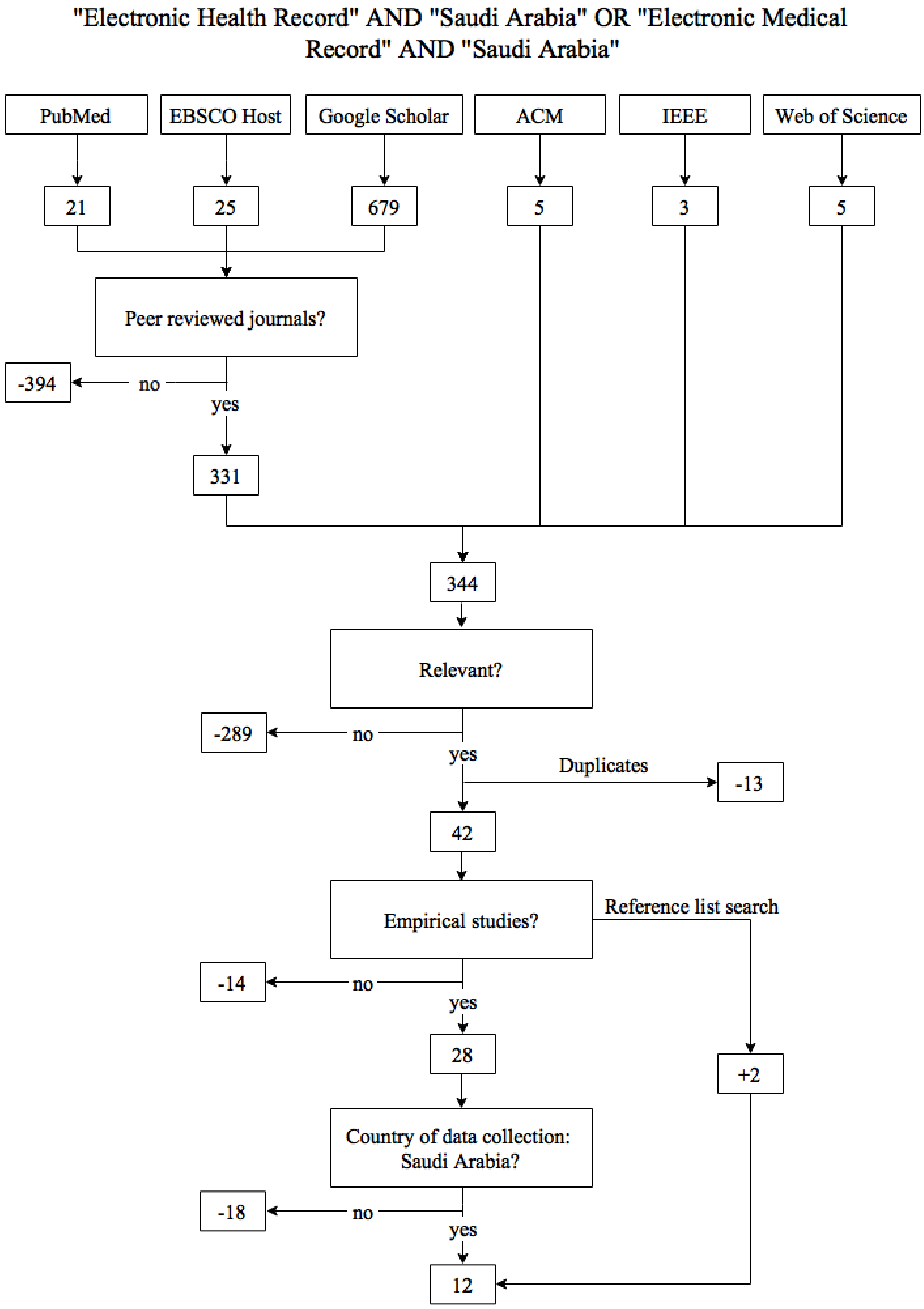


Figure 3-1 The literature review process and the associated inclusion criteria

3.4.3 Study Selection Process

The literature review process is shown in Figure 3.1. The database search identified a total of 738 potentially relevant articles. Google Scholar alone identified 679 articles, and all the other engines identified 59 articles. As a large number of articles identified by Google Scholar were not peer-reviewed journal articles, the researcher picked criteria (1) as the first filter for the results. This criterion was also applied to PubMed and EBSCO Host results, as a number of articles identified were not journal articles. This filter removed a total of 394 articles, of which 384 articles were from Google Scholar and 5 from each of PubMed and EBSCO Host. The second filter was to "assess articles for relevancy" by applying criteria (2) and (3). Title and abstract screening and full text assessment for relevancy were applied at this stage, articles not specifically focusing on EHR or EMR, and that are not related to barriers to the adoption of EHR/EMR were excluded. This filter removed a total of 289 articles, of which 254 were from Google Scholar, 14 from EBSCO Host, 11 from PubMed, 3 from IEEE, 4 from ACM, and 3 from Web of Science. The remaining articles were checked for duplications; 13 duplicates were found and thus excluded. Then, criteria (4) was applied as the third filter, resulting in the exclusion of 14 non-empirical articles. However, reference lists of these articles were searched for relevant articles, and two articles meeting all inclusion criteria were identified and included directly to the final dataset. Finally, criteria (5) was applied as the final filter, which excluded 18 articles where the country of data collection was not the KSA. Therefore, at the conclusion of the selection procedure, 12 articles met the inclusion criteria. It is worth mentioning that 7 articles were exclusively identified through Google Scholar, including the articles identified by the reference list search.

3.4.4 Data Extraction and Analysis

Studies reported in the selected papers that met the inclusion criteria were further analyzed and the following items were extracted from each study: research methodology (quantitative, qualitative, mixed, etc.), data collection methods (interview, case study, survey, etc.), sample size, sample type (e.g. administrators, physicians, nurses, IT teams, etc.), region of data collection, number of hospitals involved in the data collection process, and types of hospitals involved (governmental or private). Then, the empirical results regarding barriers to EHR adoption were extracted from each study. Finally, the barrier focus of each study was identified.

Meta analysis of the results was not attempted because of the dissimilarity in the sample types among the studies. However, the analysis approach employed by Kruse and Goetz (2015), and by Khan et al., (2011) was applied in this study. In this approach, barriers were analyzed according to the frequency of occurrence in the literature. This approach can produce reliable results in this study, as it can provide a clear picture of what barriers were identified empirically, by how many studies and how much frequent are these barriers among the results.

3.5 Results

Table 3-1 shows the analysis of the twelve studies. All studies used a quantitative research methodology. All of the twelve studies were conducted in three regions of the KSA: Makkah Province (4 studies) (Hasanain et al., 2015; Hasanain & Cooper, 2014; Shaker & Farooq, 2013; Shaker et al., 2015), Eastern Province (5 studies) (Alharthi et al., 2014; Bah et al., 2011; El Mahalli, 2015a, 2015b; Nour El Din, 2007), and Riyadh (3 studies) (Alasmary et al., 2014; Aldosari, 2014; Mohamed & El-Naif, 2005). This can be attributed to the fact that these are the three most advanced and populated regions in the KSA. All of the identified studies were published in recent years (2011 and after), except two (Mohamed and El-Naif, 2005; Nour El Din, 2007), which reflects a new research trend in the KSA after the recent e-health initiatives undertaken by MOH. Also, all of the studies were conducted in hospital settings, and no previous study was conducted in primary healthcare centres.

Different user types were involved in the data collection process in the included studies. Eight studies involved a single sample type such as physicians (Mohamed and El-Naif, 2005; Nour El Din, 2007; Shaker and Farooq, 2013; Alharthi *et al.*, 2014; El Mahalli, 2015b; Shaker, Farooq and Dhafar, 2015), nurses (El Mahalli, 2015a), and IT managers (Bah *et al.*, 2011). The remaining studies involved a mix of medical and/or administrative staff such as EHR project team and IT managers (Aldosari, 2014), physicians and nurses (Alasmary, El Metwally and Househ, 2014), and all medical and administrative staff (Hasanain and Cooper, 2014; Hasanain, Vallmuur and Clark, 2015).

Table 3-1 Details of the included studies and the associated barriers

Study reference	Type of research (Quantitative/ Quantitative)	Methods of data collection	Number of participants/ Sampling strategy	Sample Type	Region of Data collection/ Number of hospitals involved/ Type of hospitals ownership	Barriers to EHR*	Barrier focus of the study
(Bah *et al.*, 2011)	Quantitative	Questionnaire	19/ Judgmental sampling	IT Managers	Eastern Province/ 19 Hospitals/ Governmental	• Healthcare professionals resistance to use the system	Top barriers to successful implementation
(Aldosari, 2014)	Quantitative	Questionnaire	280/ Judgmental sampling	EHR project team and IT managers	Riyadh/ 22 Hospitals/ Governmental and private	• Hospital size – *Small and medium hospitals are less likely to adopt EHR systems* • Hospital's level of care – *Non-tertiary care organizations are less likely to be advanced in EHR implementation*	Hospital characteristics
(Shaker, Farooq and Dhafar, 2015)	Quantitative	Questionnaire	317/ Random sampling	Physicians	Makkah Province/ 6 Hospitals/ Governmental	• Lack of perceived ease of use – *EHR is not comfortable for data entry* • Lack of perceived usefulness – *EHR disturbs workflow*	Perceptions of EHR
(Shaker and Farooq, 2013)	Quantitative	Questionnaire	368/ Random sampling	Physicians	Makkah Province/ 6 hospitals/ Governmental	• Lack of computer experience	Computer skills
(El Mahalli, 2015a)	Quantitative	Questionnaire	185/ Convenience sampling	Nurses	Eastern Province/ 3 Hospitals/ Governmental	• Confidentiality concerns • Technical limitations– *unplanned downtime, system hanging up problems, slow system performance.* • Lack of perceived ease of use – *more time and workload for data entry, EHR is complex to use, lack of customizability* • Lack of perceived usefulness – *lack of perceived benefits of the system, EHR disturbs communication between the healthcare team* • Lack of user support	Barriers to EHR use
(Alharthi *et al.*, 2014)	Quantitative	Questionnaire	115/ Random Sample	Physicians	Eastern Province/ 1 Hospital/ Governmental	• Lack of perceived usefulness of the system – *benefits to quality of care are less than expected* • Technical limitations – *slow system performance* • Lack of information quality– *incomplete, out-dated patient information*	Barriers to satisfaction with EHR

Table 3-1 (Continued)

Study reference	Type of research (Quantitative/ Quantitative)	Methods of data collection	Number of participants/ Sampling strategy	Sample Type	Region of Data collection/ Number of hospitals involved/ Type of hospitals ownership	Barriers to EHR*	Barrier focus of the study
(Nour El Din, 2007)	Quantitative	Questionnaire	142/ Random Sample	Physicians	Eastern Province/ 1 Hospital/ Governmental	• Lack of computer experience • Lack of user support	Barriers to EHR use
(Alasmary, El Metwally and Househ, 2014)	Quantitative	Questionnaire	112/ Convenience sampling	Physicians and nurses	Riyadh/ 1 Hospital/ Governmental	• Lack of computer experience	Computer literacy and satisfaction with EHR
(Hasanain, Vallmuur and Clark, 2015)	Quantitative	Questionnaire	333/ Sampling strategy not provided	Medical and administrative staff	Makkah Province/ 7 Hospitals/ Governmental	• Lack of computer experience	Demographic data and users' preferences
(Hasanain and Cooper, 2014)	Quantitative	Questionnaire	84/ Sampling strategy not provided	Medical and administrative staff	Makkah Province/ 6 Hospitals/ Governmental and private	• Lack of computer experience in using EHR among healthcare professionals • Lack of perceived ease of use – EHR is complex to use • Technical limitations – *lack of backup plans* • User resistance to use the system • Confidentiality concerns • Uncertainty about EHR vendor • Lack of EHR standards	Barriers to EHR implementation
(El Mahalli, 2015b)	Quantitative	Questionnaire	319/ Convenience sampling	Physicians	Eastern Province/ 3 Hospitals/ Governmental	• Confidentiality concerns • Technical limitations – *unplanned downtime, frequent system hanging up problems, slow system performance.* • Lack of perceived ease of use – *more time for data entry, EHR is complex to use, lack of customizability, EHR is difficult to use during consultation with patients* • Lack of perceived usefulness – *lack of perceived benefits of EHR* • Lack of user support	Barriers to EHR use
(Mohamed and El-Naif, 2005)	Quantitative	Questionnaire	150/ Random sampling	Physicians	Riyadh/ 1 Hospital/ Governmental	• Lack of computer experience • Lack of perceived usefulness – *EHR decreases productivity* • Lack of perceived ease of use – *EHR adds a burden to physicians, EHR requires special training*	Computer experience and Perceptions of EHR

*Barriers are listed after categorization. Three terms were used to categorize the barriers: perceived usefulness, perceived ease of use, and technical limitations; each of these terms is followed by the original barrier term (instance) as mentioned in the original studies for reference. Barriers that could not be categorized under these categories were listed without categorization.

Barriers are listed in Table 3-1 after careful categorization, that is, barriers that are linked to the same problem were grouped under a common term. The categorization of barriers was based on the theoretical concepts defined by the Technology Acceptance Model (TAM) (Davis, 1986, 1989). TAM is a well-established theory in the IS domain and has proved its validity and applicability for a wide range of information technologies (Yarbrough and Smith, 2007). TAM defines two main factors that determine technology adoption: perceived usefulness and perceived ease of use. In the IS context, *perceived usefulness* is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). In the healthcare context, perceived usefulness of system not only focuses on personal productivity, but also incorporates increased efficiency, better workflow support, improved quality and safety and similar healthcare-specific measures of usefulness (Holden and Karsh, 2010; Steininger and Stiglbauer, 2015). Based on this definition, the term lack of perceived usefulness was used to refer to the following instances of barriers: lack of perceived benefits of the system (El Mahalli, 2015b, 2015a), benefits to quality of care are less than expected (Alharthi *et al.*, 2014), EHR decreases productivity (Mohamed and El-Naif, 2005), EHR disturbs communication between the healthcare team (El Mahalli, 2015a), and EHR disturbs workflow (Shaker, Farooq and Dhafar, 2015).

Another term adapted from TAM to categorize barriers was *perceived ease of use*. TAM defines perceived ease of use as "the degree to which a person believes that using a particular system will be free of effort" (Davis, 1989). In the healthcare context, perceived ease of use of a system refers to the ease of learning and mastering the system, ease of performing tasks with the system, minimal extra workload, and ease of using the system during patient consultation (Holden and Karsh, 2010; Gagnon *et al.*, 2014). Based on this definition, the term lack of perceived ease of use was used to refer to the following barriers: EHR is not comfortable for data entry (Shaker, Farooq and Dhafar, 2015), more time and workload for data entry (El Mahalli, 2015b, 2015a), EHR is complex to use (Hasanain and Cooper, 2014; El Mahalli, 2015b, 2015a), lack of customizability (El Mahalli, 2015b, 2015a), EHR is difficult to use during consultation with patients (El Mahalli, 2015b), EHR adds a burden to physicians (Mohamed and El-Naif, 2005), and EHR requires special training (Mohamed and El-Naif, 2005).

Although TAM provided a meaningful framework to categorize the barriers, there are still many barriers that could not be categorized under TAM constructs. This may be attributed to the complex contextual nature of healthcare information systems. The remaining barriers were reported in this study as reported in the original studies without categorization, except one category introduced by the researcher, which is *technical limitations*. This category was used to refer to technical limitations of the software system such as unplanned downtime (Hasanain and Cooper, 2014; El Mahalli, 2015b, 2015a), frequent system hanging up problems (El Mahalli, 2015b, 2015a), and slow system performance (Alharthi *et al.*, 2014; El Mahalli, 2015b, 2015a).

The analysis revealed a total of 12 barriers spread across the 12 studies, as shown in Table 3-2. These barriers are: lack of computer experience by healthcare professionals (Mohamed and El-Naif, 2005; Nour El Din, 2007; Shaker and Farooq, 2013; Alasmary, El Metwally and Househ, 2014; Hasanain and Cooper, 2014; Hasanain, Vallmuur and Clark, 2015), lack of perceived usefulness by healthcare professionals (Mohamed and El-Naif, 2005; Alharthi *et al.*, 2014; El Mahalli, 2015a, 2015b; Shaker, Farooq and Dhafar, 2015), lack of perceived ease of use by healthcare professionals (Mohamed and El-Naif, 2005; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b; Shaker, Farooq and Dhafar, 2015), technical limitations of the software system (Alharthi *et al.*, 2014; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b), lack of user support (Nour El Din, 2007; El Mahalli, 2015a, 2015b), confidentiality concerns (Hasanain and Cooper, 2014; El Mahalli, 2015b, 2015a), user resistance to change (Bah *et al.*, 2011; Hasanain and Cooper, 2014), lack of information quality (Alharthi *et al.*, 2014), lack of EHR standards (Hasanain and Cooper, 2014), uncertainty about EHR vendors (Hasanain and Cooper, 2014), hospital size (Aldosari, 2014), and hospital's level of care (Aldosari, 2014).

Table 3-2 Barriers to the adoption of EHR systems in the KSA and the number of occurrences

	Barriers	References	Frequency (n=33)	%
1	Lack of computer experience by healthcare professionals	(Mohamed and El-Naif, 2005; Nour El Din, 2007; Shaker and Farooq, 2013; Alasmary, El Metwally and Househ, 2014; Hasanain and Cooper, 2014; Hasanain, Vallmuur and Clark, 2015)	6	18%
2	Lack of perceived usefulness by healthcare professionals	(Mohamed and El-Naif, 2005; Alharthi *et al.*, 2014; El Mahalli, 2015a, 2015b; Shaker, Farooq and Dhafar, 2015)	5	15%
3	Lack of perceived ease of use by healthcare professionals	(Mohamed and El-Naif, 2005; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b; Shaker, Farooq and Dhafar, 2015)	5	15%
4	Technical limitations of the software system	(Alharthi *et al.*, 2014; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b)	4	12%
5	Lack of user support	(Nour El Din, 2007; El Mahalli, 2015a, 2015b)	3	9%
6	Confidentiality concerns	(Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b)	3	9%
7	User resistance to change	(Bah *et al.*, 2011; Hasanain and Cooper, 2014)	2	6%
8	Lack of quality in patients' information	(Alharthi *et al.*, 2014)	1	3%
9	Lack of EHR standards	(Hasanain and Cooper, 2014)	1	3%
10	Uncertainty about EHR vendors	(Hasanain and Cooper, 2014)	1	3%
11	Hospital size	(Aldosari, 2014)	1	3%
12	Hospital's level of care	(Aldosari, 2014)	1	3%

The twelve barriers are listed in Table 3-2 by the frequency of occurrences among the studies, with the most frequent listed first. The frequency rates of the 12 barriers are: the “Lack of computer experience by healthcare professionals” appeared in six of the twelve studies (50%), and constituted 6/33 of total occurrences of barriers in the literature (18%); “Lack of perceived usefulness by healthcare professionals” and “Lack of perceived ease of by healthcare professionals” each appeared in five of the twelve studies (42%) and constituted 5/33 of total occurrences of barriers (15%). “Technical limitations of the software system” appeared in 4 of the twelve studies (33%) and constituted 4/33 of total occurrences of barriers (12%); “Lack of user support” and “Confidentiality concerns” each appeared in three of the twelve studies (25%) and constituted 3/33 of total occurrences of barriers (9%); “User resistance to change” appeared in two of the twelve studies (17%) and constituted 2/33 of total occurrences of barriers (6%); Five barriers, namely: “Lack of information quality”, “Lack of EHR standards”, “Uncertainty about EHR vendors”, “Hospital size”, and “Hospital’s level of care” each appeared once in the twelve articles (8%), and once out of the 33 occurrences of barriers (3%).

3.6 Discussion

The literature has shown that many barriers hinder the implementation and adoption of EHR systems in the KSA. The study reported in the present chapter revealed that the most frequent barriers reported in the literature are: lack of computer experience, lack of perceived usefulness and ease of use by healthcare professionals and technical limitations of the system. These four barriers alone comprise 60% of the barriers reported in the literature.

Lack of familiarity of the medical staff with EHR was the most frequently mentioned barrier. This is consistent with the findings of many systematic reviews (Boonstra and Broekhuis, 2010; McGinn *et al.*, 2011; Gagnon *et al.*, 2012; Li *et al.*, 2013; Najaftorkaman *et al.*, 2015), which identified lack of healthcare professionals’ computer experience and familiarity with EHR systems among the top most frequently reported barriers hindering EHR acceptance and use. In the study conducted by Shaker and Farooq (2013), it was demonstrated that physicians have “substantial” needs for computer literacy improvement including “word processing software skills”, “medical database search skills”, and “Internet search skills”. Three studies reported that computer experience is significantly correlated with healthcare professionals’ preference to use EHR (Hasanain et al., 2015), healthcare professionals’ utilization of EHR (Nour El Din, 2007), and healthcare professionals’ satisfaction with EHR (Alasmary, El Metwally and Househ, 2014).

Lack of perceived usefulness by healthcare professionals was among the most frequently reported barriers. It is suggested that perceived usefulness is the most important factor in increasing the adoption of clinical IT by healthcare professionals (Gagnon et al., 2012; Holden & Karsh, 2010; Yarbrough & Smith, 2007). However, it was reported as a barrier rather than a facilitator by the studies identified. In the study conducted by Alharthi et al. (2014), 65% of physicians were dissatisfied with EHR, 85% reported that benefits to quality of care are less than expected and 61% wished to totally abandon the system and go back to paper records. Other two studies demonstrated that at least 60% of surveyed healthcare professionals reported low utilization of the system with lack of perceived usefulness in EHRs among the significant barriers (El Mahalli, 2015b, 2015a).

Lack of perceived ease of use is another important issue. The significant influence of perceived ease of use on e-health and EHR adoption by healthcare professionals was supported by many systematic reviews (Gagnon *et al.*, 2012; Li *et al.*, 2013; Najaftorkaman *et al.*, 2015). EHR provides an enormous range of functionalities; a typical EMR system contains hundreds of screens that require users to access them through the navigational scheme of the system using tabs, buttons, and hyperlinks. Learning the right paths takes time (Smelcer, Miller-Jacobs and Kantrovich, 2009). This complexity can result in healthcare professionals having to allocate time and effort if they are to master them, which they may see as a burden. It is also possible that lack of computer experience leads users to view EHRs as extremely complicated (Boonstra and Broekhuis, 2010). The most frequently reported instances of barriers in this category were: complexity of use (Hasanain and Cooper, 2014; El Mahalli, 2015b, 2015a), more time and workload for data entry (El Mahalli, 2015b, 2015a) and lack of customizability (El Mahalli, 2015b, 2015a).

Issues related to the technical limitations of the EHR were also highly frequently reported in the literature. This is in line with the findings of many systematic reviews (McGinn *et al.*, 2011; Gagnon *et al.*, 2012), which identified design and technical limitations among the most frequently cited barriers to e-health and EHR adoption by healthcare professionals. In this study, instances reported in this category were: slow system performance (Alharthi *et al.*, 2014; El Mahalli, 2015b, 2015a), unplanned downtime/ lack of backup plans (El Mahalli, 2015a, 2015b; Hasanain & Cooper, 2014), and frequent system hanging up problems (El Mahalli, 2015b, 2015a).

Overall, the barriers identified in Table 3-2 can be classified into two categories based on the target of interventions to increase the adoption of EHRs: *individual-level adoption barriers*, and *organization-level adoption barriers*. Individual-level adoption barriers are those associated with the individual healthcare professional's decision to accept and use an EHR system (i.e. user-level adoption barriers), while organization-level adoption barriers are those associated with the healthcare organization's motivation to adopt and implement an EHR system (i.e. healthcare organization's authority-level adoption barriers). This classification is based on Eccles et al.'s (2005) classification of levels at which interventions to improve quality of healthcare might be applied. Based on this classification, interventions to increase the adoption of EHRs can be designed at two levels: users or individual healthcare professionals, and healthcare organizations. In Table 3-2, factors hindering individual healthcare professional decision to accept and use an EHR system are: lack of computer experience, lack of perceived usefulness of EHR, lack of perceived ease of use of EHR, technical limitations of the software system, lack of user support, confidentiality concerns, and lack of quality in patient information. Factors hindering healthcare organization's authority decision to purchase, implement, and move to higher levels of EHR implementation are: user resistance to change, lack of EHR standards, uncertainty about EHR vendors, confidentiality concerns, hospital size, and hospital level of care. The barriers classified as individual-level adoption barriers could provide answers to what affects *user's resistance to change* in KSA's healthcare organizations, which is a barrier classified as an organization-level adoption barrier.

3.7 Research Gaps

The study reported in the present chapter updated and summarized the existing knowledge regarding EHR adoption barriers in the KSA using a systematic review. This study revealed several important and major gaps in the literature pertaining EHR adoption in the KSA. First, although the researcher did a comprehensive search, only a limited set of studies (n=12) was identified. In addition, all of the identified studies lack an IT theory perspective and there is no framework for EHR adoption factors by any of the identified studies. Most importantly, there has been no previous study investigating primary healthcare providers' adoption of EHR, and research in this area is nearly absent in the literature.

3.8 Conclusion

Due to the recent MOH's National e-Health initiative, updating the state of knowledge regarding EHR adoption barriers is of critical importance to policy makers, health informatics professionals, academics, clinicians, and EHR vendors. The study reported in this chapter has identified these barriers using a systematic literature review.

As this review summarizes the existing evidence with regard to EHR adoption barriers in the KSA, the findings of this review will assist in developing the proposed framework of key EHR adoption factors by primary healthcare physicians in the KSA (Chapter 5).

Chapter 4 Review of Theories of User Adoption of IT and Prior Studies Employing Theoretical Models to Investigate Physician Adoption of EHR

4.1 Introduction

The previous chapter reviewed the literature of barriers to the adoption of EHR systems in the KSA. A major gap in the literature identified in the previous chapter was that no previous study employed a theoretical framework.

Employing a theoretical perspective helps developing a complex and comprehensive understanding of issues that cannot be observed directly. “Theories give the researcher with lenses through which to look at complicated problems and social issues” (Reeves *et al.*, 2008). The use of theory in research allows the researcher to understand, and to interpret to policy makers and practitioners the processes that cannot be observed directly and to develop knowledge of the underlying (generating) principles (Reeves *et al.*, 2008). In addition, using a theory in research helps guiding the analysis of data, and improves the robustness, rigour and relevance and impact of the findings (Stewart and Klein, 2016; Scott, De Keizer and Georgiou, 2019). The findings generated from a theory-driven research can fit into the larger framework of other studies, and thereby, theory-driven research helps arriving at a better understanding of the phenomena in different contexts (Stewart and Klein, 2016; Scott, De Keizer and Georgiou, 2019).

The purpose of the present chapter is to provide a review of the theories of user adoption of IT, and to review prior studies in that employed a theoretical model to investigate physician adoption of EHR. At the end of the chapter, the research gaps are presented and discussed.

4.2 Theories of User Adoption of IT

Researchers have often addressed the issue of why end-users who would benefit from interactive information systems do not use them (Al-Gahtani, 2008). Understanding what motivates individuals’ adoption of Information Systems (IS) is of critical importance for organizations and IS vendors, as such knowledge helps designing systems and tailoring implementation strategies toward factors that motivate adoption (Seeman and Gibson, 2009).

A variety of theoretical models attempted to facilitate explaining and predicting users' acceptance and use of a new information technology. The most widely used theories are (Holden and Karsh, 2010): the Theory of Reasoned Action (TRA) (Fishbein and Azjen, 1975), the Theory of Planned Behavior (TPB) (Ajzen, 1991), the Technology Acceptance Model (TAM) (Davis, 1986), and the Unified Theory of Acceptance and Use of technology (UTAUT) (Venkatesh *et al.*, 2003). The following subsections discuss each theory in detail, including its strengths and weaknesses as relevant to this research.

4.2.1 The Theory of Reasoned Action (TRA)

Originated in social psychology, the Theory of Reasoned Action (TRA) (Fishbein and Azjen, 1975) is one of the most fundamental theories in human behaviour. The TRA posits that any behaviour of an individual is determined by the behavioural intention. Stronger behavioural intention increases the likelihood of performing the behaviour. According to TRA, behavioural intention is determined by two independent factors: attitude toward the behaviour and subjective norms. Attitude toward behaviour is defined as an individual's positive or negative feelings about performing the behavior in question. A more positive attitude toward the behaviour increases the level of intention to perform that behaviour. Subjective norm is defined as an individual's perception that most people who are important to him/her think he or she should perform the behaviour in question. A higher perceived subjective norm increases the level of intention to perform the behaviour. The model of TRA is shown in Figure 4-1

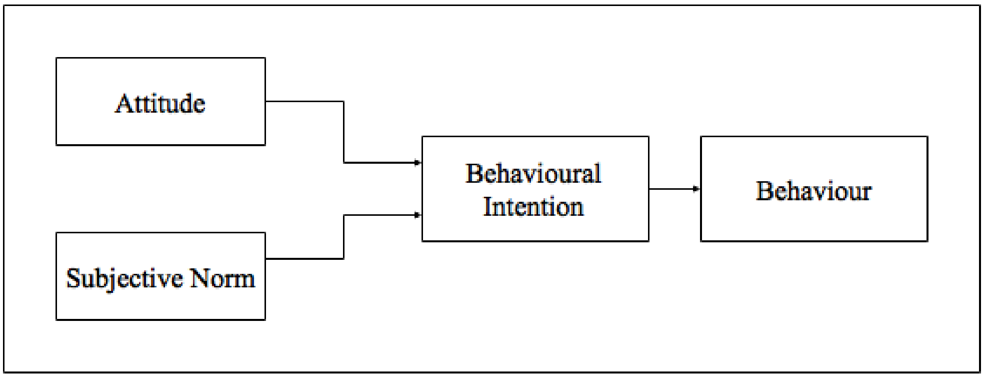


Figure 4-1 The Theory of Reasoned Action, adapted from Fishbein and Azjen (1975), showing that the bahaviour is determined by behavioural intention, which in turn is determined by attitude and subjective norm.

Although TRA has been evaluated and supported in a wide range of studies (Sheppard, Hartwick and Warshaw, 1988), it has been criticized because it assumes that behaviour is totally under volitional control (Ajzen, 1991; Ajzen & Madden, 1986). As some specific behaviours or actions may require specific resources, skills, or opportunities for an individual in order to perform them, attitude and subjective norm are not enough for predicting behaviour (Gagnon et al., 2010).

4.2.2 The Theory of Planned Behaviour (TPB)

To address the limitation of TRA, Ajzen (1985) developed the Theory of Planned Behaviour (TPB) by extending TRA with a new construct, namely, *perceived behavioural control*. Perceived behavioural control was defined as the perceived ease or difficulty of performing the behavior in question. TPB posits that perceived behavioural control determines both intention and behaviour as shown in Figure 4-2. The inclusion of perceived behavioural control in TPB demonstrates the importance of one's perceptions about his or her capabilities and resources available for performing the target behaviour. That is, an individual with insufficient capabilities or resources might have less intention to perform the behaviour and might not perform the behaviour even if he or she holds a positive attitude toward the behaviour and perceives support from important others (Ajzen, 1991; Ajzen & Madden, 1986).

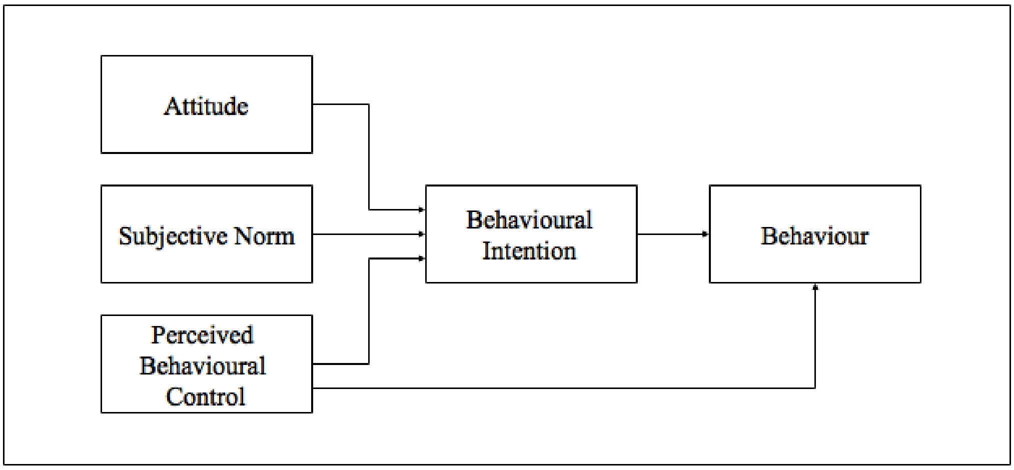


Figure 4-2. The Theory of Planned Behaviour, adapted from (Ajzen, 1991), which extended the TRA by adding perceived behavioural control as a determinant of both behaviour and behavioural intention.

The TPB has been widely applied to understand behaviour and behaviour intention in different settings (Ajzen, 1991). However, both TPB and TRA have been criticized for the general belief measurements, which need to be adjusted according to behavioural contexts (Davis, Bagozzi and Warshaw, 1989; Mathieson, 1991). Further, TPB and TRA do not include constructs specific to the behaviour of technology acceptance and use, which was regarded as a critical shortcoming of the model in information systems context (Davis, Bagozzi and Warshaw, 1989; Mathieson, 1991).

4.2.3 The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) (Davis, 1986) was designed specifically for the IS context and was developed to predict user's acceptance and use of technology on the job. The TAM was adapted from TRA, and similarly, it predicts technology adoption based on intention. However, it assumes that intention is determined by attitude, which is determined by two technology-related beliefs: *perceived usefulness* and *perceived ease of use* (Figure 4-3). Perceived usefulness was defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Perceived ease of use was defined as "the degree to which a person believes that using a particular system will be free of effort" (Davis, 1989). TAM also assumes that perceived ease of use has a casual direct effect on perceived usefulness. Based on subsequent research and empirical evidence, the final model of TAM (Davis, 1989) excludes attitude because it did not fully mediate the effect of PU on intention. In summary, TAM assumes that a user has a greater intention to use a technology when he or she perceives a higher ease of use and usefulness.

The TAM became the most widely used model to study the adoption of various technologies and has arguably become the most influential theory in the information systems field. It has proven to be effective in predicting variance in technology acceptance in a wide variety of contexts for different types of users (Yarbrough and Smith, 2007). The determinants in the TAM are easy to understand for system developers and can be considered during system requirement analysis and other system development stages to solve the acceptance problem (Taylor and Todd, 1995).

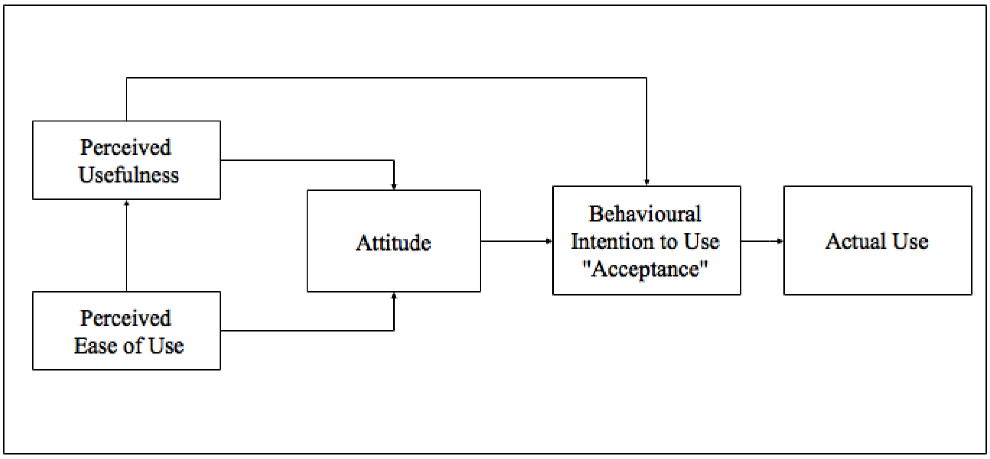


Figure 4-3. The Technology Acceptance Model (TAM), adapted from (Davis et al., 1989), showing that technology acceptance is determined by attitude toward technology and perceived usefulness, and that attitude toward technology is determined by perceived usefulness and perceived ease of use.

However, TAM does not consider the social environment in which the technology is introduced (Gagnon et al., 2010). Existent research indicates that while the TAM has the capacity to generally predict variance in technology acceptance, context-specific variables must be added to the model to increase its explanatory power (Yarbrough and Smith, 2007). Consequently, various efforts have been made to extend the TAM by either introducing variables from other theoretical models or by examining antecedents and moderators of perceived ease of use and perceived usefulness (Moore and Benbasat, 1991; Venkatesh, 2000; Gagnon *et al.*, 2014).

4.2.4 The Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.*, 2003) was developed based on the combination of constructs of eight theories including TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), TAM (Davis, 1989; Davis et al., 1989), Decomposed Theory of Planned Behaviour (DTPB) (Taylor and Todd, 1995), Innovation Diffusion Theory (IDT) (Moore and Benbasat, 1991; Rogers Everett, 1995), Motivation Model (MM) (Davis, Bagozzi, & Warshaw, 1992), Model of PC-Utilization (MPCU) (Triandis, 1977; Thompson, Higgins and Howell, 1991), and Social Cognitive Theory (SCT) (Bandura, 1986; Compeau and Higgins, 1995a).

The UTAUT hypothesizes that three constructs, namely: *performance expectancy*, *effort expectancy*, and *social influence* can explain IT usage intention. Further, a fourth construct called *facilitating conditions* along with usage intention can explain actual usage of IT, as shown in Figure 4-4. Performance expectancy is “the degree to which the user expects that using the system will help him or her attain gains in job performance” (Venkatesh *et al.*, 2003). Effort expectancy is “the degree of ease associated with the use of the system” (Venkatesh *et al.*, 2003). Social influence is “the degree to which an individual perceives that important others believe that he or she should use the new system” (Venkatesh *et al.*, 2003). Facilitating conditions is “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” (Venkatesh *et al.*, 2003). In addition, UTAUT posits the role of four key moderator variables: gender, age, experience, and voluntariness of use in explaining usage intention.

According Venkatesh et al., (2003), UTAUT was able to explain 70% of variance in IT usage intention, whereas the original eight models explained only 40% of variance. However, although UTAUT successfully integrates all constructs from eight important models, it was tested in the original study against these models in industrial and economic areas, such as product development, sales, banking and accounting (Venkatesh *et al.*, 2003). When applied to the healthcare context in their later study (Venkatesh, Sykes and Zhang, 2011), the model only explained 21% of variance in usage intention. However, a modified UTAUT was effective and was able to explain 44% of variance in usage intention (Venkatesh, Sykes and Zhang, 2011).

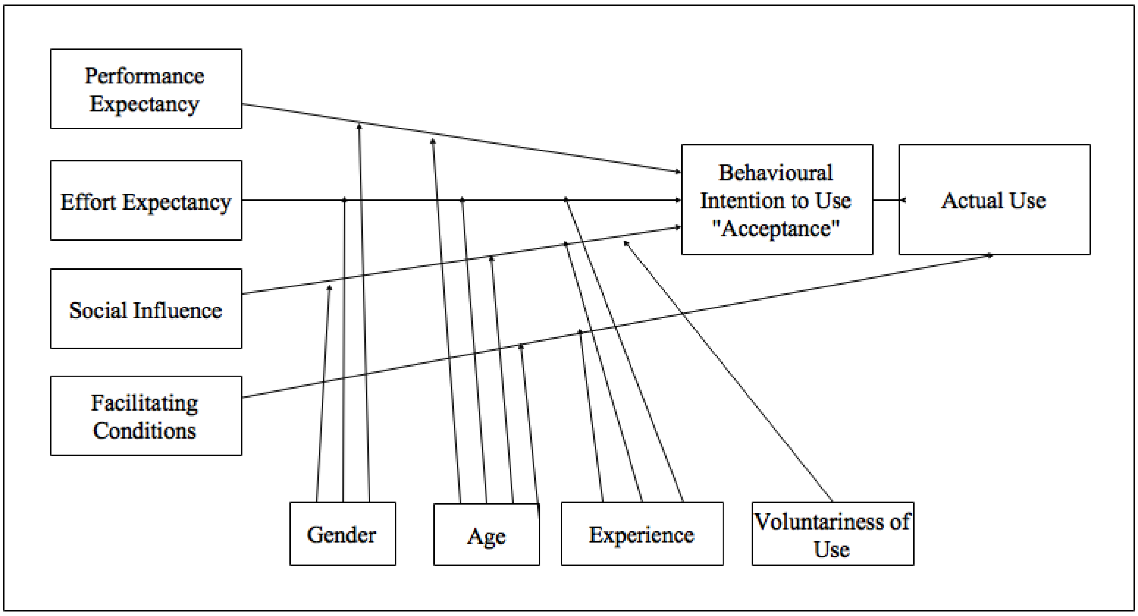


Figure 4-4. The Unified Theory of Acceptance and use of Technology (UTAUT), adapted from (Venkatesh et al., 2003), showing that technology acceptance is determined by three factors: performance expectancy, effort expectancy, and social influence. While actual technology use is determined by both technology acceptance and facilitating conditions.

4.2.5 Summary of Theories of User Adoption of IT

The aforementioned theories are summarized in Table 4-1. It can be seen that five main (independent) factors affecting behavior and behavior intention spread across the theories:

(1) *Attitude toward IT use*, which is hypothesized by TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), and TAM (Davis, 1986).

(2) Perceived benefits of the system, such as *perceived usefulness* hypothesized by TAM (Davis, 1986) and *performance expectancy* hypothesized by UTAUT (Venkatesh *et al.*, 2003).

(3) Perceived usability of the system, such as *perceived ease of use* hypothesized by TAM (Davis, 1986) *and effort expectancy* hypothesized by UTAUT (Venkatesh *et al.*, 2003).

(4) Social factors such *as subjective norms* hypothesized by TRA (Fishbein and Azjen, 1975) and TPB (Ajzen, 1991), and *social Influence* hypothesized by UTAUT (Venkatesh *et al.*, 2003).

(5) Controllability factors, such as *perceived behavioral control* hypothesized by TPB (Ajzen, 1991), and *facilitating conditions* hypothesized by UTAUT (Venkatesh *et al.*, 2003).

Table 4-1. Summary of theories of user acceptance and use of technology

Theory	Main Dependent Factor	Main Independent Factors	Originating Domain
Theory of Reasoned Action (TRA) (Fishbein and Azjen, 1975)	Behavioural Intention Behaviour	Attitude Subjective Norm	Social psychology
Theory of Planned Behaviour (TPB) (Ajzen, 1991)	Behavioural Intention Behaviour	Attitude Subjective Norm Perceived Behavioural Control	Social psychology
Technology Acceptance Model (TAM) (Davis, 1986)	IT Usage Intention (acceptance) IT Usage	Attitude Perceived Ease of Use Perceived Usefulness	Information systems
Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.*, 2003)	IT Usage Intention (acceptance) IT Usage	Performance Expectancy Effort Expectancy Social Influence Facilitating Conditions	Information systems

4.3 Weakness of Technology Adoption Theories in Healthcare Context

Despite the usefulness of employing IT adoption theories to predict and understand user adoption of IT, their application in the healthcare context has yielded limited explanatory power (Yarbrough and Smith, 2007; Venkatesh, Sykes and Zhang, 2011; Ammenwerth, 2019) and discrepancies in the findings (Yarbrough and Smith, 2007; Holden and Karsh, 2010; Ammenwerth, 2019). According to Venkatesh et al. (2011), the specific context in which the theory is applied is as an important boundary condition for the generalizability of these theories. IT adoption theories were developed outside the healthcare context, tested on simple rather than complex systems (Davis, 1989; Taylor and Todd, 1995; Venkatesh *et al.*, 2003; Ammenwerth, 2019), and have received a considerable support from studies in which the subjects have been students or knowledge workers from industrial or economic settings (Venkatesh *et al.*, 2003; Schepers and Wetzels, 2007). Ammenwerth (2019) points to the fact that the technologies upon which the technology adoption theories were developed (e.g. email and word processing for TAM (Davis, 1989), online meeting manager, database application and an accounting system for UTAUT (Venkatesh *et al.*, 2003)) are different from the much more complex healthcare information systems. Healthcare information systems, such as EHR, CPOE or nursing documentation, represent socio-technical systems, where the adoption of the system depends not only on the systems' utility or usability, but on many other factors such as workflow integration, emotional aspects, and user support and training, which are not covered well in the original technology adoption theories. This may provide an explanation to why the application of the original technology adoption theories to the healthcare context provided mixed results and limited predictive capabilities (Ammenwerth, 2019). Furthermore, it has been suggested that physicians differ from the other types of IT users investigated in the literature with regard to IT acceptance (Hu et al. 1999; Hu et al. 1999; Walter & Lopez 2008). According to Walter and Lopez (2008), physicians tend to be relatively independent when making decisions about IT acceptance. Explanations for their independence include specialized training, autonomous practices, and professional work arrangements. Recommended improvements to IT adoption theories to increase their explanatory power in the healthcare context include: extending them with context-specific factors (Yarbrough and Smith, 2007; Holden and Karsh, 2010), integrating multiple theories (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014), and using a qualitative approach to explain the dimensions of their core concepts in the healthcare context (Holden and Karsh, 2010). The following section reviews prior studies that employed IT adoption theories to predict physician adoption of EHR.

4.4 Prior Studies Employing Theoretical Models to Investigate Physician Adoption of EHR

In order to identify prior studies employing IT adoption theories to explain physician adoption of EHR, three search engines were searched: Web of Science, PubMed, and Google Scholar, using the following search query: (Physician AND (Adoption OR Acceptance OR Use) AND (“Electronic Health Record” OR “Electronic Medical Record”)). Titles, abstracts and reference lists of the retrieved studies were screened for relevance. A study is selected for inclusion if:

(1) The study investigated the adoption of EHR or EMR
(2) The study is published in a scientific journal,
(3) The study is empirical,
(4) The sample employed in the study was composed of physicians only (i.e. not the other user groups), and
(5) The study employed or developed a theoretical model to explain physicians’ adoption of EHR.

As a result, only ten studies were identified (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015). Table 4-2 provides a summary of these studies as well as key determinants of EHR adoption identified by these studies.

Table 4-2 Key determinants of EHR adoption identified by prior studies that employed a theoretical model to understand physician adoption of EHR

Study	Country	Settings/ Subjects/ Analysed responses	Theory	Key Determinants of EHR Adoption	% of Variance Explained
(Walter and Lopez, 2008)	USA	No specific settings*/ Physicians/ 203	Extended TAM	• **Perceived usefulness** • **Perceived threat to physician autonomy**	Not provided
(Morton and Wiedenbeck, 2009)	USA	A large university hospital/ Physicians/ 239	Extended TAM	• **Perceived usefulness** • **Physician involvement**	73%
(Seeman and Gibson, 2009)	USA	A large university hospital and a large private hospital/ Physicians/ 102	Combined TAM+TPB	• **Attitude** • **Perceived behavioural control** • **Social influence**	71%
(Venkatesh, Sykes and Zhang, 2011)	USA	A large private hospital/ Physicians/ 141	UTAUT	• **Performance expectancy** • **Effort expectancy** • **Social influence** • **Age (moderator)**	44%
(Gagnon *et al.*, 2014)	Canada	No specific settings*/ Physicians/ 150	Combined TAM+TIB	• **Perceived ease of use** • **Demonstrability of results** • **Social norm** • **Professional norm**	55%
(Gagnon *et al.*, 2016)	Canada	Primary care practices/ Physicians/ 278	Combined TAM+TIB	• **Professional Norms** • **Perceived ease of use** • **Computer Self-efficacy**	64%
(Archer and Cocosila, 2011)	Canada	No specific settings*/ Physicians/ 102 users + 83 non-users	Extended UTAUT	• **Performance expectancy (users, non-users)** • **Effort expectancy (non users)** • **Perceived risk (users)**	55% (users) 66.8% (non-users)
(Steininger and Stiglbauer, 2015)	Austria	Private practices including primary care and specialists/ Physicians/ 204	Extended TAM	• **Perceived usefulness** • **Attitude** • **Confidentiality concerns**	69%
(Abdekhoda *et al.*, 2015)	Iran	University hospitals/ Physicians/ 237	Extended TAM	• **Perceived usefulness** • **Perceived ease of use** • **Management support**	56%
(Esmaeilzadeh and Sambasivan, 2012)	Malaysia	12 Hospitals/ Physicians/ 300	Extended TAM	• **Perceived usefulness** • **Perceived ease of use** • **Perceived threat to professional autonomy** • **Management support**	51%

* Survey administration was outsourced to a national or regional party (e.g. medical association, commercial firm) having a panel of pre-registered physicians. No particular setting (i.e. primary, secondary or tertiary care) was determined by the study.

Walter and Lopez (2008) suggested that phyisicians differ from other user groups in terms of technology acceptance due to their high professional autonomy. They extended TAM with Percpieved Threat to Professional Aunomoty (PTPA) and examined the model using reponses from 203 physicians in the USA. The findings of their analysis showed that percieved usefulness was the strongest predcitor of physicinas' intentions to use EHR, but these perceptions were strongly negatively influenced by perceptions of threat to professioanl autonomy. PTPA was found to be among the strongest determinants of EHR usage intentions in subsequent studies (Archer and Cocosila, 2011; Esmaeilzadeh and Sambasivan, 2012), but other studies found only a small effect of this factor (Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015).

Morton and Wiedenbeck (2009) extended TAM with PTPA, management support, training, physician participation, and doctor-patient relationship, to study physicians' attitudes toward EHR prior to system implementation. The study was conducted in a large teaching medical centre in the USA. Their analysis of 239 responses revealed that perceived usefulness and physician participation were the strongest determinants of physicians' attitudes toward using EHR. The significant effect of perceived ease of use on attitude was not supported in this study. In addition, the significance of training was not supported in the model. Although PTPA had a statistically significant effect on attitude, it was only a small effect. None of the physicians' characteristics (age, years in practice, clinical specialty, and prior computer experience) were significantly correlated with any of the factors (Morton & Wiedenbeck, 2009). The model explained 73% of variance in physicians' attitudes toward EHR. However, this model did not assess physicians' intentions to use EHR.

Seeman and Gibson (2009) conducted a study to compare the explanatory power of TAM and TPB in explaining physicians' acceptance of EHR in the USA. A total of 102 physicians participated in the study through a convenience sampling approach. The results of their analysis showed that TPB provided a greater explanatory power (66%) than TAM (56%). However, a third model combining the factors of both TAM and TPB provided the greatest explanatory power (71%). Attitude toward EHR, perceived behavioural control and social influence were the strongest determinants of physicians' intentions to use EHR in this study.

In an effort to examine UTAUT's effectiveness in explaining physicians' adoption of EHR, Venkatesh et al. (2011), conducted a study at a private hospital in the USA at the time of system's implementation. Survey data and system's logs of 141 physicians were used for the analysis. The results showed that the original UTAUT explained only 21% of variance in EHR usage intention. However, a modified UTAUT that excludes gender, voluntariness of use, and experience explained 44% and 47% of variance in usage intention and use, respectively. The significance of facilitating conditions was not supported in this study, and performance expectancy and social influence were more important than effort expectancy in predicting EHR usage behaviour. The authors of this study suggest that high professional values and beliefs that are imparted as part of doctors' professional training, commitment to the profession and professional associations eliminate the moderating effect of the gender in the model. Further, this study suggests that voluntariness of use is not applicable to physicians due to their high professional autonomy. Finally, the authors recommended Integrating UTAUT with other theoretical perspectives in order to enrich its applicability for the context of physicians' adoption of EHR.

Gagnon et al. (2014) developed an integrated theoretical model that combines TAM, the Theory of Interpersonal Behavior (TIB) (Triandis, 1977) adapted from the psychosocial domain, and other factors to understand Canadian physicians' acceptance of EHR. This integrated model included nine factors: perceived ease of use, perceived usefulness, personal identity, social norm, professional norm, computer self-efficacy, demonstrability of the results, information about change, and resistance to change. The authors surveyed physicians in the Province of Quebec in Canada and received a total of 150 responses. The results of their analysis showed that perceived ease of use, followed by social norms, professional norms and demonstrability of results were the most important predictors of physicians' intentions to use EHR in Canada, whereas all other factors had no significant direct influence on EHR usage intention based on the integrated model. The integrated model provided the best explanatory power (55%) as opposed to TAM (44%), extended TAM (44%) and TIB (53%). The findings of this study support the findings of Seeman and Gibson (2009) in that using an integrated theoretical model performs better in explaining physicians' adoption of EHR.

In their recent study, Gagnon et al. (2016) used the same nine constructs examined in their previous study (Gagnon *et al.*, 2014) to investigate the adoption of EHR by primary healthcare physicians in the Province of Quebec in Canada. The results of their analysis showed that professional norm, perceived ease of use and computer self-efficacy were the strongest predictors of EHR usage intentions, while the significance of results demonstrability, information about change and resistance to change was not supported in this study. This model explained 64% of variance in EHR usage intentions by primary healthcare physicians in Canada.

Archer and Cocosila (2011), compared the perceptions of physicians who already adopted and used EHRs with those not yet using them using an extended UTAUT. The hypothesized model had three direct determinants of EHR usage intention: performance expectancy, effort expectancy, and perceived risk (a concept similar to perceived threat to professional autonomy in (Walter and Lopez, 2008)). The authors surveyed a large-scale convenience sample of physicians in Canada and received responses from 102 users and 83 non-users. The results of their analysis suggest that EHR users and non-users have different perceptions regarding EHR usage intentions. For the non-users group, performance expectancy and effort expectancy were the strongest predictors of EHR usage intention, while perceived risk was not supported in the model. For the EHR users group, performance expectancy was the strongest predictor of continuous usage intention, while perceived risk was a significant de-motivator. The model explained 55.8% of variance on continuous usage intention for EHR users and 66.8% of usage intention for non-users.

Steininger and Stiglbauer (2015) extended TAM with three constructs, namely: health IT experience, social influence, and privacy concerns, to understand physicians' acceptance of EHR in Austria prior to system implementation. They surveyed a nationwide random sample of physicians in private practices and received responses of 204 physicians. The results of their analysis showed that perceived usefulness, attitude toward EHR and confidentiality concerns were the strongest predictors in the model. This model explained 69% of variance in usage intention by Austrian physicians.

In a non-western context, Abdekhoda et al. (2015) extended TAM with the same external factors examined by Morton ad Wiedenbeck (2009), to investigate factors influencing Iranian physicians' adoption of EHR. They surveyed a random sample of physicians from a number of teaching hospitals and received responses from 237 physicians. The results of their analysis showed that perceived usefulness, perceived ease of use, and management support were the strongest predictors of physicians' adoption of EHR. In addition, the findings of this study indicate that training has no significant effect in the model, and that PTPA had only a small effect in the model, which is consistent with the findings of (Morton and Wiedenbeck, 2009). The model examined in this study explained 56% of variance in EHR adoption decisions by Iranian physicians.

Esmaeilzadeh and Sambasivan (2012) extended TAM with three variables: perceived threat to physician autonomy, management support, and affective commitment, to understand Malaysian physicians' acceptance of clinical IT, including EHR and Clinical Decision Support System (CDSS). Affective commitment is defined as "having tendency to remain in the organization" (Esmaeilzadeh & Sambasivan 2012). The authors surveyed physicians in 12 hospitals in Malaysia, and received a total of 300 responses. The results of their analysis indicated that perceived ease of use, perceived usefulness, and perceived threat to professional autonomy were significant determinants of clinical IT usage intention among Malaysian physicians. Management support was stronger than affective commitment in mitigating the negative effect of perceived threat to physician autonomy. This model explained 51% of variance in clinical IT usage intention.

In summary, most of the previous studies employed TAM, however, in order to increase its explanatory power, they either extended it (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015), or integrated it with other theoretical models (Gagnon *et al.*, 2014, 2016). The findings of Venkatesh et al. (2011) and Gagnon et al. (2014) suggest that the original technology adoption theories (i.e. without adding external factors or integrating multiple theoretical perspectives) provide a limited explanatory power in the context of physician adoption of EHR. Seeman and Gibson (2009) showed that integrating TAM and TPB provides a greater explanatory power than using either TAM or TPB alone. The usefulness of integrating multiple theoretical perspectives have been also demonstrated by (Gagnon et al. 2014), who suggested that an integrated theoretical model provides a better explanatory power than does a single theory or an extended one.

4.5 Other Research Gaps

The findings of the systematic review study performed in Chapter 3 revealed major gaps in the literature pertaining EHR adoption in the KSA. Among the major gaps identified were that there has been no previous study employing a theoretical model to investigate the adoption of EHR in the KSA, there is no framework of critical EHR adoption factors, and no previous study investigated the adoption of EHR in primary healthcare. However, the review conducted in the present chapter revealed other major gaps in the literature. First, the examination of the literature conducted in the present chapter revealed that there exist only few studies employing a theoretical model to investigate physician adoption of EHR. This is consistent with the findings of many systematic reviews (Yarbrough and Smith, 2007; Holden and Karsh, 2010; Li *et al.*, 2013; Garavand *et al.*, 2016). In addition, most of these studies were performed in developed countries (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016; Steininger and Stiglbauer, 2015), and focused on large healthcare organizations, or were general in scope involving physicians from all healthcare levels (i.e. primary, secondary, and tertiary healthcare levels) (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014; Steininger and Stiglbauer, 2015). Hence, studies conducted in primary healthcare or in developing countries are limited. The review of the literature also revealed that there exists no previous study employing a theoretical model to understand physician adoption of EHR not only in the KSA, but also in all of the Arabian countries, therefore, evidence-based knowledge and guidelines for policy makers in these countries are scarce.

Furthermore, discrepancies exist in the findings of previous studies (Section 4.4), which is a problem that has been highlighted in many studies and systematic reviews concerning the application of theories of user acceptance and use of IT to the healthcare context (Yarbrough and Smith, 2007; Holden and Karsh, 2010; Ammenwerth, 2019). For example, while perceived ease of use was the most important predictor of EHR usage intention in some studies (Gagnon *et al.*, 2014, 2016), other studies suggest no effect of PEOU on attitude or EHR usage intention (Morton and Wiedenbeck, 2009), or that perceived usefulness is more important than perceived ease of use in the context of physician adoption of EHR (Walter and Lopez, 2008; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015). Perceived threat to physician autonomy was among the most important determinants of EHR usage intention in some studies (Walter and Lopez, 2008; Esmaeilzadeh and Sambasivan, 2012), but other studies reported only a small effect (Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015). This discrepancy in the findings indicates that more studies are needed in order to identify potential moderators of the effect of these factors in different contexts and to enrich the body of knowledge about key EHR adoption factors.

Finally, the limited explanatory power of the original technology adoption theories when applied to the healthcare context has been attributed to the general belief measurements of these theories, which may not be fitting well with the healthcare context (Holden and Karsh, 2010). Holden and Karsh (2010) reviewed studies that applied IT adoption theories to the healthcare context and concluded that measures used in prior research are mostly generic measures adapted from the general IT adoption literature. This resulted in an inconsistency in the predictive power of factors of IT adoption theories in the healthcare context. Theories of IT adoption were developed outside the healthcare context, and therefore some of their core measures may not adequately capture users' beliefs and perceptions. For example, measures of perceived usefulness in TAM focus mainly on personal productivity, which may not be meaningful or sufficient in the healthcare settings. Other measures such as improved quality of care and reduced medical errors should be incorporated. Also, perceived ease of use in TAM focuses mainly on complexity of using and understanding the system, which may not be sufficient in healthcare context. Other measures such as time constraint/increased workload and patient-healthcare professional communication should be incorporated (Holden and Karsh, 2010). Consequently, Holden and Karsh (2010) strongly advocated for qualitative studies that provide more understanding of the dimensions or meanings of these factors in the healthcare context. Therefore, there is a need for qualitative studies that define the meanings or dimensions of factors originated in IT adoption theories in the context of physician adoption of EHR. Such studies will help developing more contextualised theories in the unique context of healthcare IT (Holden and Karsh, 2010). To the best of the researcher's knowledge, there has been no previous qualitative study employing IT adoption theories to investigate healthcare professionals' adoption of EHR.

4.6 Summary and Conclusion

This chapter has reviewed theories of user adoption of information technology and analyzed prior studies that employed theoretical models to investigate physician adoption of EHR. Based on the findings that the original technology adoption theories are insufficient in explaining EHR adoption among physicians (Yarbrough and Smith, 2007; Holden and Karsh, 2010; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014), and that an integrated theoretical approach provides a better explanatory power than does a single theory or an extended one (Seeman and Gibson, 2009;

Gagnon *et al.*, 2014), an integrated theoretical approach was seen to be appropriate for the purpose of this research as to be discussed in the following chapter. In addition, the review of prior studies that employed theoretical models revealed other factors that might be important in the specific context of EHR adoption by physicians. Therefore, key findings of prior theoretical models of physician adoption of EHR will also be used to inform the development of the proposed framework in the next chapter. The framework development methodology and the proposed framework are discussed in the following chapter.

Chapter 5 The Proposed Framework for the Adoption of EHR by Primary Healthcare Physicians in the KSA

5.1 Introduction

The aim of the literature reviews conducted in Chapters 3 and 4 was to develop knowledge into potential key EHR adoption factors by primary healthcare physicians in the KSA. The present chapter proposes a framework of key EHR adoption factors based on the literature reviews conducted. The following section discusses the framework development methodology. Following this, a description of the framework and its components is provided.

5.2 The Framework Development Methodology

The aim of this section is to develop a theoretical framework of key factors that are likely to affect the adoption of EHRs by primary healthcare physicians in the KSA. Three stages were conducted in order to construct the appropriate framework as shown in Figure 5-1. In stage 1, barriers to physician adoption of EHRs in the KSA were identified based on the systematic review study conducted in Chapter 3. In stage 2, determinants of user adoption of IT were identified based on theories of user adoption of IT (Section 4.2.5, Chapter 4). In stage 3, determinants of physician adoption of EHRs were identified based on prior studies that applied IT adoption theories to investigate physician adoption of EHR (Section 4.4, Chapter 4).

At the end of each stage, factors identified were filtered in order to remove those irrelevant to the purpose of the current study. Particularly, semantically duplicates were excluded. Also, because very rare primary healthcare centers in the KSA have applied or piloted EHRs (Almaiman *et al.*, 2014), factors that are not applicable for the pre-implementation phase were excluded. Therefore, the focus of this research is to identify factors that lead to the acceptance, and hence use, of EHR systems, similar to most previous studies, e.g. (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015). Because acceptance (i.e. intention to use) is the main determinant of system's use according to technology adoption theories (e.g. TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), TAM (Davis, 1986), UTAUT (Venkatesh *et al.*, 2003)), it is crucial to understand what influences acceptance of EHR systems.

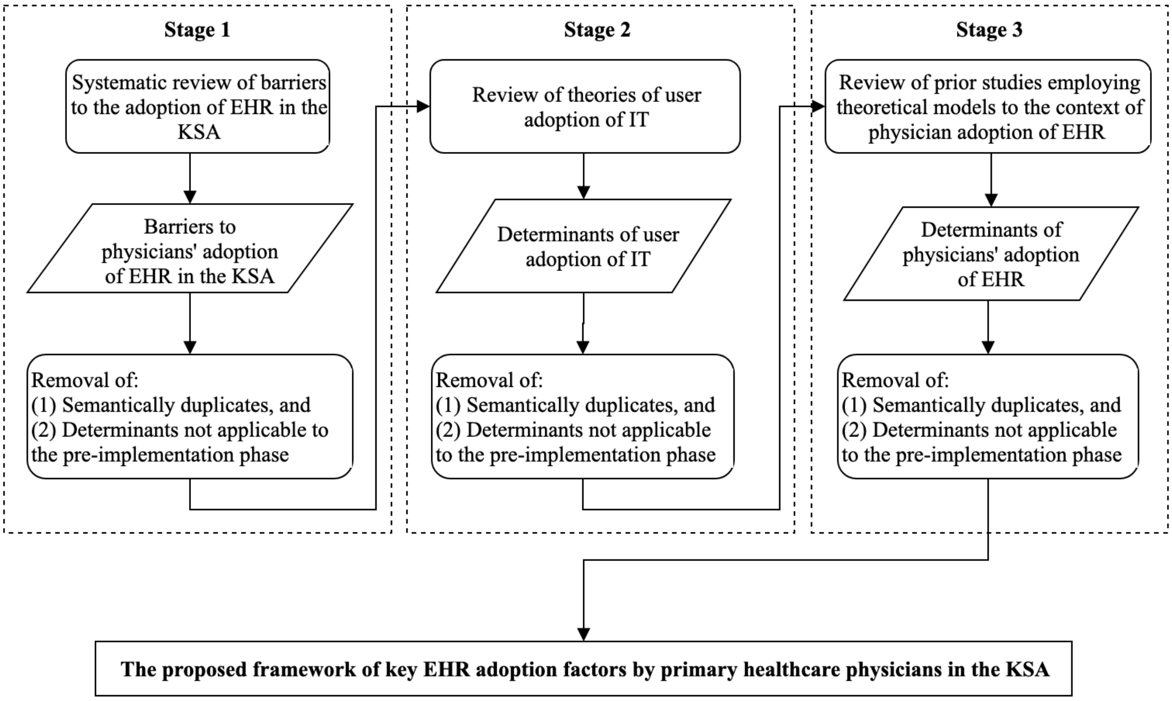


Figure 5-1 The framework construction methodology

5.2.1 Stage 1: Barriers to Physician Adoption of EHR in the KSA

Based on the systematic literature review study of barriers to the adoption of EHR in the KSA (Chapter 3), many barriers to the adoption of EHR were identified (see Table 3-2). These barriers can be divided into two levels: individual-level adoption barriers, and organization-level adoption barriers. Individual-level adoption barriers are those associated with the individual healthcare professional's (i.e. user's) decision to accept and use an EHR system, while organization-level adoption barriers are those associated with the healthcare organization's motivation to adopt and implement an EHR system. From Table 3-2, factors specific to the individual healthcare professional's decision are: lack of computer experience, lack of perceived usefulness of EHR, lack of perceived ease of use of EHR, technical limitations of the software system, lack of user support, confidentiality concerns, and lack of information quality. Factors specific to the organization-level decision are: user resistance to change, lack of EHR standards, uncertainty about EHR vendors, confidentiality concerns, hospital size, and hospital level of care. As the goal of the present research is to study factors influencing individual physician (i.e. user) decision to accept EHR, the researcher excluded factors not specific to individual physician decision from the framework.

Moreover, factors not applicable for the pre-implementation phase were excluded, namely: technical limitations of the software system, lack of user support, and lack of quality in patient information. These three barriers are semantically similar to system performance quality, service quality and information quality, respectively, which are hypothesized by the Information Systems (IS) success model as determinants of continuous usage intention of the IS by its users (DeLone and McLean, 2003), meaning that the system must be already in place when investigating these factors. Based on the criterion specified for excluding factors not applicable for the pre- implementation phase, these three factors were excluded. At the end of this stage, the following factors were selected for inclusion in the proposed framework: computer experience, perceived usefulness, perceived ease of use and confidentiality concerns.

5.2.2 Stage 2: Determinants of User Adoption of IT

Based on the review of theories of user adoption of IT (Section 4.2, Chapter 4), the researcher identified five main factors influencing user acceptance and use of new information technology spread across the theories (see Section 4.2.5), these are: attitude toward the system, perceived benefits of the system (e.g. perceived usefulness in TAM, or performance expectancy in UTAUT), perceived usability of the system (e.g. perceived ease of use in TAM, or effort expectancy in UTAUT), social norms (e.g. subjective norms in TRA and TPB, or social influence in UTAUT), and controllability factors (e.g. perceived behavioural control in TPB or facilitating conditions in UTAUT).

Because facilitating conditions is a determinant of IT usage, not acceptance (Venkatesh et al., 2003), it was excluded from the proposed framework. According to Venkatesh et al. (2003), perceived behavioral control is a dimension of facilitating conditions. Many authors consider facilitating conditions and perceived behavioral control as referring to the same concept (Holden and Karsh, 2010). The Decomposed Theory of Planned Behavior (DTPB) (Taylor and Todd, 1995) decomposed perceived behavioral control into two factors: facilitating conditions and *computer self-efficacy* (i.e. judgment of one's ability to use technology to accomplish a particular task). Computer self-efficacy was adapted from Social Cognitive Theory (Compeau and Higgins, 1995a, 1995b). Based on DTPB's definition of perceived behavioral control, and because facilitating conditions was excluded from the proposed framework, computer self-efficacy was included in the proposed framework as a control factor instead of perceived behavioral control. At the end of this stage, the following factors were selected for inclusion in the proposed framework: attitude, perceived usefulness, perceived ease of use, social influence and computer self-efficacy. Computer-self efficacy replaced computer experience identified in stage 1 (Section 5.2.1) in order to avoid duplication of factors.

5.2.3 Stage 3: Determinants of Physician Adoption of EHRs

Based on the review of prior studies that employed theoretical models in the context of physician adoption of EHRs (Section 4.4, Chapter 4), many factors were identified (see Table 4.2). At this stage, it was found that most determinants identified by technology adoption theories were found to be key determinants of EHR adoption by different studies, particularly: attitude (Seeman and Gibson, 2009; Steininger and Stiglbauer, 2015), perceived usefulness/ performance expectancy (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015), perceived ease of use/ effort expectancy (Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015), computer self-efficacy (Gagnon *et al.*, 2016), social influence/ social norms/ professional norms (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016). However, new significant determinants were identified, particularly: perceived threat to physician autonomy (Walter and Lopez, 2008; Esmaeilzadeh and Sambasivan, 2012), physician involvement (Morton and Wiedenbeck, 2009), and confidentiality concerns (Steininger and Stiglbauer, 2015), which were selected for inclusion in the proposed framework.

The two studies conducted by Gagnon et al., (2014, 2016) showed conflicting findings regarding the significance of demonstrability of results, which was found to be significant in (Gagnon et al., 2014), but insignificant in (Gagnon et al., 2016). Demonstrability of results refers to "the tangibility of the results of using an innovation, including their observability and communicability" (Moore and Benbasat, 1991). Prior research suggests that demonstrability of results is a factor that cannot be valued by new users of the system (Leiva, Ríos and Zapata, 2007), therefore it was not considered for inclusion in the proposed framework of this research. Another key determinant identified by prior research was management support (Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015). However, because management support is considered as a dimension of social influence according to UTAUT (Venkatesh *et al.*, 2003), it was not included as a main factor in the proposed framework.

5.3 The Proposed Framework

Factors identified as a result of the framework development process are shown in Table 5-1. The following subsections discuss these factors in detail.

Table 5-1 The proposed framework of key EHR adoption factors by primary healthcare physicians in the KSA

Factor	Definition	Supporting studies conducted in the KSA	Supporting theories of IT adoption	Supporting models in EHR adoption literature
Attitude	An individual's positive or negative feelings about performing the target behaviour (Fishbein & Azjen 1975)		TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), TAM (Davis, 1986)	(Seeman and Gibson, 2009; Steininger and Stiglbauer, 2015)
Perceived Usefulness	The degree to which an individual believes that using a particular system would enhance job performance (Davis et al. 1989)	Chapter 3	TAM (Davis, 1986, 1989)	(Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda et al., 2015; Steininger and Stiglbauer, 2015)
Perceived Ease of Use	The degree to which an individual believes that using a particular system will be free of effort (Davis et al. 1989)	Chapter 3	TAM (Davis, 1986, 1989)	(Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015)
Social Influence	The degree to which an individual perceives that most people who are important to him/her think he or she should use the new system (Venkatesh et al., 2003)		UTAUT (Venkatesh *et al.*, 2003)	(Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon et al., 2014, 2016).
Computer Self-Efficacy	Judgment of one's ability to use technology to accomplish a particular task (Compeau & Higgins, 1995a, 1995b)	Chapter 3	SCT (Compeau and Higgins, 1995b, 1995a)	(Gagnon et al., 2016)
Perceived Threat to Physician Autonomy	The degree to which an individual believes that using a particular system would decrease his or her control over the conditions, processes, procedures, or content of his or her work (Walter and Lopez 2008)			(Walter and Lopez, 2008; Esmaeilzadeh and Sambasivan, 2012)
Confidentiality Concerns	The degree to which a physician believes that using EHR would impose risk to the confidentiality of patients' information.	Chapter 3		(Steininger and Stiglbauer, 2015)
Physician Participation	The degree to which a physician believes that participation of physicians in the selection and implementation of EHR is important for system adoption.			(Morton and Wiedenbeck, 2009)

5.3.1 Attitude

Attitude toward behaviour refers to an individual's positive or negative evaluative affect about performing a certain behaviour (Fishbein and Azjen, 1975). According to TAM (Davis, 1986), attitude toward using technology is the immediate determinant of behavioural intention to use technology, i.e. *technology acceptance*. Many systematic reviews support the significance of attitude on e-health technology acceptance by healthcare professionals (Gagnon *et al.*, 2012; Najaftorkaman *et al.*, 2015). In their analysis of 68 studies to identify critical adoption factors of EHRs by physicians, Castillo et al. (2010) found physicians' attitude toward EHR to be the most critical adoption factor, and indicated that EHR adoption can be predicted based on it. Another systematic literature review (Gagnon *et al.*, 2012) reported that, before implementation, healthcare professionals need to be aware of the capabilities of the e-health system, and training programs must focus on influencing their attitudes toward the system.

5.3.2 Perceived Usefulness

Perceived usefulness refers to the degree to which an individual beliefs that using a particular system would enhance job performance (Davis, 1989). According to TAM, perceived usefulness is a significant determinant of both attitude and technology acceptance (Davis, 1989). In e-health acceptance research, perceived usefulness was reported to have the greatest impact on healthcare professional's adoption of e-health (Li et al. 2013; Gagnon et al. 2012; Najaftorkaman et al. 2015; Holden & Karsh 2010). Gagnon et al. (2012) pointed out that successful cases of e-health adoption were usually characterized by a clear understanding of the benefits of the e-health technology by its users, i.e. perceived usefulness. Many studies support the critical influence of perceived usefulness on physician acceptance of EHR (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015). In the systematic literature review study conducted in Chapter 3, lack of perceived usefulness of EHR by healthcare professionals was found to be a major obstacle, constituting 15% of barriers reported in studies conducted in the KSA (see Table 3-2).

In IT acceptance research, perceived usefulness focuses mainly on improved job performance (Davis, 1989). However, some studies reported additional dimensions of perceived usefulness to better fit the healthcare context (Holden and Karsh, 2010; Gagnon *et al.*, 2014; Steininger and Stiglbauer, 2015). Therefore, a more holistic picture of perceived usefulness was defined in the present research, and two main dimensions were proposed for defining perceived usefulness of

EHR, namely: improved job performance (e.g. work effectiveness and efficiency, increased productivity, better workflow support), and improved safety and quality of healthcare for patients (e.g. reduction of errors, improved access to data). These dimensions were informed by previous research (Holden and Karsh, 2010; Gagnon *et al.*, 2014; Steininger and Stiglbauer, 2015).

5.3.3 Perceived Ease of Use

Perceived ease of use refers to the degree to which an individual believes that using a particular system will be free of effort (Davis, 1989). In the healthcare context, perceived ease of use refers to ease of learning and mastering the system, ease of accomplishing tasks with the system, minimal extra workload, and ease of using the system during patient consultation (Holden and Karsh, 2010; Gagnon *et al.*, 2014). According to TAM, perceived ease of use is a significant determinant of both attitude toward technology and perceived usefulness. The significant influence of perceived ease of use on e-health technology acceptance by healthcare professionals was supported by many studies (Li et al. 2013; Gagnon et al. 2012; Najaftorkaman et al. 2015; Holden & Karsh 2010). Perceived ease of use was found to be one of the strongest predictors of EHR usage intention by many studies (Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015). In the systematic review study conducted in Chapter 3, lack of perceived ease of use was found to be a major obstacle to EHR adoption by healthcare professionals in the KSA, constituting 15% of barriers reported in the literature (see Table 3-2).

5.3.4 Computer Self-Efficacy

Many studies reported lack of physician ability and familiarity with EHR as a major obstacle hindering EHR acceptance and use (Boonstra & Broekhuis 2010; Gagnon et al. 2012; Li et al. 2013; McGinn et al. 2011; Najaftorkaman et al. 2015). This barrier was also reported by most studies conducted in the KSA according to the systematic literature review study conducted in Chapter 3.

Computer self-efficacy refers to the judgment of one's ability to use technology to accomplish a particular task (Compeau and Higgins, 1995b, 1995a). Gagnon et al. (2014) demonstrated increased explanatory power of TAM when it was extended by computer-self efficacy. In their recent study (Gagnon *et al.*, 2016), computer-self efficacy was one of the strongest predictors of EHR usage intentions by physicians, suggesting that physicians with high computer self-efficacy are likely to support EHR implementation.

Based on previous research (Compeau and Higgins, 1995b, 1995a; Venkatesh *et al.*, 2003; Gagnon *et al.*, 2014), two dimensions of computer self-efficacy were proposed in the present research:

training and IT support.

5.3.5 Social Influence

Within technology acceptance research, social influence refers to the degree to which an individual perceives that most people who are important to him/her think he or she should use the new system (Venkatesh *et al.*, 2003). According to UTAUT social influence is a significant determinant of users' acceptance of a new system (Venkatesh *et al.*, 2003). Many systematic reviews reported social influence to be an important factor effecting healthcare professionals' acceptance of e-health technology (Li et al. 2013; Gagnon et al. 2012; Najaftorkaman et al. 2015; Holden & Karsh 2010; Castillo et al. 2010). Social influence was one of the strongest predictors of EHR usage intention by physicians in many studies (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016). Because physicians develop norms through professional socialization, decisions regarding EHR acceptance could be strongly influenced by their colleagues and peers (Castillo, Martínez-García and Pulido, 2010; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016). Another important source of social influence is top management support (Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015).

Based on UTAUT (Venkatesh *et al.*, 2003) and prior research on physicians' adoption of EHR (Morton and Wiedenbeck, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015), four dimensions (sources) of social influence were proposed in this research to define social influence factor in the EHR adoption context: peers support, colleagues support, top management support, and perceptions of patients' attitudes.

5.3.6 Perceived Threat to Physician Autonomy

It has been recognized that physicians are characterized by their high professional autonomy (Walter and Lopez, 2008; Venkatesh, Sykes and Zhang, 2011). The implementation of EHR involves substantial changes that could affect positions or power relations in the medical practice. Consequently, when work roles, professional status and autonomy are negatively affected, resistance is likely to occur (Walter and Lopez, 2008; Abdekhoda *et al.*, 2015). As suggested by Walter and Lopez (2008), physicians' concerns about loss of autonomy should be investigated in studies aiming to understand physicians' acceptance of information technology. Perceived threat to physician autonomy is the degree to which an individual believes that using a particular system would decrease his or her control over the conditions, processes, procedures, or content of his or her work (Walter and Lopez, 2008). Previous studies have shown that perceived threat to professional autonomy was among the most important determinants of EHR adoption by physicians

(Walter and Lopez, 2008; Esmaeilzadeh and Sambasivan, 2012).

5.3.7 Confidentiality Concerns

Confidentiality concerns refer to the degree to which the physician believes that using EHR would impose risk to the confidentiality of patients' information. Concerns over the confidentiality of patients' information were among the most frequently reported barriers to EHR adoption according to previous systematic reviews (Boonstra and Broekhuis, 2010; Li *et al.*, 2013). According to Boonstra and Broekhuis (2010), physicians are concerned that the EHRs could be accessible to those who are not authorized to obtain them. The study conducted by Steininger and Stiglbauer (2015), suggests that confidentiality concerns have a significant negative effect on physicians attitudes toward EHR systems.

5.3.8 Physician Participation

Many studies reported that participation of healthcare professionals in the design and implementation of EHR and e-health systems is essential for system success (Li et al. 2013; Gagnon et al. 2012). In the study conducted by Pare et al. (2006), physician participation was significantly associated with psychological ownership of the system. This psychological ownership has a significant positive influence on the perception of the system's usefulness and ease of use. Consequently, involving physicians early in EHR selection and implementation is expected to enhance the utility and usability of the system (Gagnon et al. 2012). The study conducted by Morton and Wiedenbeck (2009) showed that physician involvement was one of the strongest determinants of physicians' attitudes toward using the system.

5.4 Discussion and Conclusion

The proposed framework was developed based on a comprehensive review of relevant academic literature. For theoretical frameworks explaining behaviour change at the individual healthcare professional level to be practically useful for implementation, Eccles et al. (2005) reported that such framework should explain behaviour in terms of factors that are changeable (e.g., knowledge, beliefs, attitudes) rather than non-modifiable determinants (e.g., age, gender, intelligence) as such factors are difficult or impossible to change. All factors in the proposed framework are changeable, which makes them practically useful for implementation. The proposed framework provides an integrative view of key EHR adoption factors. Previous studies are limited in terms of providing an integrative view of EHR adoption factors. The next chapter explains the methodology applied to validate the proposed framework.

Chapter 6 Research Methodology for the First Stage of This Research

6.1 Introduction

The previous chapter proposed a framework for the adoption of EHR by primary healthcare physicians in the KSA. The next step is to validate this framework. The aim of this chapter is to show how this framework is going to be validated. In the following sections, a discussion of research methodologies used in information systems research is provided, followed by a discussion of the research methodology designed for the first stage of this research.

6.2 Research Methods

Research methods are the techniques used to collect and analyse data. In information systems research, there are three main research methods: qualitative, quantitative and mixed methods (Recker, 2013). The following subsections discuss these methods in detail.

6.2.1 Qualitative Research

Qualitative methods involve the collection, analysis and interpretation of data that are not easily shown in the form of numbers. Qualitative methods are typically used for developing a deep understanding of a phenomenon and/or to uncover new theoretical insights (Recker, 2013; Venkatesh, Brown and Bala, 2013). Data collection methods for qualitative research include interviews, observations, focus groups and document analysis (Anderson, 2010; Recker, 2013). Most qualitative research studying human phenomena uses interviews as the data collection method (Carter et al., 2014).

Interviews can be classified into three types based on how rigorously the interviewer sticks to a prepared list of questions: structured interviews, semi-structured interviews, and unstructured interviews. Semi-structured interviews are the most commonly employed technique. They have a major advantage over the other interviewing techniques. They can be used to confirm what is already known while at the same time providing the interviewer the opportunity to learn new insights that have not been considered (e.g. by requesting the participant to say more information about the issues investigated). Hence, the interviewer not only obtains answers, but also reasons for these answers (Recker, 2013).

The most popular technique for qualitative data analysis is *thematic analysis*, which refers to identifying, analysing and reporting patterns (or themes) within data. A theme captures something important within the data with regard to the research inquiry, and represents some level of meaning, through coded instances, within the data. The ‘keyness’ of a theme is not necessarily dependent on quantifiable measures (e.g. number of instances of the theme across the dataset), but rather it depends on whether it captures something important with regard to the research inquiry. Themes within the dataset are identified in either an *inductive* (data-driven) or a *deductive* (theory-driven) way. In an inductive approach, themes are identified within the dataset without trying to fit the data into a pre-existing theoretical coded frame, whereas in a deductive approach, themes are identified based on a priori theoretical perspectives. Therefore, the inductive approach can be improved by not engaging with literature in the early stages of analysis, whereas the deductive approach requires engagement with the literature prior to analysis. A combination of inductive and deductive analysis is also possible (Braun and Clarke, 2006). Braun and Clarke (2006) recommended six phases for thematic analysis as shown in Table 6-1. Thematic analysis is a recursive process, which requires the researcher to move back and forth through these phases until the final report is produced. Tools such as NVivo and MAXQDA can be used to aid in qualitative data analysis.

Table 6-1 Phases of thematic analysis – adapted from (Braun and Clarke, 2006)

Phase		Description
1	Familiarization with the data	Transcribing the data, reading and re-reading the data, noting down an initial list of ideas for coding.
2	Generating initial codes	Coding interesting extracts of the data across the entire dataset in a systematic way, sorting coded extracts together within each code.
3	Searching for themes	Sorting codes and coded extracts into potential themes. Some initial codes and coded extracts may be assigned to the main theme, others may be assigned to sub-themes and others may be discarded.
4	Reviewing themes	Checking if the coded extracts within each theme form a coherent pattern, and if the themes are meaningfully distinct from each other.
5	Defining and naming themes	On-going analysis to refine the specifics of each theme and to define the story each theme tells in relation to the research inquiry, assigning a working title for each theme.
6	Producing the report	Selection of vivid, compelling extract examples, final analysis of the selected extracts, referring back to the research question and literature, and writing up the report.

Because qualitative research involves analysing and interpreting a large amount of non-numerical ("text") data, the number of participants should be small (Anderson, 2010). Sample size for qualitative research depends on saturation. Saturation is "the point at which no new information or themes are observed in the data" (Guest, Bunce and Johnson, 2006). Guest et al., (2006) suggest that saturation is usually reached by six to twelve interviews. McCracken (1988) suggests that eight participants is often a sufficient number in qualitative research. Qualitative methods typically rely on purposive sampling, in which participants are selected because they possess certain characteristics of interest (Recker, 2013).

6.2.2 Quantitative Research

Quantitative research involves the collection, analysis, and interpretation of data that can be expressed in numbers. Quantitative methods are typically used for confirmatory studies in which a previously developed hypothesis needs to be confirmed (Recker, 2013; Venkatesh et al., 2013).

A common way of conducting quantitative research is through questionnaires (Recker, 2013). A questionnaire is a well-established technique for collecting participants' demographic data and opinions. The main benefit of questionnaires is that they can be used to collect data from a large number of people and can reach a wide spectrum. Developing a questionnaire requires efforts and skills to ensure that the questions are clearly worded and that answers can be analysed efficiently (Preece, Rogers and Sharp, 2002).

Numeric data collected through quantitative research can be analysed in two different ways: *descriptive* and *inferential*. Descriptive analysis refers to the statistical techniques that are used to describe the population or the dataset under study. Examples include mean, mode, median, range, frequency distribution and standard deviation. Inferential analysis refers to the statistical techniques that are used to analyse data from a sample to draw conclusions about the population. Examples of inferential analysis include t-test, correlation analysis, regression analysis and structural equation modelling (Creswell, 2011). Software tools, such as SPSS, can be used for analysing quantitative data.

6.2.3 Mixed Methods Research

Mixed methods research is an approach that combines qualitative and quantitative approaches, either sequentially or concurrently, in a single study. This research design combines the strengths of qualitative and quantitative research approaches, and offers a greater understanding on a phenomenon that each of these methods individually cannot offer (Venkatesh et al., 2013).

There are five main purposes for conducting mixed methods research (Johnson and Onwuegbuzie, 2004):

- Triangulation – to confirm the findings from one study using other methods and designs.
- Complementarity – to elaborate the findings from one study using other methods.
- Initiation – to discover contradictions that will lead to re-framing the research question.
- Development – findings from one study inform other research methods.
- Expansion – to expand the scope of the research by using different methods for different inquiry components.

Triangulation research design in its larger scope refers to an approach that involves investigating a problem from two or more angles in order to cross-validate or confirm the findings from different sources (Jupp, 2006). The use of triangulation assists researchers in increasing the robustness of the findings (Recker, 2013). There are four different forms of triangulation (Jupp, 2006):

- Triangulation of data – refers to collecting data from different sources, e.g. different types or groups of people.
- Investigator triangulation – refers to using different researchers to collect and interpret the data in order to balance out the subjective influence of individuals.
- Triangulation of theory – refers to approaching data from different theoretical perspectives in order to assess their usefulness.
- Methodological triangulation – refers to using different methods to collect, analyse and interpret the data in order to confirm the findings.

6.3 Research Methodology Designed for the First Stage of This Research

The aim of the first stage of this research is to identify the factors that influence the adoption of EHR by primary healthcare physicians in the KSA. Given that EHR is still an emerging phenomenon in the KSA, and that existing theories and findings are still lacking in terms of offering a comprehensive set of factors that influence primary healthcare physicians' adoption of EHR, it is important to first validate the factors proposed in the initial framework and to explore other significant factors. A qualitative research method can provide a powerful mechanism in such situations, as it helps in achieving an in-depth understanding of the phenomena under investigation (Anderson, 2010). In addition, qualitative approaches are responsive to the context, and to the needs and experiences of stakeholders (Johnson and Onwuegbuzie, 2004).

Therefore, the first stage of this research has applies a qualitative approach to understand the significance of the factors in the proposed framework and to explore other significant factors. The interview data collection method was selected as it enables an in-depth investigation and exploration (Anderson, 2010; Carter et al., 2014; Recker, 2013). A data triangulation methodology was applied in order to develop a comprehensive understanding of the factors and to increase the validity of the findings (Carter et al., 2014). The following subsections describe the data triangulation methodology designed for the first stage of this research.

6.3.1 Data Triangulation

Data triangulation refers to collecting data from different types of individuals, groups, or communities in order to get multiple perspectives and validation of data (Carter *et al.*, 2014). In qualitative research, triangulation is considered critical for the quality of research, particularly the credibility of the findings. Credibility is enhanced through collecting data from different sources in order to confirm the findings and to ensure that all aspects of the phenomena have been investigated (Krefting, 1991).

In the KSA, large and tertiary healthcare organisations are in advanced stages of EHR implementation (Aldosari, 2014), while the adoption of EHRs, and health IT in general, in primary healthcare practices is rare (Almaiman et al., 2014). The views of leaders and experts of EHR implementation from those large healthcare organisations will provide significant insights. However, to improve the credibility of the findings, the views of primary healthcare physicians should be investigated. Therefore, a data triangulation methodology was performed in order to produce the validated framework. Three main components of triangulation were used for the first stage of this research, as shown in Figure 6-1.

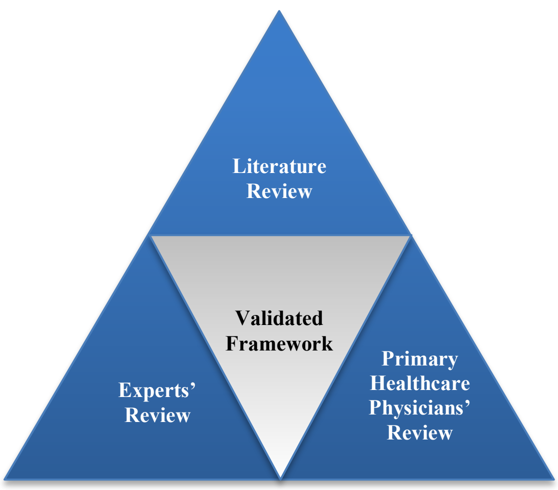


Figure 6-1 The data triangulation methodology design for the first stage of this research

First, an extensive literature review (Chapters 3 and 4) was performed in order to identify the factors that are likely to impact primary healthcare physicians' adoption of the EHR in the KSA, resulting in the proposed framework presented in Table 5.1 (Chapter 5). Then, the framework was validated by two groups of informants: (1) leaders and experts of EHR implementation, and (2) primary healthcare physicians.

The validation of the framework was achieved through a concurrent data triangulation strategy (Creswell et al., 2003), which involves collecting data from two or more sources, concurrently at one phase of the research, and afterwards integrating the results together in the interpretation stage. Figure 6-2 illustrates the concurrent data triangulation strategy applied to this research. Benefits of using this approach include its efficiency, obtaining different but complementary perspectives on the same topic, and obtaining findings that substantiate each other in a meaningful way (Creswell et al., 2003). In addition, the convergence of the data from multiple perspectives enhances the trustworthiness of the findings (Carter et al., 2014).

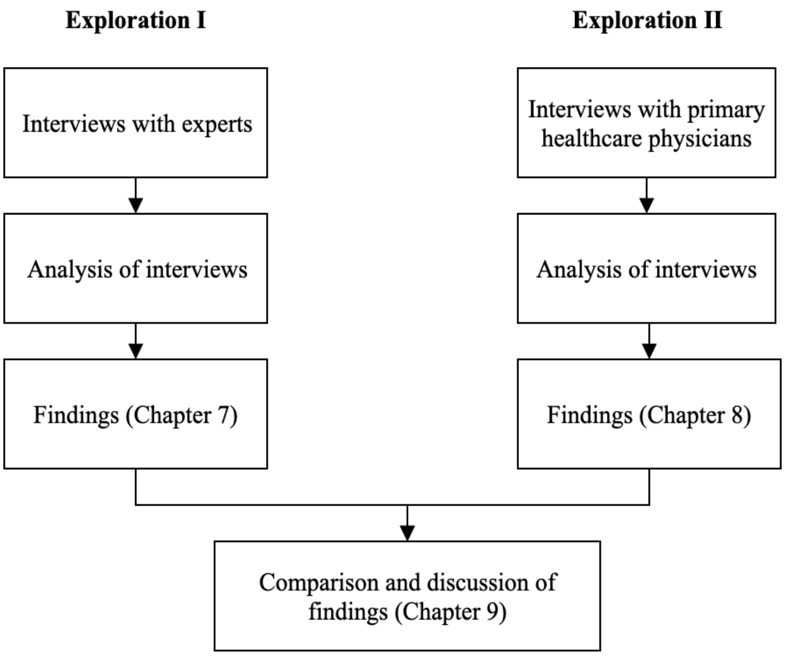


Figure 6-2 The concurrent data triangulation strategy applied to validate the proposed framework

Theoretically, the collection of data happens at the same time, however, in practical application, the priority of data collection may be given to one data source over the other (Creswell et al., 2003). In this research, the researcher conducted interviews with experts first, and then with primary healthcare physicians. After that, experts' interviews were analysed and the findings were reported (Chapter 7), then, primary healthcare physicians' interviews were analysed and the findings were reported (Chapter 8). Finally, the findings were integrated and discussed (Chapter 9).

The following section explains the design of the interviews. Following this, the details of experts' review as well as primary healthcare physicians' review are explained, including the sampling strategy, sample size, time and place of interviews, and the data analysis method applied.

6.3.2 The Design of the Interviews

The goal of the interviews with experts and primary healthcare physicians was to validate the factors in the proposed framework and to explore other important factors. Therefore, interviews were conducted in a semi-structured interview format. The interview questions were composed of two sections. The first section captures demographic information about the respondents. The demographic questions asked for experts and primary healthcare physicians are provided in Appendix B. The second section consists of 23 open-ended questions: 22 questions aim to investigate and explore respondents' perspectives about the proposed factors and one question aims at exploring other important factors not mentioned in the proposed framework. The full list of the questions in this section is provided in Table 6-2. The clarity and organisation of interview questions were validated by one expert and one primary healthcare physician who participated in the study.

Table 6-2 Interview questions

Factor	Questions
Perceived Usefulness	1) Do you agree that *perceived usefulness* has an important effect on the adoption of an EHR system by physicians? Can you explain your experience regarding this factor? 2) Do you think that perceived benefits of an EHR system on personal performance are important for physicians when they use the system? Can you explain? 3) Do you think that perceived benefits of an EHR system on safety and quality of care for patients are important for physicians when they use the system? Can you explain? 4) What else could affect physicians' perceptions about the usefulness of an EHR system?
Perceived ease of use	5) Do you agree that *perceived ease of use* has an important effect on the adoption of an EHR system by physicians? Can you explain your experience regarding this factor? 6) Do you think that the use of an EHR system makes it difficult for the physician to communicate with the patient effectively during patient's consultation? Would this affect physicians' perceptions about ease of use and hence adoption of the system? 7) Do you think that physicians need to spend a long time in order to learn the system? Do you think that this could affect their decisions to adopt an EHR system? Can you explain? 8) Do you think that the use of an EHR system increases the workload for physicians? Do you think that this could affect their decisions to adopt an EHR system? Can you explain?

Factor	Questions
	9) What else could affect physician's perceptions about the ease of use of an EHR system?
Computer Self-Efficacy	10) Do you agree that *Computer self-efficacy* has an important effect on the adoption of the EHR system by physicians? Can you explain your experience regarding this factor? 11) Do you think that training is important for increasing physicians' computer self-efficacy and hence their adoption of the EHR system? 12) Do you think that IT support is important for increasing physicians' computer self-efficacy and hence their adoption of the EHR system?
Social Influence	13) Do you agree that *social influence* in general has an important effect on the adoption of an EHR system by physicians? Can you explain? 14) Do you think that peer influence is an important source of social influence affecting physicians' adoption of an EHR system? 15) Do you think that top management support is an important source of social influence affecting physicians' adoption of an EHR system? 16) Do you think that patients' feelings about the use of the EHR system are an important source of social influence affecting physicians' adoption of an EHR system? 17) Do you think that the perceptions of other medical staffs toward the use of an EHR system are an important source of social influence affecting physicians' adoption of the EHR system? 18) What are the other sources of social influence that could influence physicians' adoption of an EHR system?
Perceived Threat to Physician Autonomy	19) Do you agree that *perceived threat to physician autonomy* has an important effect on physicians' adoption of an EHR system? Can you explain?
Confidentiality Concerns	20) Do you agree that concerns over the confidentiality of patient information have an important effect on physicians' adoption of the EHR system? Can you explain?
Physician Participation	21) Do you agree that physician participation in the implementation process of the EHR system is important for physicians to adopt the system? Can you explain?
Attitude toward and EHR system use	22) Do you agree that attitude toward EHR system use has an important effect on physicians' adoption of the system? Can you explain?
Other factors	23) Do you think that there are other important factors affecting physicians' decisions to adopt an EHR system that are missing from the proposed framework? Can you explain?

6.3.3 Experts' Review

Experts can provide significant insights based on their practical experience in EHR implementation in healthcare organisations in the KSA. It is among the key recommendations to policy makers to learn the experiences of others who have successfully implemented an EHR system (Cresswell, Bates and Sheikh, 2017). The selection of experts was based on a purposive sampling. That is, people who hold the following characteristics were selected:

1. People who are in charge of EHR implementation, such as heads of IT departments, EHR project managers, or senior members of the EHR development teams, and
2. Employed by governmental healthcare authorities that are either in advanced stages of EHR implementation, such as those presented in (Aldosari, 2014), or are in the provision of EHR/National EHR implementation in major healthcare organizations, such as the Ministry of Health (MOH) and the Saudi Health Council (SHC), and
3. Have at least 5 years of practical experience in EHR implementation

Initially, interviews with Chief Information Officers (CIOs) and general directors of IT/health informatics departments in these healthcare organizations were conducted. The chain referral or snowball sampling method (Bhattacherjee, 2012) was also used to identify other experts. The snowball sample was obtained by asking participants to suggest other experts who are appropriate for the study.

The number of experts totalled twelve. Notes were taken during the interviews and repetition of information was obtained in the last three interviews, which was an indication that data saturation was reached.

The interviews were conducted from December 2016 to January 2017. They were conducted face-to-face, online or over the phone depending on the availability and location of the experts. Each interview lasted between 30 to 80 minutes. The average duration of interviews was 50 minutes.

Interviews were audio taped and then transcribed by the researcher. The transcripts were then analysed using thematic analysis. The qualitative data analysis software, MAXQDA, was used to facilitate the analysis. MAXQDA has an advantage over other alternative tools such as NVivo in that it supports Arabic language, and therefore it was selected for the analysis.

The analysis of the interviews was based on the six phases of thematic analysis developed by Braun and Clarke (2006). Figure 6-3 illustrates the phases of thematic analysis applied in this research. In phase 1, an initial list of codes was obtained based on several rounds of reading throughout the transcripts. Then in phase 2, interesting extracts were assigned to these codes, with the flexibility to add new codes as needed. By the end of phase 2, each code has a number of coded extracts that provide similar meanings. In phase 3, the codes were sorted into themes. A theme captures something important within the data with regard to the research inquiry (Braun & Clarke, 2006). Then, large and complex themes were divided into sub-themes. Sub-themes are essentially themes-within-a-theme. They can be useful for giving structure to a particularly large and complex theme and also for demonstrating the hierarchy of meaning within themes (Braun & Clarke, 2006). In this research, a theme represents a factor, and a sub-theme represents a dimension of a factor. In phase

4, themes and sub-themes were reviewed to ensure that the data within each theme cohere together meaningfully and that there is a clear distinction between the themes. Then phase 5 involved the final decision on the names of themes and sub-themes, particularly those identified through inductive analysis. The purpose of this phase is to ensure that the names given to themes and sub-themes are concise, clear and effective. Finally, the results were reported in phase 6. The full list of codes, themes and sub-themes, as well as examples of coded extracts within each code is provided in Appendix C.

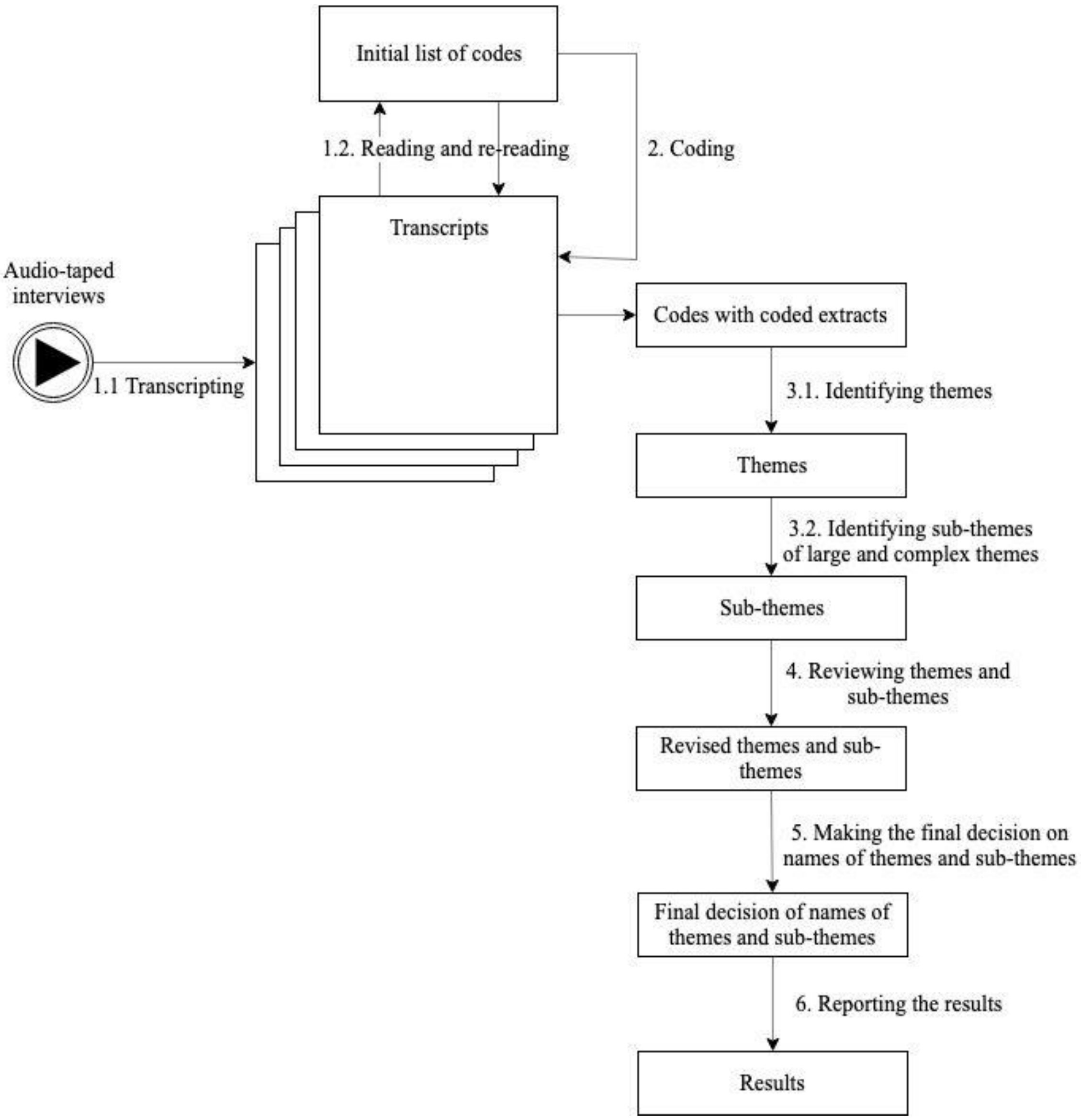


Figure 6-3 Thematic analysis phases applied in this research, adapted from (Braun and Clarke, 2006)

The coded extracts presented in Appendix C and in the findings section (Chapter 7) were translated into English by the researcher. The accuracy of the translation was reviewed and validated by three research students at the University of Southampton.

6.3.4 Primary Healthcare Physicians' Review

Investigating perceptions of primary healthcare physicians is important in order to increase the validity of the framework. Purposive sampling in this category included primary healthcare physicians at senior management positions and other primary healthcare physicians at lower or no managerial positions. Physicians at senior or other management positions were recruited because, in addition to being primary healthcare physicians, their involvement will allow the research to benefit from their experiences in managing the change in primary healthcare practices. Thus, they are an important source of knowledge for the purpose of this research. In addition, a primary healthcare physician must have at least five years of experience in medical practice to be included in the study.

Furthermore, in order to ensure maximum variation in terms of EHR experience, the status of EHR implementation at the primary healthcare department/centre the physician is affiliated to was considered during the sampling strategy. In the KSA, some major healthcare organisations such as King Faisal Specialist Hospital and Research Centre (KFSHRC), National Guard Health Affairs (NGHA), and university hospitals, have implemented an EHR system in the affiliated primary healthcare departments. Also, the Ministry of Health (MOH) has piloted the EHR in a number of its primary healthcare centres, but these piloted projects were discontinued. Targeting primary healthcare physicians who have lived the experience of the transition to an EHR system can provide significant insights. Therefore, primary healthcare physicians from three main categories of primary healthcare practices in terms of EHR implementation were interviewed:

1. Primary healthcare practices that have implemented an EHR system
2. Primary healthcare practices that piloted an EHR system but discontinued
3. Primary healthcare practices that have not piloted or implemented an EHR system

Initially, an interview was conducted with the Deputy Minister of Primary Healthcare, then other primary healthcare physicians at different managerial positions in primary healthcare were interviewed, including chairpersons of primary healthcare departments at major healthcare authorities such as KFSHRC, NGHA, and university hospitals, and supervisors of primary healthcare sectors at the MOH. A snowball sampling (Bhattacherjee, 2012) was also used to identify other participants. The snowball sample was achieved by asking participants to identify other participants who are appropriate for the study. However, physicians from primary healthcare centres that have piloted an EHR could not be identified through snowball sampling, therefore, a random list of physicians from these primary healthcare centres was obtained from the MOH.

The number of primary healthcare physicians totalled twelve. Data saturation was obtained in the last four interviews, therefore it was concluded that interviewing more participants would not contribute additional knowledge.

The interviews with primary healthcare physicians were conducted from January to February 2017. They were conducted face-to-face, online or over the phone depending on the availability and location of participants. Each interview lasted between 30 to 60 minutes. The average duration of interviews was 40 minutes.

The analysis of primary healthcare physicians' interviews applied the same procedure used for analysing experts' interviews. That is, interviews were audio taped, transcribed and analysed using thematic analysis, following the same procedure illustrated in Figure 6-3. The full list of codes, themes and sub-themes, as well as examples of coded extracts within each code is provided in Appendix D. The qualitative data analysis software, MAXQDA, was used to facilitate the analysis. Finally, the accuracy of the translation of coded extracts reported in Appendix D and in the findings section (Chapter 8) was validated by three research students at the University of Southampton.

6.4 Ethical Approval

Prior to conducting the interviews with participants, ethical approval was sought and obtained from the University of Southampton's ethics committee. The reference for the ethics approval is ERGO/FPSE/24595. The template of email invitation letters sent to participants requesting them to participate as well as the participant information sheet and the consent form are provided in Appendix A. All participants gave their written consent by signing the consent form. All data was de-identified to maintain confidentiality.

6.5 Summary and Conclusion

This chapter briefly reviewed research methods in information systems research, and discussed the design of research methodology applied for the first stage of this research. The first stage of this research employed a qualitative data triangulation approach in order to validate the proposed framework and to explore other significant factors. The methodology was designed to validate the framework through interviews with two key groups of informants: experts and primary healthcare physicians. The following three chapters will present and discuss the findings of this qualitative study.

Chapter 7 Findings of the Interviews with Experts and Leaders of EHR Implementation in the KSA

7.1 Introduction

The aim of this chapter is to report and discuss the findings of interviews with experts and leaders of EHR implementation in the KSA. These interviews were conducted to validate the existing factors in the proposed framework, to explore other important factors, and to obtain an in-depth analysis on what defines these factors in the context of physician adoption of EHR systems. In the following sections, characteristics of respondents are described. Then, Experts' responses regarding existing factors in the proposed framework are discussed. After that, new factors emerged from the interviews are discussed. Finally, a summary of the findings is provided.

7.2 Description of Experts

An overall description of experts is provided in Table 7-1. Nine experts are CIOs or similar executives, including: the director of the National Health Information System (NHIS) at the MOH, the assistant director of NHIS at the MOH, the director of clinical information systems at the MOH, the director general of the National Health Information Centre at the Saudi Health Council (SHC), the CIOs at King Faisal Specialist Hospital and Research Centre (KFSHRC), National Guard Health Affairs (NGHA) and King Khalid Eye Specialist Hospital (KKESH), the executive director of Health Informatics and Information Technology Department at King Fahad Medical City (KFMC), and the Director of Medical Informatics Department at King Fahad Specialist Hospital in Dammam (KFSH-Dammam).

Of these nine experts, five experts, in addition to three more experts, are medical informatics specialists, totalling 8 medical informatics specialists. Of the total twelve experts, six are physicians or healthcare professionals. Also, of the twelve experts, four have 5-10 years of experience in EHR implementation. Two experts have 10-15 years of experience in EHR implementation. Five experts have 15-20 years of experience in EHR implementation, and one expert has over 20 years of experience in EHR implementation.

Of the twelve experts, three experts are from the Ministry of Health (MOH). Three are from King Faisal Specialist Hospital and Research Centre (KFSHRC). One participant from each of National

Guard Health Affairs (NGHA), King Fahad Medical City (KFMC), King Khalid University Hospital (KKUH), King Khalid Eye Specialist Hospital (KKESH), King Fahad Specialist Hospital in Dammam (KFSH-D), and the Saudi Health Council (SHC). Table 7-2 provides a brief description of the healthcare authorities of experts. These healthcare authorities represent the largest and the most advanced healthcare authorities in the KSA, which ensures that the selected experts have an extensive knowledge and experience that could reveal significant insights for the purpose of this research.

Table 7-1. Overall description of experts

Area of expertise*	Chief Information Officer (CIO) or a similar executive position	9
	Medical informatics specialist	8
Healthcare experience	Physician or healthcare professional	6
	Other	6
Years of experience in EHR implementation	Over 20 years	1
	15 – 20	5
	10 – 15	2
	5 – 10	4
Healthcare authority	Ministry of Health (MOH)	3
	King Faisal Specialist Hospital & Research Centre (KFSHRC)	3
	National Guard Health Affairs (NGHA)	1
	King Fahd Medical City (KFMC)	1
	King Khalid University Hospital (KKUH)	1
	King Khalid Eye Specialist Hospital (KKESH)	1
	King Fahd Specialist Hospital in Dammam (KFSH-D)	1
	Saudi Health Council (SHC)	1
Age	50 years or more	1
	40 – 50	8
	30 – 40	3
Gender	Male	11
	Female	1

* Areas of expertise overlap

Table 7-2 Description of healthcare authorities of experts

Healthcare authority	Number of beds	Main Speciality	Type of EHR implemented
Ministry of Health (MOH)	43,080 beds	Tertiary, Secondary, and primary care	N/A
King Faisal Specialist Hospital & Research Centre (KFSH&RC)	1549 beds	Tertiary care*	Cerner
National Guard Health Affairs (NGHA)	2860 beds	Tertiary care*	BESTcare
King Fahd Medical City (KFMC)	1200 beds	Tertiary care*	Cortex
King Khalid University Hospital (KKUH)	800 beds	Tertiary care*	Cerner
King Khalid Eye Specialist Hospital (KKESH)	229 beds	Tertiary ophthalmic care*	InterSystems
King Fahd Specialist Hospital in Dammam (KFSH-D)	350 beds	Tertiary care*	MedicaPlus
Saudi Health Council (SHC)	N/A	Coordination between healthcare authorities in the KSA to build and apply healthcare services standards	N/A

* Tertiary healthcare authorities are the central, specialised healthcare organisations

7.3 De-Identification of experts

To maintain confidentiality, the numbering of experts is not following the ordering of experts descried in Section 7.2. Moreover, although some experts are physicians or healthcare professionals as described in Table 7.1, they are identified hereafter as experts.

7.4 Experts' Evaluation of the Proposed Framework

Understanding factors influencing the adoption of EHRs by physicians is critical for EHR systems' success. Most experts commented on the importance of understanding physicians' perceptions with regard to the adoption of EHR systems, as one expert reported:

> *"I worked on the implementation of many EHR systems since 2000 and the latest implementation I worked on was in 2014. The change in implementation strategy and the change in dealing with physicians provides a clear impression that there is a great tendency to focus on physicians' acceptance... Both EHR vendors and clients such as MOH or KFSH&RC are now providing this side a great importance… Large international vendors of EHR such as Epic or Cerner or InterSystems have recognized the importance of physicians' acceptance recently, now they are hiring physicians within the implementation teams and they have a specific position called a Physician Advocate because they know that adoption is a key to any successful project"* (Expert 10).

The MOH had previous initiatives to apply the EHR on a number of primary healthcare centres. However, the implementation was not successful because of many reasons, including lack of adoption by physicians, as one expert reported:

> *"To give a brief the history of subject, the MOH does not have a comprehensive solution for primary care centres, but it had previous initiatives to apply a system in primary healthcare care centres, on a limited number of centres, and the implementation did not succeed because of many issues, the physicians were one domain, the technology was another domain, and the administration and regulations were another domain"* (Expert 9).

Another expert commented on the difficulty of EHR implementation faced because of the need to get physicians' acceptance and engagement, as explained below:

> "*When we decided to change to another EHR solution, the major concern we had is the adoption or the change management of healthcare professionals, and mainly the physicians. The main reason is that we want to change to a completely paper-less environment. This caused challenges especially with physicians, great challenges, because you say to the physician nothing is going to be recorded out of the system, everything has to be documented on the system... Here, there was a difficulty in the adoption from the physicians' side"* (Expert 3).

Details of experts' evaluation regarding the importance of the factors in the proposed framework as well as minor themes emerged from the analysis of experts' responses regarding each factor are provided in the following subsections.

7.4.1 Perceived Usefulness

All experts reported the critical importance of perceived usefulness on physicians' acceptance of EHR, as one expert stated:

> "*It is very important that the provider knows how will the system benefit him. If the physician beliefs that the system will assist him in an effective way he will fight for it*" (Expert 4).

However, in order to realize the benefits of the system, the system should address current work problems and provide an added value for practitioners rather than simply automating the processes, as explained by one expert:

"*It is not about automation, but about addressing problems. The system should be able to solve problems and to provide an added value, otherwise the physician will not go for it*" (Expert 2).

The following minor themes emerged from experts' responses regarding perceived usefulness. These minor themes explain what does it mean for an EHR to be useful from the perspective of the physician; they are listed below in the descending order with regard to the number of comments supporting each sub-theme:

a) Improved job performance

Most experts reported that the system should provide clear benefits in terms of improved job performance, as two experts stated:

"I stress more on the issue that there should be a complete clarification on what's in it for you as a physician" (Expert 10)

"Benefits for him personally will matter a lot" (Expert 7)

Experts frequently mentioned the importance of making certain aspects of the job easier, supporting physicians' decisions and saving physicians' time, as reported by three experts:

"The most important thing is that the benefits of the system are clarified to them. How the EHR system will simplify their workflow, how it will facilitate their communication with the other departments, how it will make it easy to access patient's information without having to go back to paper records" (Expert 1)

"*If there is a usefulness for the professional practice, I mean if it makes his job easier, helps him to get drug-drug interactions, or helps him in deciding the follow-up with the patient, or helps him in making prescription, or in selecting or ordering the right lab tests or other investigations*" (Expert 11)

"*Many seniors [senior physicians] became motivated because he found that the system saves his time*" (Expert 3)

b) Quick and easy access to information

Quick and easy access to information through the use of an EHR was another important dimension of perceived usefulness stressed by most experts, as one expert reported:

"When we ask the groups of physicians about the benefits of EMR, it is the easy access to the patient chart, you access it from your computer, you can make an order through the

CPOE, you can view the lab results, view the x-rays, you do not need to call the lab" (Expert 5).

Experts reported that paper-based patient records are fragmented between various clinics in a single primary healthcare centre, which is an important motivator toward EHR adoption if it provides a comprehensive view of patient's information, as one expert explained:

"The current situation in the primacy healthcare centre, the chronic diseases physician keeps patients' records separately, and so as the general practitioner, the obstetrician, and the dentist. There is no holistic view of the patient's information in front of the physician under his fingertips, this is extremely important from the perspective of physicians" (Expert 9).

Data visualization and analysis was another important motivator stressed by the experts, as one expert reported:

"*When they realise the benefits and feel the power of the data and reports and graphs I think definitely it will make them accept the system and adopt the change easily*" (Expert 10).

c) Enhanced patient safety

Most experts reported that one of the most important benefits of EHR from the perspective of a physician is enhancing patient's safety through decision support capabilities, as two experts explained:

"The system must help in improving patient's safety, and there are systems that do not, if it is just a data entry system without clinical decision support, the adoption will decrease, the physician will find no value in using the system" (Expert 1)

"We had one the of the physicians completely resisting the system and trying to convince others not to use it. Later, after a few years of implementation I met him, he became one of the most supportive people for EHR systems. He said I did not realize the benefits until after 3 or 4 years, I started to feel that the system is providing me with things that are very powerful, in knowing my patients, sometimes when I am at home I receive an alert about a critical result, this could save patients' lives" (Expert 10)

d) Improved quality of care for patients

This dimension was expressed by most experts. Again, the EHR should provide a comprehensive view of patients' information and support continuity of care, as explained by one expert:

> "*The EHR improves quality of care, the physician will be able to view information held by various clinics about the patient, this helps in continuity of care, there will be no fragmented information*" (Expert 1)

Having a complete history of the patient allows for better decisions for patient's care and results in increased perceptions of improved quality of care for patients, as one expert stated:

> "*If he has a holistic view of patient's medical information in one screen, he knows if this patient is a diabetic patient, or has allergies, or is a high risk patient, the system should handle it and give him these information directly instead of looking into and searching in many papers where he may not get these information*" (Expert 9)

An important motivator toward EHR adoption reported by many experts is improved follow-up and monitoring of patients' health condition, as one expert reported:

> "*If he has a chronic disease patient, he can do a correlation between the medication he takes and the blood pressure or sugar level for example, is it under control? Or do I need to increase or decrease the dose, so these functionalities enable him to improve the quality of care for the patient*" (Expert 9)

e) Improved communication between healthcare providers

Five experts reported that an important indicator of EHR usefulness from the perspective of a physician is improved communication between healthcare providers. One expert reported that the absence of referral tools decreased physicians' perceptions of usefulness of the system, as stated by the expert:

> "*We changed the previous system because it was not much useful for physicians. The documentation was almost on paper, and no referral tools for other physicians*" (Expert 3).

A major challenge in the current primary healthcare system is the lack of electronic connection between primary healthcare centres and hospitals. Most primary healthcare centres make the referrals to hospitals manually, which is an inefficient process in which the feedback may not arrive from the hospital, as one expert stated:

> *"There is no [electronic] connection between the primacy healthcare centre and the hospital. When the primary healthcare physician makes a referral to the hospital [in paper], the patient takes this referral and goes to the hospital, the hospital will do more advanced investigations and identify the condition of the patient and provide the treatment, then the patient will follow up with the primary healthcare physician. However, the primary healthcare physician does not receive the feedback from the hospital, and he has no ability to view the patient's record at the hospital's system"* (Expert 6).

In KFSHRC and NGHA, the EHR enabled the connectivity between the affiliated primary healthcare departments and the hospital, and this was one of the main reasons for perceived usefulness of EHR by primary healthcare physicians, as explained by one expert

> *"This problem has disappeared in NGHA, the primary healthcare physician has the ability to view patient's information at the hospital. This led to patient's trust in the primary healthcare physician, because he knows his condition and will not give him a wrong medication or make a wrong diagnoses. This connectivity made the system very useful from the perspective of the primary healthcare physicians"* (Expert 6).

f) Empowering patients

Two experts explained perceived usefulness of EHR in terms of empowering patients. Perceptions of usefulness will increase if the EHR helps in involving the patient in decision making by providing him/her an access to his/her personal health record, as one expert reported:

> *"I want the patient to participate in decision making by allowing him to access his or her record, for example if we made a diabetes screening test, the patient can view the result on his or her personal record"* (Expert 2).

Also, improving the communication with patients was another important element that is expected to increase perceptions of system's usefulness, as reported by one expert:

> *"The presence of EHR will help communicate with the patient. I will give you an example, if I have vaccinations, when the MOH used SMS as a reminder for vaccinations, the load on primary care centres increased substantially. Therefore when you are able to communicate with patients more, and when you are able to know the condition of the patient with all details, the medications he takes, his allergies, practically you will be able to make prevention of major problems before they happen"* (Expert 4).

In summary, the characteristics of an EHR system that were acknowledged most and will make an EHR system useful for a primary healthcare physician are: improved job performance, quick and easy access to information, improved quality of care for patients, improved communication between healthcare providers, enhanced patient safety and empowering patients.

7.4.2 Perceived Ease of Use

All experts reported the critical importance of perceived ease of use on physicians' acceptance of EHR. Perceived ease of use is essential for system acceptance even if the system is perceived as useful, as one expert stated:

> *"if I brought him a system, although he knows the benefits of it, but if it is not easy to use, he will not accept it, it will be difficult to adopt"* (Expert 1)

The following minor themes emerged from experts' responses regarding what constitutes perceptions system's ease of use by physicians. The minor themes are listed below in the descending order with regard to the number of comments supporting each theme:

a) Time required for data entry

All experts stressed the importance that the system should help the physician to enter data faster. Entries should be made in the form of closed-ended questions as possible rather than text. Also, the more data entry tasks required by the system, the more the system will be perceived as complex by physicians. As one expert reported:

> *"If I have a system that is text-based or designed with more keyboard entries, the acceptance will be more difficult for us, and this is something I am sure of. Because of this I sometimes return to the developers and request changes… If we make all the data entries in the form of radio buttons or check boxes, always the acceptance will be better"* (Expert 4).

Not only reducing the data entry tasks is required, but also providing tools that can help in simplifying these tasks such as speech recognition systems, touch screens, or digital boards for handwriting are extremely important and were recommended by most experts, as one expert reported:

> *"Time to enter data is very important, the majority of companies are now trying to introduce logics or rules, business rules, to make the system thinks and do things on behalf of the physician, they are reducing the number of clicks, they are reducing the number of*

entries the physician has to do, just to help increasing physicians' acceptance or adoption of the system. They introduced tools such as voice recognition when we talk about dictation. There have been touch screens and using pens on the screens, using the tablet, so all of these they are extremely important" (Expert 10).

b) Interference with physician-patient communication

Most experts reported that the complexity of the system could affect physician-patient communication negatively, which forms a barrier to the use of the EHR by the physician. The negative effect on physician-patient communication may result in the dissatisfaction of the patient about the care provided and this may limit the acceptance of EHRs by physicians, as explained by one expert:

"Doctor-patient relationship worsens if the physician has to enter the data during the time he is required to see the patient, If the system is complex and difficult and its use requires more time, this affects negatively the ability of the physician to communicate with the patient" (Expert 4)

Selection of an EHR solution should take into consideration this aspect. EHR solutions that aim to enhance-physician patient communication by reducing the complexity of the system and introducing communication channels with the patient should be selected, are stated by one expert:

"*Now they [EHR vendors] have reduced the level of complexity and provided tools to make the system less complex and more useful. They have introduced channels of communication between the physician and patient, such as patient portals, instant messaging that comes between physicians and their patients. These systems are empowering patients. I am talking about the solutions that are classified as good solutions, I am not talking about EHRs that are ranked low in the market, these do not help in that aspect. In general, if we talk about proper EHRs that are in the market, they play a major role in communication with the patient*" (Expert 10)

c) Initial workload increase

Eight experts reported that system use at the beginning is expected to require an extra time and workload until users get used to the system. This initial workload increase may cause user frustration and resistance. It may lead some physicians to do the work twice, on paper and then on computer, or request the nurse to enter the notes into the system later, as explained by one expert:

"In the beginning initially people were resisting because normally on the paper it took them two minutes to write all of their investigations, now they have to go to the computer. Initially it took them 10 times or even 20 times more than the time they spend on the paper, and people were not happy. Either they write it on a paper and then they request the nurse to type it on the computer, which is completely wrong, or they do the work twice [on paper and then on the computer]" (Expert 8)

Therefore, five experts stressed the importance of reducing the number of appointments at the beginning of implementation, as one expert reported:

"Always in any EHR implementation, at the beginning of implementation, it is very important to reduce the appointments by certain percentages to help in the adoption. Because physicians need time to adopt, they need to see fewer patients so that they can realise the benefits gradually. Always there are recommendations to cut down the appointments between 30-40% depending on the volume; this will tremendously help physicians to adopt the system easily. And then the appointments can be increased gradually after two or three months. You reduce and then you start to increase" (Expert 10)

d) Ease of navigation

Nine experts reported ease of system navigation as one of the most important dimensions of perceived ease of use by physicians. It is important that all system components are accessible during one login, and that links to these components are easily accessible in one screen, as explained by one expert:

"The more the functions a physician needs are easily accessible from one screen, during one login, without the need for more than one login, the more the system acceptance will be easier. And I have many systems in the hospital, and I see the difference between them. One of the systems requires you to open four screens in order to enter a type of data or to read this same type of data, this system I really face a difficulty in convincing people to use it, even the people who know how to use it, they do not want it" (Expert 4)

e) Time to master the system

Five experts expressed ease of use in terms of ease of learning and mastering the system. Physicians may not be able to spend a long time on learning how to use the system, which may affect the adoption of the system, as reported by four experts:

"The system should be easy to use and does not require the physician to spend a long time whether on training or use" (Expert 1)

"Physicians are very busy, he [the physician] says I cannot leave the work for two days for training" (Expert 12)

"For an EHR system to be efficient and easy to use, it should be easy to learn directly by individual users and it should be understandable using common sense" (Expert 6)

7.4.3 Computer Self-Efficacy

All experts supported the significant influence of computer self-efficacy on physicians' adoption of an EHR system, as reported by two experts below:

"Some physicians who were resisting, he says that he came to see the patient not to work on the computer. This is because he does not have knowledge on how to use it and the ability to use it effectively" (Expert 9)

"The third challenge, is the fear from technology, for them EMRs or EHRs or IT in general is a black box… when they do not see the expected data right away they jump to the conclusion that the system is not working" " (Expert 7)

One expert reported that it is important to make a proper assessment of physicians' computer skills before system implementation and to provide training on areas that need improvement, as stated by the expert:

"It is very important that the physician advocate or the implementation team makes a proper assessment of physicians' computer skills before the implementation. And if there are specific areas that need to be improved, and they helped in this, I think it is worth" (Expert 10)

Minor themes emerged from the interviews regarding computer self-efficacy are discussed below. The themes are listed in the descending order with regard to the number of comments supported each theme:

a) Training

All experts stressed the critical significance of training. In fact, many experts considered training as a critical success factor for EHR implementation, as reported by two experts:

"There must be a training plan at the implementation and before the go live, during the go live and after the go live. Training is a critical success factor in the beginning, because

at the beginning people will not accept the change, especially the physicians, the physicians are very difficult to convince, if he finds the colour of a field changed he will say no I won't use it" (Expert 4)

"Many times projects fail because of lack of training. Once they do not get training they cannot use the system and cannot get the work done…or the worse, he would share his user name with the nurse to finish his work… Training is extremely important, and continuous training it is not a one-time training, it should be continuous and follow-up" (Expert 7)

Some healthcare authorities do not provide training to users, and this might be a barrier to EHR adoption, as reported by one expert:

"We underestimate the capabilities. There are no training programs for them, the HIS [Hospital Information System] comes and people are requested to start working on it and they might fail, they might not know how to perform their tasks with it, it takes much more time for them to accomplish their work" (Expert 8)

Many experts stressed the importance of providing continuous training. Especially for primary healthcare centres affiliated to large healthcare authorities such as the MOH, continuous training is extremely important because of the high level of turnover by physicians, as reported by one expert:

"In primary healthcare enters in the KSA, we have a large percentage of turnover especially in rural areas. This is because most of the physicians are expatriates and therefore their turnover is quick, may be less than two years, and someone new comes in his place. Therefore, it is important to provide an online-training course or that training programs are arranged for the newly employed physicians. So continuous training is especially important for large healthcare authorities such as the MOH because the turnover there is high, you do not want the system to stop when you changed the physicians" (Expert 6)

Experts recommended providing multiple methods for training, providing one-to-one training for those resisting the system and making the contents of training available to physicians, as explained by the experts below:

"The methods of training need to be done in an innovative way to deliver these materials. Do not only depend on the typical and old approach. Use multiple methods of training and be innovative. Make use of nowadays-social media to deliver the message. Do not depend on the manual method of training, or training z and x, no, deliver it in methods that could

be nice like these innovations to attract physicians. In each method of training, you will attract a specific group of people. Different methods in delivering training will make the adoption greatly faster” (Expert 3)

“Some users will start to seek for any reason in order not to use the system. The solution for these cases is simple, he can talk to the CEO or his head, and he will assign someone to help him in the form of one-to-one training, not group training, usually this lasts for only few days” (Expert 5)

“You have to invest that the content of training is always available, and accessible from anywhere, the content should be written in a way that is really smooth and can be easily understood by healthcare professionals, this is very important. The contents should not only be in the form of text or slides, there have to be videos as well” (Expert 3)

Almost all experts stressed the importance of providing training through champions and super users as explained later in social influence factor (section 7.4.4, (b), (d)).

b) IT support

Almost all experts stressed the importance of providing immediate IT support, as two experts stated:

“If the level of support is not up to the standard, the physician will eventually abandon the system. He will say I cannot keep the patient waiting 10 minutes or 20 minutes until the IT replies to me to tell me what to do” (Expert 7)

“The presence of IT support staff is important whether inside the primary healthcare centre or supporting three primary healthcare centres for example, so that if the physician encounters a problem such as the patient’s record was not found, the patient will not be delayed” (Expert 6)

At the beginning of the implementation, it was strongly advised by most experts to provide IT support by super users, as explained later in social influence factor (section 7.4.4, (b), (d)).

7.4.4 Social Influence

All experts reported that the social side is a very important factor in the success or failure of EHR projects, as stated by two experts:

“The whole social environment around him, if it is positive he will change with them, he will step with them, and vice versa if the people around him are complaining about the

system, he will start building barriers and barriers over that. It is a very careful approach, because if someone's attitude becomes extremely negative, it is very difficult to win his attention again" (Expert 8)

"Let me tell you the social side in our country is the one that makes projects succeed or fail" (Expert 4)

Sources of social influence are discussed below. They are listed in the descending order with regard to the number of comments supporting each source:

a) Senior management support

All experts reported the crucial role of the senior management in pushing the adoption of EHRs forward. Without direct support and commitment by the senior management, the project may not succeed, as explained by two experts:

"Now because of the importance of management, the major international companies or the main health IT suppliers, before they start any project they do something called strategic assessment, the most important thing in strategic assessment is not to assess the building or the readiness of the infrastructure, no, it is mainly to assess the management or the decision support process in the organisation and they give a clear recommendation that in order for you to achieve your goal, you need to have a proper decision making and you need to have a quick response. For example, if there is a specific change, there must be enforcement from the MOH or the CEO of the organisation or even the manager of the organisation etc. If there is no support and no enforcement, you will definitely fail in the adoption. Because physicians are very difficult people to deal with unless there is a strong management that is clear and having solid goals and objectives" (Expert 10).

"Higher management support or influence is the key success factor for system acceptance. If the manager said no more orders can go to the pharmacy except through the system, it is done, people will have no other choice. But if he allows paper and electronic orders, people will refuse the system… The senior management support is make it or break it, literally. If the manager is not strong and weak, physicians are the most difficult people in these systems. If you ask me about one main reason for our success, I will say it is the senior management support" (Expert 2).

b) Peers influence

Peers influence was the second most frequently reported source of social influence reported by experts. All experts reported that the presence of champions from the physicians' team to act as change agents for the project and to market the system and promote for it is essential for system success, as explained by two experts:

> *"We had 5 or 6 physicians who were the leading physicians' team, they were responsible for the awareness before the implementation. They visited every department and made a presentation about the system and its benefits. When the physician gets the information from another physician, this helped in paving the way for the go-live. So it is very important to have champions from the physicians themselves because the physician accepts the information from a physician, but not from an IT specialist"* (Expert 12)

> *"The strategic mistake is that, the physician is a logical person, I mean when you come and tell him that I will implement the system, he views it as a pure IT system, just another version of paper charts… Who is the right person to convince them about the benefits? he should be a physician or a person who talks to them in their own terminology. Because of this many, many physicians resist technology more than others because people in charge of the implementation fail to consider that the person who talks to them should be a physician"* (Expert 10)

In addition, it is essential to provide training and technical support at the beginning of implementation through champions and super users, as explained by two experts:

> *"Physicians can talk easily to other physicians. They will accept it from their colleagues more than from someone who they consider a programmer. If he said the system is difficult, and another physician came and said you see only 5 patients in the clinic, I see 20 patients and I am using the system and it is good and these are the added values, he will accept it more. So, peer pressure is important, therefore we let physicians be trained only by other physicians, or nurses, so that they can answer their clinical questions"* (Expert 2)

> *"You will need what is called subject-matter experts from the physicians to go and train the physicians, assist the physicians, solve their problems, understand their issues. And that's what the word CMIO [Chief Medical Information Officer] means, he is the layer between the IT and the medical group, you need physicians to talk to physicians, IT cannot talk to physicians, unless he has a degree in health informatics and these are very rare. And you have to put someone respected in the physician community to speak to them, someone who is proactive in the medical group"* (Expert 7)

A good practice is to select champions and super users from the senior physicians, as this will affect the adoption of the system positively by younger physicians, as explained by one expert:

"I was training the physicians in 2002, and a team of senior physicians were training with me. If the residents and fellow physicians see the senior is training, it's done, they will adopt the system easily" (Expert 2)

One of the important motivators that increased the use of the system by physicians in a major healthcare authority was the use of social networks to promote the use of the system among physicians, as reported by one expert:

"We created a social network for physicians, any physician who has an idea, a specific method he discovered in working with the system that could simplify the life for others, I mean in how to work with the system, he can share it through WhatsApp as a video clip and we announce it under his name. So when we created a social life among those, everybody wants to show that he is capable to use the system, he shares the video, how you can do this from line A to Z. This social network also created another training material, it is not structured, but nice and the people like to use it especially the middle aged and junior physicians" (Expert 3).

c) Perceptions of patients' attitudes

Seven experts reported that physicians' perceptions regarding patients' attitudes, i.e. whether they are welcoming the use of EHR or are uncomfortable with it, could influence physicians' attitudes toward using the system. Therefore, negative attitudes of patients can impede the adoption of EHR by the physician, as expressed by one expert:

"We have in the KSA the issue of attention or cultural aspect, some people you need to give them a specific attention to feel that you are treating him and that you are with him and that you are passionate with the patient, and these things are influential because the physician if he used the computer and turned to the screen to write while the patient is in front of him some people get offended. Many of the physicians lose this balance at some point, so I think it is very important" (Expert 10)

On the other hand, positive patients' attitudes are an important motivator toward the adoption of the system, as explained by one expert:

"The patient experience is important, when the patient feels that his information is already in the system and that it is being managed correctly, this builds up trust on the physician who uses the system" (Expert 11)

d) Other medical staff's influence

Eight experts reported that other members of the healthcare team could impact the adoption of EHRs by physicians, as stated by one expert:

> *"Motivation has two types: a group motivation, at the level of the primary healthcare centre, and individual motivation, at the level of individual users. Individual motivation is good but what is better is the group motivation, because in a group motivation all individual stakeholders support each other"* (Expert 6)

Many experts reported that training and IT support at the beginning of implementation can also be provided by the other members of the healthcare team such as nurses, as explained by one expert:

> *"It is not necessarily that super users are only physicians, we had super users who are nurses. They received an advanced training on the system as a physician user. These were assigned completely to help physicians at the beginning of the implementation, if any physician has a problem, for example, he does not know how to order a specific medication or how to enter his notes, the super user is available and will come directly and help him… this helped the physicians greatly"* (Expert 12)

7.4.5 Physician Participation

All experts stressed the significant importance of physician participation in EHR implementation. It was strongly advised by all experts that physicians should participate heavily in EHR implementation from the very beginning. This includes: requirements analysis, selection and customisation of the system, workflow re-design, usability testing, and continuous feedback evaluation. Physicians should have a high psychological ownership of the system and the project should be perceived as a providers-driven not an IT-driven project, as three experts explained:

> *"I emphasise this hundred times, implementing an EMR or an EHR is not an IT project. As soon as they consider it an IT project, it becomes a failure. It is an organisational project, a strategic project touching the organisation. So everybody involved, everybody has ownership in the implementation of this project. IT [department] is an enabling tool, an empowering tool, IT [department] provides the technology and everything but to get the business value out of it, it is the responsibility of both the IT [department] and stakeholders"* (Expert 7)

"You as an IT [department], you have to be a back-end supporter and facilitator. The physician has to own the solution… Physician participation starts from the selection and continues until the implementation of the solution" (Expert 3)

One expert reported that this factor is almost absent in most healthcare organisations, which is one of the main reasons for the failure of most EHR projects:

"This factor in my opinion is the most important factor. And it is almost completely absent in most healthcare organisations. Most organisations do not ask physicians about their opinions effectively, and most decisions are limited to managerial decisions, which are far different from reality. And this makes the system fail on the long term" (Expert 4)

7.4.6 Perceived Threat to Physician Autonomy (PTPA)

Eight experts reported the importance of PTPA in affecting the adoption of EHRs by physicians, as explained by one expert:

"The physician likes to be a black-box, no one knows what he is doing. Let's admit that they are the leaders in the hospital. Some physicians think that this system was put to monitor them or to spy on them or to measure their performance, how many patients he sees, how many hours he works. We need to assure them that the system was not put for this, it will enhance the patient journey, it is not here to monitor the practitioner or to measure his performance" (Expert 5)

However, five experts reported that the more the perceived usefulness and ease of use of the system, the less the PTPA, as explained by one expert:

"The more the system is perceived as easy to use and useful, the more the physician will be inclined to it and will overcome the limitations… PTPA may increase or decrease based on the solution we select, we are supporting this feeling if we selected a system that is bad, not helping the physician, and at the same time counts his mistakes" (Expert 6)

In addition, three experts reported that the presence of a strong support and commitment by the senior management is essential in order to reduce resistance due to PTPA, as explained by one expert:

"Yes, it is really important, because there will be KPIs on the productivity of physician, the number of patients he has seen, number of surgeries he has made. It is very critical; especially when it is a private organization sometimes the pay is based on the productivity. So, definitely physicians do worry, and this is one of the reasons for their resistance,

because it will measure their productivity. I have seen this in the hospital, some physicians were resisting because of this. But this is not a very important factor if there is a strong leadership" (Expert 1)

7.4.7 Attitude

Attitude is reflexive of the other factors, as two experts reported:

"Attitude is reflexive of some of the factors we mentioned, it could also be reflexive of a failure story in another hospital" (Expert 2)

"The people complaining about the system, when we investigated their complains we found that the complains have no reason. He is internally against the system and doesn't want to learn. Many factors contributing there is no clear concept to describe this" (Expert 8)

Most experts stressed the importance of making awareness programs prior to system implementation through champions in order influence physicians' attitudes toward using the system, as two experts explained:

"We created an awareness campaign several months before the implementation. Our team, the champions who were physicians, went to the departments and explained to people about the system and its benefits. They also distributed brochures and posters. We also made a paper-off day to release the project, and we made a presentation to explain about the project and its importance" (Expert 12)

"For awareness you have to use multiple methods, intranet, mobile apps, SMS, social media, all methods available. And choose based on demographics, the junior physicians and nurses are more into social media, so use multiple methods for awareness, this is very effective and very important" (Expert 3)

Moreover, the expectations of physicians should be managed properly as very high expectations may lead to disappointment when the system is implemented, as one expert explained:

"Sometimes the expectations become very high, and if the expectations become very high, the acceptance of the system will decrease upon the delivery… Therefore you need to manage this part, you need to manage the expectations of people and keep them always involved in decision making" (Expert 4)

7.4.8 Confidentiality Concerns

Eleven experts disagreed to the importance of confidentiality concerns in affecting physicians' decisions to adopt EHRs. Most experts (7 experts) reported that confidentiality concerns are mostly concerns of the patient or the healthcare organisation rather than the physician or the other end users. Other experts (3 experts) reported trust as an explanation for their disagreement to the importance of this factor, and one expert reported that the EHR system in fact increases the confidentiality of data, as explained below:

> *"I don't think so. Long time ago we were looking to the computer system that it is possible to be accessed by anyone and data can be seen by anyone. But now everyone knows that the confidentiality is reserved and protected on the computer and that every user has a username and password"* (Expert 11)

> *"I don't remember that any of the physicians was rejecting the system because of confidentiality concerns...people underestimate things rather than overestimating"* (Expert 8)

> *"No, this is not a barrier. The paper file is more vulnerable to confidentiality breaches. The person who brings the file to the physician can view it from the beginning to the end while he/she is in the elevator and no one knows about this. Whereas in the EHR, there are logs and privileges, who are you to access this file and what is your relationship with the patient, and you cannot change anything in the system's log"* (Expert 2)

> *"In my opinion confidentiality concerns do not affect the physician's decision, rather they affect the organization's decision"* (Expert 4)

> *"Data confidentiality may be a concern of the patient not the physician or other end-users"* (Expert 5)

7.5 New Factors Emerged from Experts' Interviews

One new factor emerged from experts' interviews, *compatibility*. Eight experts stressed the importance of compatibility on the adoption process. In IT adoption context, compatibility refers to the degree to which the system matches users' prior experience, existing values, practice needs and individual requirements (Moore and Benbasat, 1991). When implementing an EHR system, changes in the work process may be required. Introducing two changes at the same time, i.e. process and technology, increases users' frustration and may lead to failure. Most experts stressed the importance of not introducing two changes at the same time. If the current work process is not compatible with the system, it is important to perform *Business-Process Reengineering* (BPR) before the system is implemented. Also, the optimised workflow should be implemented gradually, i.e. changes in the work process should be minimised until the users are used to the technology, as two experts explained:

> *"With the system there might be a change in the process, a change in the form of documentation, and changes in the way of providing primary care. So it is important not to do two changes at the same time. The regulators sometimes use the technology as a way of changing work procedures, and this is an extreme risk… You need to change the process and the form of documentation, then introduce the technology"* (Expert 9)

> *"Now we start the issue of change with the change, when you implement a new system you are changing the technology, sometimes when you change the technology you have to change with it another change which is process, this is scary. You have to minimise the change in process, do not do multiple changes at the same time. If you do both changes people will be confused, this sometimes increases frustration. Once people are used to the technology you can refine the processes in a second frame, multiple changes normally lead to failure"* (Expert 3)

Another important aspect of compatibility is tailoring or configuring the system itself to the needs of different specialties and allowing individual physicians to further tailor the system to their own use. This issue should be put into consideration during the selection and customisation of the system, as one expert explained:

> *"Before, they [EHR vendors] were trying to come up with a unified use, the same as what is happening with papers, with papers there is only one form of progress notes and is used by different people. Vendors or suppliers started to realise that I need to focus on what is written on the paper not the paper itself. So, before, they were developing it as one complex screen where you can capture massive data, and these systems were very difficult for physicians to adopt. But now vendors started to reduce the complexity by tailoring the solution or views to the specialty level and at the same time they provided the physician the ability to tailor it more to his/her own use. So this factor was very influential on the issue of adoption"* (Expert 10)

A major problem with most of the implemented or piloted EHR systems in primary care practices in the KSA is that they are not specialized in primary healthcare, rather, they are an extension of the hospital system, thus lacking the business value of primary healthcare, as one expert explained:

"Most systems implemented in primary healthcare enters in the KSA are not specialised in primary care, they are either an extension of the hospital's system or a polyclinic system, so the business values required for primary care are not supported by these systems… So the physician, if they brought him a system that is not compatible with his work process, the system does not encourage him because it does not help him in his work and does not support his decisions, for example, guides him to the steps, alerts him when there are errors, all of these make the physician excited and feel that the system is useful" (Expert 6)

7.6 Summary of the Findings

Table 7-3 summarises the main themes (i.e. factors) and sub-themes (i.e. dimensions of large and complex factors) identified from experts' interviews and discussed in the present chapter. In summary, nine main themes were identified from the interviews, eight of which represent the factors in the proposed framework (i.e. deductive analysis) and one theme represents the new factor, c*ompatibility*, which emerged from the interviews (i.e. inductive analysis). Four factors, particularly: perceived usefulness, perceived ease of use, social influence and computer self-efficacy, had large and complex themes. Based on the thematic analysis process described by Braun and Clarke (Braun and Clarke, 2006), these themes were divided into sub-themes in order to demonstrate the hierarchy of meaning within them. The themes and sub-themes are sorted in Table 7-3 in the descending order with regard to the number of comments relevant to each theme.

Experts' evaluation of the proposed framework revealed that all the proposed factors have an important effect on EHR adoption decisions by physicians, except confidentiality concerns, which was not reported to have an important effect by most experts. In addition, the new factor identified from the interviews, *compatibility,* was reported to have an important effect by eight experts. The findings also revealed a number of dimensions that define or determine perceived usefulness and ease of use of EHR systems by physicians as shown in Table 7-3. Two important dimensions of computer self-efficacy were identified, training and IT support, which were strongly supported by almost all experts. In addition, important sources of social influence that affect EHR adoption behaviours by physicians were identified. A detailed discussion of the findings relevant to each factor is provided in Chapter 9.

Table 7-3. Themes, sub-themes and the number of coded extracts from experts' interviews

Main themes (Factors)	Sub-themes (Dimensions)	Coded extracts from experts' interviews
Perceived ease of use		115
	Time required for data entry	27
	Interference with physician-patient communication	18
	Initial workload increase	18
	Navigation	15
	Time to master the system	9
Perceived usefulness		110
	Improved job performance	23
	Quick and easy access to information	21
	Enhanced patient safety	14
	Improved quality of care for patients	12
	Improved communication between healthcare providers	9
	Empowering patients	2
Computer self-efficacy		91
	Training	44
	IT support	23
Social influence		86
	Senior management support	37
	Peers influence	24
	Perceptions of patients' attitudes	10
	Other medical staff's influence	8
Physician Participation (PP)	N/A*	47
Perceived Threat to Physician Autonomy (PTPA)	N/A*	32
Compatibility (COM)	N/A*	24
Attitude toward EHR (ATT)	N/A*	16
Confidentiality Concerns (CC)	N/A*	12

* Codes identified cannot be grouped into sub-themes (see Appendix C)

7.7 Conclusion

The interviews with EHR implementation experts have enriched the proposed framework with significant insights. The study reported in this chapter found that eight main factors are associated with EHR adoption by physicians, namely, perceived ease of use, perceived usefulness, computer self-Efficacy, social influence, physician participation, compatibility, perceived threat to physician autonomy, and attitude toward EHR. As the views of interviewed experts are based on extensive practical experience in EHR implementation, this increases the trustworthiness of the results. However, in order to increase the validity and credibility of the findings, it is important to investigate the perceptions of primary healthcare physicians. The next chapter reports on the findings of interviews with primary healthcare physicians.

Chapter 8 Findings of the Interviews with Primary Healthcare Physicians

8.1 Introduction

The aim of this chapter is to report and discuss the findings of interviews with Primary Healthcare (PHC) physicians. These interviews were conducted to validate the existing factors in the framework, to explore other important factors and to obtain an in-depth analysis on what defines these factors in the context of physician adoption of EHR systems. In the following sections, characteristics of respondents are described. Then, physicians' responses regarding existing factors in the proposed framework are discussed. After that, new factors emerged from physicians' interviews are discussed. Finally, a summary of the findings is provided.

8.2 Description of Primary Healthcare Physicians

An overall description of primary healthcare physicians is provided in Table 8-1. The sample included the Assistant Deputy Minister for Primary Healthcare, the chairpersons of primary healthcare departments at KFSHRC, NGHA and KKUH. Four physicians are supervisors of primary healthcare sectors at the MOH. Two physicians are medical directors of primary healthcare centres at the MOH. Ten physicians are family physicians and two physicians are other primary health physicians, particularly: a general obstetrician/gynaecologist and a specialist of public health.

All physicians have at least five years in medical practice. Physicians have varied EHR experience, locations, gender, age and years in medical practice. Eight physicians are from the MOH, two physicians are from KKUH, and one physician from each of KFSHRC and NGHA. Finally, four physicians have an EHR implemented at the primary healthcare practices they are affiliated to, five physicians had an EHR piloted but discontinued at their medical practices, and two physicians did not have an EHR system at all in their medical practices.

Table 8-1. Overall description of primary healthcare physicians

Position	Assistant Deputy Minister for Primary Healthcare	1
	Supervisors of primary healthcare sectors	4
	Chairpersons of primary healthcare departments at major healthcare authorities	3
	Medical director of a primary healthcare centre	2
	Others	2
Specialisation	Family physician	10
	Others	2
Years in medical practice	20 years or more	5
	15 – 20	2
	10 – 15	3
	5 – 10	2
Years of EHR experience	20 years or more	2
	15 – 20	2
	10 – 15	0
	5 – 10	4
	1 - 5	2
	No experience in EHR	2
Healthcare authority	Ministry of Health (MOH)	8
	King Khalid University Hospital (KKUH)	2
	King Faisal Specialist Hospital & Research Centre (KFSHRC)	1
	National Guard Health Affairs (NGHA)	1
Location	Riyadh	5
	Dammam	3
	Alqatif	2
	Aljouf	1
	Jazan	1
EHR status in the primary healthcare centre /department	EHR system implemented	4
	EHR system piloted but discontinued	5
	No previous implementation or piloting of EHR system	2
Age	50 years or more	5
	40 – 50	3
	30 – 40	4
Gender	Male	9
	Female	3

8.3 De-Identification of Participants

To maintain confidentiality, the numbering of primary healthcare physicians reported in this chapter is not following the ordering of participants described in Section 8.2.

8.4 Physicians' Evaluation of the Proposed Framework

Details of physicians' responses regarding the importance of the factors in the proposed framework as well as minor themes emerged from the analysis are provided in the following subsections.

8.4.1 Perceived Usefulness

All physicians reported the critical the importance of perceived usefulness on the acceptance of EHR, as one physician stated:

> "*An automated or a semi-automated system is better than the situation now. In terms of documentation, ease of work, extracting indicators, and many other things. The primary healthcare centre that has a partial EHR system is better than the one that works completely with paper records*" (Physician 1)

One physician reported an example of a currently used system for chronic disease management, which was funded and adopted by a group of primary healthcare physicians in a major province. According to the participant, the successful adoption of this system provides evidence that perceived usefulness plays a major role in physicians' adoption of EHR, as explained below:

> *"We have a system I can't say it is a full EHR but it is for monitoring the quality of chronic disease management programs in one of the health sectors in the province with around 30 primary healthcare centres. This system is completely successful despite the so many barriers and despite that the system is self-funded, it is not funded by any program or by the ministry, it is funded by the people working in chronic disease management. This provides evidence that if the user is convinced with the system, he will be motivated for it and he will adopt it even if he pays for it from his own pocket"* (Physician 6)

However, perceived usefulness should be viewed from the perspective of a primary healthcare physician, as one physician explained:

> *"If they see its usefulness, they will adopt it. However, its usefulness should be viewed from their perspective, not from the perspective of the manager or the IT engineer"* (Physician 6)

The following minor themes emerged from physicians' responses regarding perceived usefulness. These minor themes explain what makes an EHR useful from the perspective of the primary healthcare physician; they are listed below in the descending order with regard to the number of comments supporting each theme:

a) Improved job performance

All physicians expressed the usefulness of EHR in terms of improved job performance. Particularly, it is important for primary healthcare physicians that the EHR improves documentation of patients' encounters, provides a better workflow support, supports a physician's decisions and saves a physician's time, as explained by three participants:

> *"Mainly the documentation, he [the physician] will see his own documentation every time he wants to see the patient. What happens now is that the patient comes sometimes without a file because the file is lost in another clinic. With an EHR, the documentation will be systematic, you will see your own records in the system whenever you encounter the patient"* (Physician 9)

> "*Useful means integrated, it has decision support, easy workflow, I have all the resources automated*" (Physician 1)

> *"they became motivated to use the system [a system for chronic disease management implemented by a groups of physicians] because they realized that it saves their time and effort"* (Physician 6)

One physician, who had tried the pilot EHR system, reported that one of the main reasons for the unsuccessful adoption of the system was that the documentation of encounters was not completely electronic, which requires the physician to go back and forth between paper files and the electronic system, as stated by the physician:

> *"The previous system didn't succeed because it was not serving the goal, it was not supporting patient-centred care, this was very disappointing... there was no place to enter clinical notes in the system"* (Physician 8)

b) Quick and easy access to information

Many physicians reported that paper files and test reports are sometimes lost. In some primary healthcare centres there is a shortage of medical records' staff. Also, test reports are sometimes placed in the wrong order within the record. As two physicians explained:

> *"Imagine when I receive a case with specific symptoms and I don't know what did this case have before, for one reason, the file is lost. This problem happens to me frequently once a day or once a week with the paper medical records"* (Physician 6)

> *"Sometimes you don't find the papers because people who made the classification of papers put them in the wrong place [within the record]"* (Physician 5)

Therefore, improving the availability of patients' information is considered among the most important motivators toward EHR adoption by physicians. Moreover, a major advantage expected with the use of EHR and reported by most physicians is the ability to visualise and analyse the data, as one physician reported:

> *"Previously, with a paper-based record, I had to spend time searching for a specific data… and the file is sometimes large and not organised. But now, with the EHR, I can access lab reports with just one click, even the old reports are retrieved, this is a very excellent feature, I can browse them in one minute… Especially the system in another medical practice, you can visualise data such as trends… so you can make a follow-up easily, it was great"* (Physician 7)

However, in some EHR systems, data retrieval is a complicated process, which could reduce perceptions of system's usefulness, as reported by one physician:

> *"in our system it is sometimes silly to order a medical report, it will take a huge number of clicks to issue one medical report and this is not because the user, it is the system's problem"* (Physician 11)

c) Improved quality of care for patients

Most physicians expressed the usefulness of an EHR in terms of improving the quality of care for patients. One physician stated that improved quality of care is the most important advantage of EHR systems, as follows:

> *"The benefit in my opinion is that it helps providing comprehensive care and in high quality...this is the most important point in my opinion"* (Physician 10)

A very frequently mentioned motivator reported by physicians was improved monitoring and follow-up of patients' health condition, which is particularly important for chronic disease management in primary healthcare, as explained by two participants:

> *"I can retrieve the KPIs and know how many patients are controlled in diabetes and how many are uncontrolled"* (Physician 10)

> *"For me, it greatly helped me, greatly, in the follow-up with the patients… even the patient himself, when he sees that in a second I can get data on what medications he had before and what investigations he made, these things are very difficult to find in a paper record"* (Physician 7)

In addition, one of the main advantages discussed was reducing the patient's waiting time in the primary healthcare center. This advantage is particularly important in the KSA because there is no appointment system in primary healthcare centres, rather, patients come and register in a waiting list and are served in the order in which they arrived, as one physician explained:

> *"The system will improve quality of care for the patient. For example, I can know the time the patient arrived to the centre. This is one of the most important factors. I can know when did he come and how long he waited until he was seen by the physician. This is not happening with paper records. The patient comes and registers and may wait for one hour or for ten minutes, he doesn't know when will the physician see him, it depends. The EHR system will enable me to improve my KPIs, that is, how long my patient waits in order to improve the quality. I can know the waiting time in clinic A and compare it to clinic B"* (Physician 10)

d) Improved communication between healthcare providers

For an EHR to be perceived as useful by primary healthcare physicians, it should improve the communication between healthcare providers, including departments within the same primary healthcare centre, the supervisory primary healthcare centres, the regional labs, and the hospitals. Most physicians discussed the critical importance of having these types connections. However, physicians who experienced the pilot EHR criticised the system for not providing this feature, as two physicians explained:

> *"The system was not supporting patient centred-care, no, it was not fulfilling this goal… there were no links between the departments, means I cannot see the laboratory reports… We only still use the referral system, when the patient needs a referral this is still done through the system, but we do not use the system for the other parts of work"* (Physician 8)

> *"The system was not integrated with the hospital system, this is the first and biggest problem we suffer from… When I want to send the patient to the hospital, I make a paper referral, and I cannot know what happened to the patient in the hospital, I do not receive a feedback, as if I did nothing. The system in the primary healthcare centre should be integrated with the hospital in its region, there must be a link between the system I have and the system in the hospital"* (Physician 10)

e) Enhanced patient safety

All physicians expressed the importance of having decision support capabilities in the system, such as alerts for drug-drug interactions, contradictions with current health conditions or allergies, and reminders for important tests and scans, as explained by one physician:

> *"The system should be clinically intelligent, means, when I enter the temperature or order a medication, the system should be intelligent enough to tell me if there is a contradiction with another medication the patient takes or with another health condition with the patient or with a laboratory investigation of the patient"* (Physician 6)

Lack of decision support features reduced perceptions of system's usefulness by the physicians who experienced the pilot EHR system, as reported by one physician:

> *"For the safety of patients we need to make sure that there is no known allergy to medication or to food before the medication order is sent to the pharmacy. This was not available in the system we had, you may not be able to check for these types of allergies [manually] because of overload. This was one of the negative points"* (Physician 7)

f) Empowering patients

Two physicians explained perceived usefulness of EHR in terms of empowering patients. According to physicians, the EHR should help in involving patients in decision-making by providing them an access to their personal health records. The EHR should also provide functions to support patients' education, as this is one of the main priorities in primary healthcare, as one physician reported:

> *"One of the priorities is that the system should support patient's education… In the primary healthcare centre, it is important to provide patient's education, such as sending educational materials to the patient based on his/her case and allowing him/her to access his/her personal health record and to view these educational materials"* (Physician 10)

In summary, the characteristics of an EHR system that were acknowledged most and will make an EHR system useful for a primary healthcare physician are: improved job performance, quick and easy access to information, improved quality of care for patients, improved communication between healthcare providers, enhanced patient safety and empowering patients.

8.4.2 Perceived Ease of Use

All physicians reported the critical importance of ease of using the system. One physician reported that this is the most important factor impacting the adoption of EHR systems, as follows:

> *"In my opinion, the first and the most important factor for a physician is the ease of use. This is the most influential factor on the usage of the system. The system must be user friendly"* (Physician 10)

Another physician, who had experienced the pilot EHR system, considered lack of perceived ease of use as major reason for system abandonment by users, as follows:

> *"May be this is the reason that users no longer want to use the system, it was not user friendly, this was a major barrier"* (Physician 8)

The following minor themes emerged from physicians' responses regarding what constitutes perceptions system's ease of use by primary healthcare physicians. The minor themes are listed below in the descending order with regard to the number of comments supporting each theme:

a) Time required for data entry

All physicians stressed the importance that the data entry tasks should be minimised and simplified. Considering that there is no appointment system in the primary healthcare system in the KSA and that the primary healthcare in the KSA is a busy service, the physician may not be able to use the system just because of time required for data entry. One physician reported that the time required for data entry was one of the major reasons for the discontinuation of the pilot EHR by users, as explained by the physician:

> *"We discovered that it [the piloted system] was so much difficult, it was not applicable at all. Primary healthcare is a very busy service and the patients are drop-in, means there are no appointments, we do not know who will come next. This system was requiring 10-15 minutes in order to fill the forms out for each patient. If the physician has only 10-15 minutes to encounter the patient as a whole, he cannot spend this much time typing on the system, so it was so difficult…You have to click on so many things and you have to enter each and every piece of information… You have to be descriptive so much while you are writing for your patient, that was very difficult"* (Physician 9)

A chairperson of a primary healthcare department at a major healthcare authority, which has successfully implemented an EHR system, reported that one of the important strategies that contributed to system's success was that they provided physicians with voice recognition tools such as Dictaphones to simplify data entry tasks, in addition templates were provided to increase the usability of the system, as follows:

> *"Time factor is very important, because in our culture, typing was not provided in our training. In the UK, Canada, and USA, people are trained on typing on computers from the first day in school so they are good in typing. This is weak in our culture. So this was a problem, but we solved it in fact by using Dictaphones, and this solved a large problem we faced. I know a group of physicians in another healthcare facility who suffer greatly from this problem"* (Physician 12)

> *"We made templates for the top ten diagnosis and we put them in the favourites area for each physician, so it became easy for them, you just click one or two clicks and the diagnosis of the patient is inserted automatically… previously we had a major problem in that no one enters the diagnosis, but now 95% of the diagnosis are documented in the system"* (Physician 12)

b) Interference with physician-patient communication

Seven physicians reported that the complexity of the system could affect physician-patient communication negatively, which could form a barrier to the use of the system by the physician, as one physician reported:

> *"Yesterday I was sitting with my colleagues and one of them was complaining greatly about the EHR and that it is wasting his time and that he cannot spend the time very well with the patient, rather, he is spending most of the time facing the computer"* (Physician 4)

According to physicians, this problem should be addressed by not only by reducing the complexity of the system, but also by increasing computer self-efficacy and by incorporating this issue during system training, as explained by two physicians:

> *"It is important to train physicians on how to deal with the EHR during patient's consultation. Otherwise they are computer-illiterate and it might be difficult for them to deal with the situation"* (Physician 3)

> *"I don't think that physician-patient communication will be affected if time the system takes was put into consideration and the physician was provided adequate training on the*

system, training and not orientation or introduction. And this training should include how to use the EHR during the consultation with the patient" (Physician 6)

c) Ease of navigation

Nine physicians reported ease of system navigation as one of the most important dimensions of perceived ease of use, as explained by two physicians:

"Some systems are complex and require one log-in in one place, then another log-in in another place, then a another log-in in a third place, taking around ten minutes to complete while the patient is in the clinic" (Physician 12)

"I am completely convinced in using the electronic system, but if you bring me a system that has too many windows I will be disappointed and will abandon it" (Physician 7)

Complex navigation such as multiple-logins required by the system was one of the main reasons physicians who experienced the pilot EHR systems discontinued using them, as two physicians stated:

"The windows do not come together… it was not integrated efficiently" (Physician 9)

"It was very difficult to navigate… there was no integration between the departments" (Physician 8)

d) Time to master the system

Seven physicians expressed ease of use in terms of ease of learning and mastering the system. Physicians may not be able to spend a long time on learning how to use the system, which may affect their adoption of the system, as reported by two participants:

"The second factor that is very important from my experience is the time required to learn the system, if the system requires much time to learn it, it will exhaust me, but if it takes short time it will benefit me" (Physician 6)

"*Time to master the system is very important especially for physicians… They do not have time to learn and explore the system… the more the system is easy to learn, the more the adoption*" (Physician 4)

e) Initial workload increase

As reported previously, primary healthcare in the KSA is a busy service, and workload increase was a concern for primary healthcare physicians, as reported by one physician:

"The negative thing is that physicians may feel, due to the crowdedness of patients in primary healthcare centres, that the EHR is time-wasting" (Physician 3)

According to the physicians who have an EHR system successfully implemented, system use at the beginning of implementation is expected to create an extra workload. Lessons learned from the primary healthcare practices that have implemented the EHR include reducing the number of appointments during the first few weeks of implementation and providing users with an extensive support until all issues are resolved, as explained by two physicians:

"From our experience, when we started, people were working one hour or two hours overtime to finish their jobs…and there were lots of complaints. But we were supporting them all the time until all issues were resolved. Lately, after around 6 to 9 months, they leave before their duty time one hour earlier" (Physician 11)

"The first time we introduced an EHR system we reduced the number of patients received for two weeks" (Physician 12)

8.4.3 Computer Self-Efficacy (CSE)

All physicians supported the significant influence of computer self-efficacy on physicians' adoption of EHR systems. One physician, who is a champion for EHR implementation in the primary healthcare department at a major healthcare authority, reported that this factor is one of the most critical factors for system adoption, as follows:

"The second critical adoption factor of EHR from my experience is user's literacy of information technology in general… I noticed from my experience in training physicians that it is difficult for people with low computer literacy… This is a major factor" (Physician 11)

Minor themes emerged from the interviews regarding computer self-efficacy are discussed below. The themes are listed in the descending order with regard to the number of comments supporting each theme:

a) IT support

Almost all physicians stressed the need of providing technical support. Physicians who experienced the pilot EHR project reported that no IT support was provided, which contributed to work inefficiencies and low adoption rates by users, as explained by two participants:

"We did not have any technical support… there must be a continuous technical support so that if I have a problem or I do not know how to do something I can return to the technical

support instead of facing the problem myself and asking colleagues and friends how do you do this and this, this was what consumes time" (Physician 10)

"The problem that we faced during the previous attempt [the pilot EHR project] is that there was no IT support for any problem facing the physician" (Physician 9)

Providing training and IT support at the beginning of implementation through super users was one of the important strategies that contributed to the successful implementation of EHR in a primary healthcare department at a major healthcare authority:

"We provided a half-day one-to-one training and then they started working on the system. We supported them with super users in the department, especially in the first two weeks, you can start working and if you need any assistance you can call the super user and he/she will come and assist you, we had nurses and physicians super users" (Physician 12)

b) Training

All physicians stressed the critical significance of training. Similarly to IT-support, physicians who experienced the pilot EHR project reported that the training was inefficient or no training was provided, which resulted in work inefficiencies and low adoption rates by users, as explained by one physician:

"We did not get any training. It is true that we were worried from making mistakes, and indeed we had some mistakes in using the system as a result of our lack of knowledge. Therefore, I reassure that training should be provided. You cannot ask a physician to be perfect if you did not provide training to him/her" (Physician 7)

Providing training by non-subject matter experts, i.e. trainers other than healthcare professionals, may not be adequate and may negatively affect physicians' acceptance of the system, as one physician explained:

"The vendor came and their employee responsible for system maintenance conducted the training, it did not work for us… the training was a barrier, it was weak" (Physician 8)

8.4.4 Social Influence

All physicians supported the importance of social influence on the adoption of EHRs. Sources of social influence are discussed below. They are listed in the descending order with regard to the number of comments supporting each source:

a) Senior management support

All physicians stressed the significant influence of senior management support and commitment, as reported by two physicians:

> *"This might be the most important factor. If the system is not fully supported by the senior management, this will be the quick route to failure. If there is only a technical support, meaning, if the IT department will lead and do it, the system will just become like any infrastructure, or networking, or a new computer or a new printer. There should be high support from the top management. Because otherwise, there will be gaps and a big area for resistance"* (Physician 4)

> *"I went to the Internal Medicine Department, and it took us six months trying to convince them to use the CPOE before the EHR and they refused. It was a bad experience that we spent six months and we were unable to convince them. And during one month when the order came from the CEO, all physicians attended the training"* (Physician 11)

b) Peers influence

Eleven physicians reported the significant influence of peers support on the adoption of EHR by physicians, including champions, super users, and other peers, as three physicians explained:

> *"The first and the most important thing is the availability of a champion in the organisation, who will lead the EHR and will promote for it. This is very, very, important… If there are no champions, this will reduce physicians' motivation to use the system"* (Physician 11)

> *"The thing that can help us is the availability of someone with expertise, because my experience is different from someone who is still a beginner with the system, when we have an expert user he can help us more with the system"* (Physician 5)

> *"Peers influence is very important. When we have a physician refusing the system, he can influence others' attitudes toward the system. Therefore, once a physician is resisting the system, they should resolve the problem before it becomes larger and he starts affecting the other physicians. This is very important, peers' influence is very important"* (Physician 7)

c) Perceptions of patients' attitudes

Physicians reported positive and negative perceptions about patient satisfaction with the use of the EHR. Four physicians reported concerns that the EHR system decreased or would decrease patient satisfaction with the quality of their healthcare, as explained by two physicians:

> *"The second thing is personal, we have principles in medicine, when you make a consultation with the patient, you have to make eye-to-eye contact. However, when I work on the EHR, most of my time is spent facing the screen and working with the keyboard and mouse, more than the time I make an eye-to-eye contact with the patient and take verbal and non-verbal information. Sometimes patients were not happy with this relatively long time, he says the previous [paper-based] system is more comfortable and easier and faster"* (Physician 7)

> *"The patient requires an eye to eye contact. It is one disadvantage that the EHR prevents good communication with the patient. So I think some patients may be uncomfortable with the use of EHR "* (Physician 10)

However, most physicians reported that the EHR increased or expected to increase patients' overall satisfaction, as explained by two physicians:

> *"There has been a big difference with the system… and even the patient became more satisfied when he/she comes and finds that we have everything in the system"* (Physician 5)

> *"I think that patients will welcome the use of the system…the technology will help the patient, saves his time, reduces his waiting time… when the patient feels the benefits whether in his health or in his time, he will definitely welcome the use of the system"* (Physician 6)

A chairperson of a primary healthcare department that has successfully implemented an EHR system reported that patients' attitudes were positive and encouraging because they were empowered and provided access to their personal health records:

> *"Patients were involved in our implementation, we gave them access to their health records. He/she can access the system and view his/her lab results and clinical notes, and view the things that he/she should perform for health maintenance or preventive care. We empowered patients and they were very happy in fact, they were welcoming the use of the system because we empowered them"* (Physician 12)

d) Other medical staff's influence

Five physicians reported that other medical staffs such as nurses could impact physicians' adoption of the EHR, as stated by two physicians:

> *"One of the things that will facilitate the adoption is the support from the nurse, if the nurse working with the physician in the clinic is trained this will facilitate the adoption"* (Physician 4)

> *"I as a physician, when I work on the system, the other healthcare professionals should be motivated to work on the system. For example, when I access the profile of the patient, I need to find the registration completed and the nurse should have entered the vital signs and made the assessment, the appointment should be working properly so that my work becomes organized… the pharmacist should have entered the stock and updated it, all medications should be available on the system without delay. So it is important for me that the other workers are motivated to work on the system*" (Physician 10)

8.4.5 Perceived Threat to Physician Autonomy (PTPA)

Six physicians reported the importance of PTPA in affecting the adoption of EHR systems by physicians, while four physicians disagreed to the importance of this factor and two provided neutral responses regarding the importance of this factor. Most physicians, including those who disagreed to the importance of this factor, stressed the importance of fostering positive attitudes toward using the system, as explained by two physicians:

> *"They [physicians] feel that this will breach their autonomy. The audit will be easier, and the access to information by the superiors will be easier. Sometimes in the current audit, they see us coming to their clinics and taking their records and reviewing the files, while on the other hand when it becomes electronic the physician cannot know that you are auditing his/her own file. So what I think is that it might affect their behaviour"* (Physician 9)

> *"People who put the system should understand that the system was put to assist us and to help us improving our performance not to monitor us for any mistakes, otherwise physicians will abandon it. Physicians should know that the review of their performance is being done for educational purposes, not for monitoring purposes"* (Physician 5)

8.4.6 Confidentiality Concerns

Only two physicians agreed to the importance of this factor. However, they did not report major concerns and only provided general comments about this factor, as explained by one physician below:

> *"I agree, and this is the thing that makes companies compete on making secure systems. Every country and every institution works toward making a secure system"* (Physician 8)

In fact, the majority of physicians (10 physicians) disagreed to the importance of confidentiality concerns in affecting physicians' adoption of the system. Trust was the most common reason reported by physicians (8 physicians). Other physicians reported that confidentiality concerns are mostly concerns of the organization rather than the physician or the other users. Below are some explanations by the physicians:

> *"I don't think so. Before 10 years ago this factor may be important but now fears about confidentiality loss have decreased a lot with the penetration of mobile devices and most importantly with the use of Absher system [e-Government]. If the system is protected by secure access and everything, people now trust the technology"* (Physician 1)

> *"No, I don't agree with this. Even the paper file, it is placed in a cabinet and can get into any hand, so it is like the electronic file. I mean this is not a big issue. And also when I started using the EHR I signed an obligation that I do not share my username and password with anyone. And no one can view the patients' file or the data I typed"* (Physician 7)

> *"I don't think so, they [physicians] understand that these things will have limited access by the IT [personnel]"* (Physician 9)

> *"This is an organization's authoritative concern not a physician's concern. Because when they were using paper charts before no body was concerned about the confidentiality and privacy because they know there are systems through the medical record department to ensure these issues. Physicians are concerned about the clinical things not the administrative things. My opinion will there be concerns over confidentiality? yes but it does not create resistance to using the system, and this is the difference"* (Physician 11)

8.4.7 Physician Participation

All physicians reported that physician participation is essential. Physicians reported negative perceptions about IT-led projects and that those systems are unable to meet the needs and requirements of physicians. Hence, participation from the very beginning was emphasised by all physicians, and most physicians also stressed the importance of incorporating their feedback regularly in order to improve the system to better fit their needs and requirements. Even the physicians who are not involved, they should always be briefed about the project, as explained by five physicians:

> *"I think that the most frequent problem here in Saudi Arabia regarding the success of these projects is the involvement of the end users. If they [physicians] were involved during the implementation, this will have a large role in adoption. Especially that IT-led projects become as something enforced by the IT department, and this will make resistance"* (Physician 4)

> *"Because I am the leader of the clinic, I am able to organise the processes in my clinic and make them for the best of the patient and the care management of the patient, by doing this the issues will be resolved. It is not workable that someone comes from the outside and arranges the processes for me, it's me who should tell them that I need this and this in the system"* (Physician 5)

> *"IT engineers and most managers, and most physicians as well, think that the EHR is just a computerisation of papers, means the information instead of being on papers, it becomes on a screen, and this belief is very very very wrong, it is very risky and very dangerous… the physician should participate in everything requires him/her to use the system starting from seeing the patient to the follow-up procedures and to the monitoring of cases"* (Physician 6)

> *"Physician participation is very important and this is one reason for our success. The team, composed of physicians and nurses, was involved from day 1. Even the rest who were not in the committee, they were being briefed about the system"* (Physician 12)

> *"Periodic feedback form the user is important. If there are issues in the system, and the system was not improved, and the physician must work on it, this will be frustrating"* (Physician 8)

8.4.8 Attitude toward EHR

Attitude is reflexive of the other factors. Most physicians explained attitude in terms of motivation, and stressed the importance of making awareness programs that focus mainly on system's usefulness in order to influence physicians' attitudes toward using the system, as two physicians commented:

> *"At the beginning, there should be orientation sessions for all people about the system… People must understand the importance of the system. They must know their role in the system very clear. They should target the motivation at the beginning "* (Physician 10)

> *"During the training phase the primary focus should be on understanding the importance of the system"* (Physician 2)

8.5 New Factors Emerged from Physicians' Interviews

As with interviews with experts, one new factor emerged from physicians' interviews, *compatibility*, which emerged from the interviews of eight physicians. Physicians who experienced the pilot EHR systems complained from lack of compatibility of the system with the priorities and requirements of primary healthcare. Responsibilities of primary healthcare such as preventive care, continuity of care, and patient education, in addition to other important features for improving patient safety such as clinical decision support capabilities, were not supported by the system. According to the physicians, most systems implemented or piloted in primary healthcare practices were systems designed for hospital settings, thus not only lacking the business value of primary healthcare, but also introducing irrelevant processes. This was one of the reasons that reduced physicians' interest in the system, as explained by two physicians:

> *"It is important whether the system was designed for primary healthcare or for a hospital. Many implemented systems, in most situations, are systems designed for a hospital not for primary healthcare centres… the system we had does not provide personal health records. It does not provide clinical decision support features that are designed for primary healthcare, for example reminders that this patient needs screening, or this patient based on her age needs mammogram. The family profile should be supported by the system, but it was not… The system does not support continuity of care"* (Physician 10)

> *"Because we [primary healthcare physicians] are a part of preventive care, we should have a plan for treatment, prevention, and referral, in general. For prevention, we have a program called periodic check, so if we have something electronic to support this program so that it provides us with hits and alerts, such as this patient is due for a specific investigation. We need this type of electronic systems… the system that was implemented was not serving our needs"* (Physician 8)

In addition to compatibility with the needs and priorities of primary healthcare, compatibility with existing work routines was reported by two physicians to be a significant facilitator toward EHR adoption, as explained by one physician:

"The more the system is compatible with the existing workflow of the physician, the more the system will be easy to adopt. You write the paper record in this way, and this is your workflow, so we will make the system compatible with your experience. But there are some processes that should be improved. The implementation of the EHR will correct problems in the process that were hidden or not apparent, so it is a chance for improvement. But generally, if the electronic system feels almost the same, it will be more comfortable for the physician" (Physician 4)

Finally, as reported by experts, allowing physicians to further tailor or customise the system to their own use was emphasised by one physician:

"The system should allow me to put my own options. For example, frequently used lab tests, I need to put this option on the main screen instead of having to access the lab and choose… I need to be able to make some customization to accommodate what I want from the system. Also, frequently used medication, for example if I have a list of medications I am authorised to order and I frequently use it" (Physician 10)

8.6 Summary of the Findings

Table 8-2 summarises the main themes (i.e. factors) and sub-themes (i.e. dimensions of large and complex factors) identified from primary healthcare physicians interviews and discussed in the present chapter. As with the findings of expert's interviews, thematic analysis revealed nine main themes in the data, eight of which were derived based on factors in the proposed framework, that is, by deductive analysis. One new theme (i.e factor) was discovered from the interviews with primary healthcare physicians, which converges with the new theme discovered from the interviews with experts (Chapter 7), compatibility. Four factors had large and complex themes, particularly: perceived usefulness, perceived ease of use, social influence and computer self-efficacy. These themes were divided into sub-themes to demonstrate the hierarchy of meaning within them. The sub-themes of large and complex factors also converged well with the sub-themes identified from experts' interviews. The themes and sub-themes in Table 8-2 are sorted in the descending order based on the number of comments relevant to each theme.

Primary healthcare physicians' evaluation of the proposed framework indicated that all factors in the proposed framework are important and influential, except confidentiality concerns, which was not supported by most physicians. The new factor, compatibility, emerged from the interviews of eight physicians. In general, the findings of primary healthcare physicians' interviews are consistent with those of experts' interviews (Chapter 7), providing evidence for the validity of the findings. A detailed discussion of the findings relevant to each factor is provided in Chapter 9.

Table 8-2 Themes, sub-themes and the number of coded extracts from primary healthcare physicians' interviews

Main themes (Factors)	Sub-themes (Dimensions)	Coded extracts from experts' interviews
Perceived usefulness (PU)		119
	Improved job performance	31
	Quick and easy access to information	26
	Improved quality of care for patients	13
	Improved communication between healthcare providers	12
	Enhanced patient safety	10
	Empowering patients	7
Perceived ease of use (PEOU)		88
	Time required for data entry	28
	Interference with physician-patient communication	20
	Navigation	11
	Time to master the system	10
	Initial workload increase	6
Computer self-efficacy (CSE)		70
	IT support	27
	Training	25
Social influence (SI)		70
	Senior management support	34
	Peers influence	18
	Perceptions of patients' attitudes	12
	Other medical staff's influence	6
Physician Participation (PP)	N/A*	36
Compatibility (COM)	N/A*	27
Perceived Threat to Physician Autonomy (PTPA)	N/A*	21
Attitude toward EHR (ATT)	N/A*	19
Confidentiality Concerns (CC)	N/A*	12

* Codes identified cannot be grouped into sub-themes (see Appendix C)

8.7 Conclusion

The interviews with primary healthcare physicians yielded consistent findings with the findings of interviews with experts and leaders of EHR implementation. This means that a consensus has been reached between the two parties on the factors influencing the adoption of EHRs by primary healthcare physicians. The next chapter presents the confirmed framework for the adoption of EHRs by primary healthcare physicians in the KSA and discusses the implications of these findings.

Chapter 9 The validated framework for the Adoption of EHR by Primary Healthcare Physicians in the KSA

9.1 The Findings of the Data Triangulation

The first stage of this research proposed a framework for the adoption of EHRs by primary healthcare physicians in the KSA (Chapter 5), and used a qualitative research methodology to validate the framework and to explore other significant factors (see Chapter 6 for the research methodology). A qualitative methodical approach was chosen because it can provide a high level of detail to detect the complexity of the phenomena under investigation and to take the context into account (Anderson, 2010; Recker, 2013). Data triangulation was selected as it allows gaining multiple perspectives and validation of data (Carter et al., 2014). Two important groups of informants were selected for the qualitative triangulation study: experts and leaders of EHR implementation in the KSA (Chapter 7), and primary healthcare physicians in the KSA (Chapter 8).

The primary objective of data triangulation is to test for *convergence*, or agreement, among different data sources in order to determine the consistency of findings (Krefting, 1991). Another possible outcome of data triangulation is *complementary* findings, in which the findings of one data source completement the findings of the other in order to create a more complete picture (Krefting, 1991; Erzberger and Prein, 1997). However, contradictions, or *divergence*, can also be an outcome of data triangulation. This occurs when findings obtained from two or more data sources are incompatible and oppose one another (Erzberger and Prein, 1997).

In this research, the interviews with experts and primary healthcare physicians yielded consistent findings as shown in Table 9-1. As discussed in Chapters 7 and 8, experts' and primary healthcare physicians' responses regarding factors in the proposed framework showed that all the proposed factors are important and influential, except confidentiality concerns, which was not supported by the vast majority of participants from both groups. The importance of some factors was supported by all experts and all physicians, particularly: percieved usefulness, percieved ease of use, computer self-efficacy, social influence, physician participation and attitude. The importance of perceievd threat to physician autonomy was supported by most experts and half of the physicians. Finally, the importance of compatibility was stressed by eight experts and eight physicians. All themes, sub-themes, and most codes from experts' interviews and primary healthcare physicians' interviews converged well, as shown in Appendices C and D, respectively. Therefore, it can be concluded that the findings from the two groups substantiate each other. As a result of the data triangulation, the validated framework of key factors influencing the adoption of EHR systems by primary healthcare physicians, as well as key findings relevant to each factor, are presented in Figure 9-1. The following section provides a detailed discussion of the findings.

Table 9-1 Themes, sub-themes and the total number of coded extracts within each theme and sub-theme from experts' interviews and Primary Healthcare (PHC) physicians' interviews

Main themes (Factors)	Sub-themes (Dimensions)	Coded extracts from experts' interviews	Coded extracts from PHC physicians' interviews
Perceived usefulness (PU)		110	119
	Improved job performance	23	31
	Quick and easy access to information	21	26
	Improved quality of care for patients	12	13
	Enhanced patient safety	14	10
	Improved communication between healthcare providers	9	12
	Empowering patients	2	7
Perceived ease of use (PEOU)		115	88
	Time required for data entry	27	28
	Interference with physician-patient communication	18	20
	Navigation	15	11
	Initial workload increase	18	6
	Time to master the system	9	10
Computer self-efficacy (CSE)		91	70
	Training	44	25
	IT support	23	27
Social influence (SI)		86	70
	Senior management support	37	34
	Peers influence	24	18
	Perceptions of patients' attitudes	10	12
	Other medical staff's influence	8	6
Physician Participation (PP)	N/A*	47	36
Compatibility (COM)	N/A*	24	27
Perceived Threat to Physician Autonomy (PTPA)	N/A*	32	21
Attitude toward EHR (ATT)	N/A*	16	19
Confidentiality Concerns (CC)	N/A*	12	12

* Codes identified cannot be grouped into sub-themes (see Appendices C and D)

Chapter 9

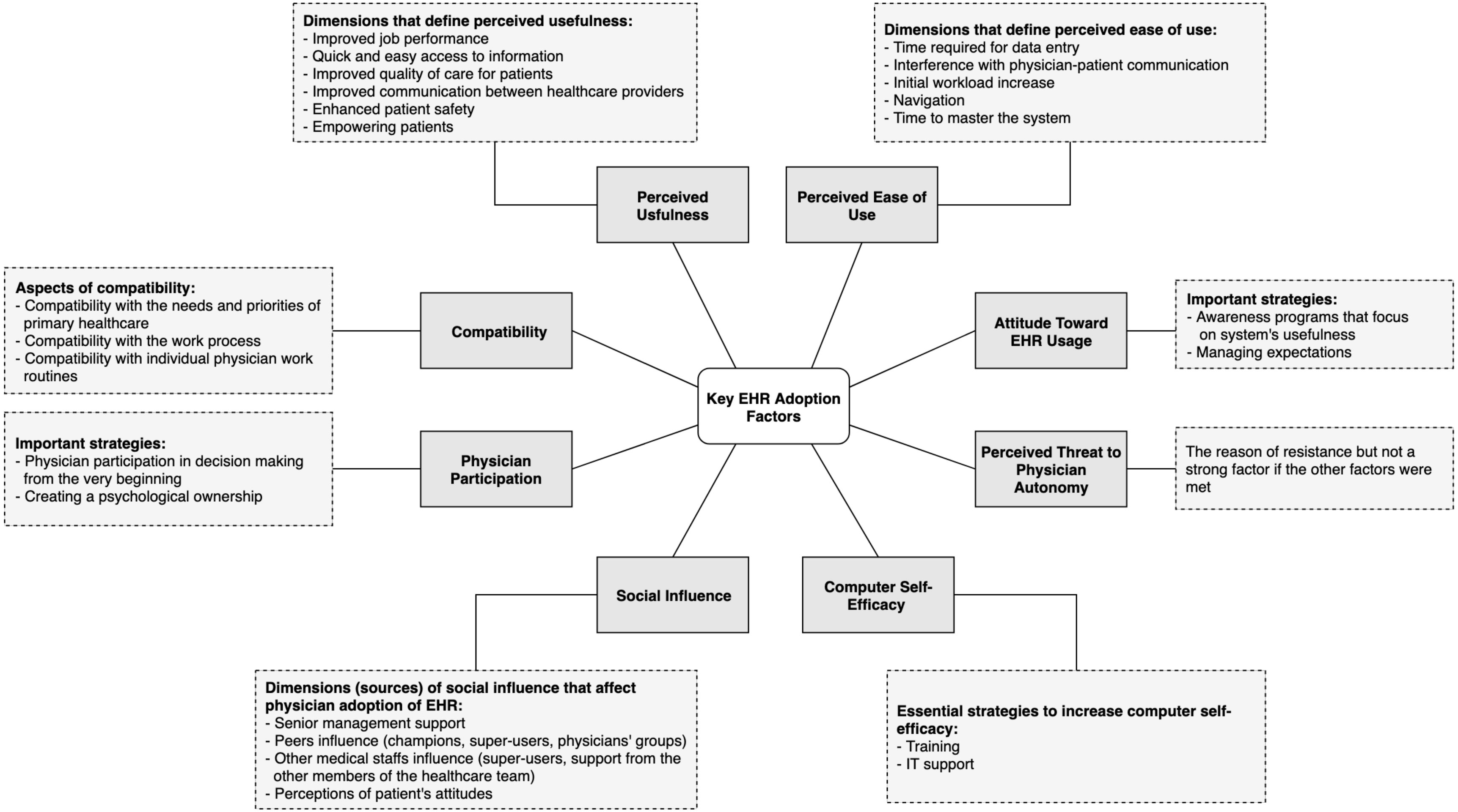


Figure 9-1 The validated framework of key EHR adoption factors by primary healthcare physicians in the KSA as well as important findings relevant to each factor

9.2 Discussion of the Findings

This research found that eight main factors are strongly associated with primary healthcare physicians' adoption of EHR systems in the KSA, namely Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Computer Self-Efficacy (CSE), Social Influence (SI), Physician Participation (PP), Compatibility (COM), Attitude Toward EHR (ATT), and Perceived Threat to Physician Autonomy (PTPA).

In this research, PU and PEOU from TAM (Davis, 1986, 1989), were the largest themes emerged from the analysis, which received the greatest attention and discussion by both groups of interviewees. This indicates that PU and PEOU are likely to be the most critical adoption factors of EHR systems, which is in line with the findings of many previous studies (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015). Systems often fail because they support the values of management, not the values of end-users (Morton and Wiedenbeck, 2009). Technology users have performance expectations, which they use to benchmark the usefulness of any system (Venkatesh *et al.*, 2003). Based on that, users are more likely to adopt technologies that meet their expectations and abandon those that do not. As the interviews revealed, the characteristics of EHR systems that were acknowledged most and will make an EHR system perceived as useful by primary healthcare physicians are: improved job performance, quick and easy access to information, improved quality of care for patients, improved communication between healthcare providers, enhanced patient safety and empowering patients. Consequently, meeting these dimensions is expected to increase physicians' perceptions of systems' usefulness. In addition, it has been reported that most physicians are not familiar with new information technologies, and that complex systems may increase physicians' frustration and resistance (Boonstra and Broekhuis, 2010; Li *et al.*, 2013). This research identified five main dimensions that determine physicians' perceptions of ease of use of EHR systems: time required for data entry, ease of using the system during patients' consultations, ease of system navigation, initial workload increase, and time required to learn and master the system. Therefore, addressing these dimensions is expected to increase physicians' perceptions of ease of use of the system.

In line with the findings of previous research (Gagnon *et al.*, 2016), CSE plays a major role on EHR acceptance. Many studies reported lack of healthcare professionals' familiarity with EHR as a major obstacle hindering EHR acceptance and use (Boonstra and Broekhuis, 2010; Li *et al.*, 2013). Consequently, training and IT support are essential for the success of EHR implementation (Terry *et al.*, 2008). Furthermore, as discussed in Chapters 7 and 8, a crucial step in the implementation phase is to identify “super users” capable of providing training and technical support in early stages of implementation. This emphasizes that user-involvement is critical to foster the ownership of the system (Pare *et al.*, 2006).

Consistent with the findings of previous studies (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016), social influence was found to be among the key EHR adoption factors. Major sources of social influence important for physicians include: senior management and peers support, which were reported to have an important effect by all experts and almost all physicians. Other important sources of social influence include: other healthcare professionals’ influence and perceptions of patients’ attitudes. Senior management support and commitment is considered a critical success factor for the implementation of IT projects (Young and Jordan, 2008). Prior research showed that senior management support and commitment has a significant positive effect on physicians’ perceptions of usefulness (Abdekhoda *et al.*, 2015) and ease of use of EHR systems (Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015). Furthermore, peers influence was found to be among the critical sources of social influence. Physicians develop strong bonds through professional socialisation, therefore, strategies that promote role modelling and peer support, such as champions and super users, are crucial for successful EHR adoption (Gagnon *et al.*, 2014, 2016). In addition, as interviews revealed, supporting the use of the system by the other medical groups such as nurses and the other members of the healthcare team is important to streamline work processes in a primary healthcare practice. As reported by experts, strategies that promote group motivation at the level of primary healthcare centres, such as accreditation, are influential in promoting system adoption. In addition, whether the use of the system would decrease or increase patient’s satisfaction in the quality of care provided was reported by most participants in both groups as an important source of social influence affecting the adoption of EHR. Again, ensuring that the system is simple to use during patient’s consultation by reducing the complexity of the system, and also empowering patients are expected to increase patient’s satisfaction and affect the physician’s adoption of EHR positively.

All participants from both groups reported that physician participation should be an integral component of any EHR implementation. Physicians reported strong negative perceptions about IT-led projects and viewed them as systems that cannot meet their needs and requirements. Experts reported that physicians should have high psychological ownership of the system and the project should be perceived as a providers-driven not an IT-driven project. According to Pare et al., (2006), psychological ownership significantly affects physicians’ perceptions about usefulness and ease of use of clinical IT. Morton and Wiedenbeck (2009) suggest that physicians’ attitudes toward EHR are significantly affected by their perceptions of involvement in the implementation, regardless of the utility or usability of the system selected. As the interviews revealed, without effective involvement and psychological ownership, the project may not succeed.

Compatibility was a new factor emerged from the interviews of both experts and primary healthcare physicians, which conforms to the theoretical assumptions of Innovation Diffusion Theory (IDT) (Moore and Benbasat, 1991). Experts reported that most systems implemented or piloted in primary healthcare practices in the KSA are systems designed for hospital settings, thus lacking the business value of primary healthcare. This aspect converged well with the responses of physicians who experienced the pilot EHR systems provided by MOH. Physicians reported that those systems not only lack the functions required to carry out key clinical tasks in primary healthcare (e.g. preventive care functions), but also introduce irrelevant processes. User-centred design is key to EHR systems implementation success (Wachter, 2016). User-centred design, which is an iterative process that entails involving end users by analysing their needs and involving them in system design and evaluation activities, not only increases the usability of the system, but also ensures that the system is safe to use (Marcilly, Peute and Beuscart-Zéphir, 2016). It is considered a pre-requisite for achieving the intended clinical and organisational impact of technology (Magrabi, Ong and Coiera, 2016; Marcilly, Peute and Beuscart-Zéphir, 2016; Wachter, 2016). In addition, most experts reported that introducing an EHR system may require changes in the work process. Experts strongly advised against introducing two changes at the same time, i.e. process and technology. It is important to assess the readiness of the current work processes, and when required, business process reengineering (i.e. workflow redesign) should be applied before implementing an EHR system. The fit between the EHR system processes and current work processes can directly affect implementation success (Ahmad *et al.*, 2002; Martin, Mariani and Rouncefield, 2004; Ludwick and Doucette, 2009; Lorenzi *et al.*, 2009). Healthcare practices need to perform a thorough mapping of existing work processes, e.g. how appointments are scheduled?, what are the workflows for patient check-in (new/registered patient)?, what is the workflow during the actual patient visit?, how medications are prescribed, both during an office visit and out of an office visit for renewal requests?, what is the referral generation process?, what are the workflows after the patient visit?, how unscheduled patient visits are handled by the practice?, questions, etc, in order to understand the fit between existing work processes and the new system (Doebbeling, Chou and Tierney, 2006; Ludwick and Doucette, 2009; Lorenzi *et al.*, 2009). Analysing existing workflows often reveals process inefficiencies (Garg *et al.*, 2005; Nowinski *et al.*, 2007; Ludwick and Doucette, 2009). Health information system implementation therefore offers an opportunity to rethink the work and workflow in order to maximise efficiencies, enhance healthcare quality and safety and improve care coordination (Ludwick and Doucette, 2009; Wachter, 2016). In addition, complex and tightly integrated systems such as EHRs/ERP are only configurable to a point, and usually necessitate the adopting healthcare practice to adapt its business processes to the new system (Ahmad *et al.*, 2002; Poon *et al.*, 2004; Doebbeling, Chou and Tierney, 2006; MacKinnon and Wasserman, 2009). Workflow redesign has become an accepted part of the cost of implementing EHR systems (Poon *et al.*, 2004; MacKinnon and Wasserman, 2009). Workflow redesign, also referred to as workflow re-engineering or business process reengineering, means considering the extent to which healthcare practices need to adjust their work processes in order to optimally utilize EHR functions (Rahimi, Vimarlund and Timpka, 2009). Therefore, analysing existing workflows is essential for determining the fit between the new system and the practice workflows, and for the important task of workflow re-design before introducing the system (Lorenzi *et al.*, 2009). Workflow redesign processes that are completed and tested prior to system implementation can help avoid “blame” for the change introduced to long established processes to the new system and/or champion/leaders when the system goes ‘live’ (Lorenzi *et al.*, 2009). The more technologically ready a physicians’ current work practice, the more likely the system is to be accepted and adopted (Spil, 2005). The literature documents two general ways for the deployment of health information systems, the “big bang” approach and the incremental or “phased” approach (Ludwick and Doucette, 2009; Cresswell, Bates and Sheikh, 2013). The former relates to installing the system quickly and requiring users to use the system immediately, while the later relates to introducing the functionality of the system incrementally and slowly. An incremental approach is recommended for large scale health information systems and/or systems with complex processes, because it permits time to adapt to the change (Ludwick and Doucette, 2009; Wachter, 2016). In addition, previous research has shown that users’ prior experiences with health information technology affect their experiences with the new system (O’Connell *et al.*, 2004; Ludwick and Doucette, 2009). The more familiar the system is to the user, the more likely it will be accepted and adopted (Ahmad *et al.*, 2002; O’Connell *et al.*, 2004; Ovretveit *et al.*, 2007; Ludwick and Doucette, 2009). Lastly, experts reported that allowing individual physicians to further adapt or customise the system to their own work styles and preferences will increase system adoption. This aspect also converged well with the interviews of physicians. Previous research has shown that an EHR system that does not fit well with clinicians’ existing work routines and that does not allow for variations in style can negatively affect clinicians’ productivity (Lorenzi et al., 2009) In summary, compatibility with practice needs, existing work processes, prior experiences and individual physician work routines is a key factor in fostering EHR adoption.

The importance of Perceived Threat to Physician Autonomy (PTPA) was supported by most experts and half of the physicians. It can be concluded from the responses of participants in both groups that PTPA is not as a strong factor as the other factors in the framework, but it might increase or decrease based on the other factors in the framework. For example, experts reported that the more the perceived usefulness and ease of use, the less the PTPA. Physicians reported that the more the positive attitudes toward using the system, the less likely that PTPA would have an effect. It is therefore important for future studies to examine the effect of the other factors in the framework on PTPA to understand what exactly would have a significant mitigating effect on PTPA. Previous studies, such as (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015), have only tried to examine the effect of PTPA on PU, PEOU, ATT and EHR acceptance. According to these studies, PTPA has a significant negative effect on PU (Walter and Lopez, 2008), PEOU (Abdekhoda *et al.*, 2015), ATT (Morton and Wiedenbeck, 2009), and EHR acceptance (Walter and Lopez, 2008).

Attitude toward EHR, although reflexive of the other factors in the framework, had unique explanations, which converged well from the responses of both groups of participants. Experts and physicians strongly emphasised that awareness programs should be provided prior to system implementation in order to increase positive attitudes toward using the system. Participants reported that most physicians lack the proper knowledge and awareness on what an EHR system is, and perceive it as just a computerisation of paper charts. This perception makes it difficult for the implementers to encourage system adoption and use. Therefore, increasing the readiness of users prior to system implementation is essential. In addition, most experts stressed the importance that the expectations of physicians should be managed properly as very high expectations may lead to disappointment when the system is implemented.

The responses of experts and physicians regarding the importance of confidentiality concerns converged well, suggesting that while there might be concerns over the confidentiality of data, these concerns are only mild concerns and will not affect the adoption of the system. This is consistent with the findings of many previous studies (Penrod and Gadd, 2001; Gans *et al.*, 2005; Wright *et al.*, 2010), which found only mild concerns about security and privacy. The most frequently reported explanation by physicians was trust, which converged with the explanations provided by many experts. Many researchers in the IS adoption literature argued that trust is a key factor for reducing perceived risk of a negative outcome (Pavlou and Gefen, 2004; Fang, Shao and Lan, 2009). The study by Hsieh (2015) showed that as perceptions of trust increase, physicians perceive a lower level of risk in using health information exchange, one of the main components of EHR.

9.3 Summary and Discussion

The qualitative triangulation study performed in the first stage of this research developed a framework of key factors that drive the acceptance and use of EHR systems by primary healthcare physicians in the KSA. These factors are: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Computer Self-Efficacy (CSE), Social Influence (SI), Physician Participation (PP), Compatibility (COM), Attitude Toward EHR (ATT), and Perceived Threat to Physician Autonomy (PTPA).

The use of the qualitative approach allowed in-depth investigation and exploration of the adoption factors. The majority of studies in the literature pertaining physicians' adoption of EHRs employed quantitative approaches (Boonstra & Broekhuis, 2010; Li et al., 2013), which limits in-depth investigation of the phenomena under investigation (Anderson, 2010; Recker, 2013).

Given the small sample size, there is a general agreement that the objective of qualitative research is not to generalise, but to develop a deep understanding and exploration of the phenomenon under investigation (Creswell, 2011; Recker, 2013; Venkatesh, Brown and Bala, 2013). However, triangulation is one of the strategies to increase the validity, confirmability, and reliability of the findings of qualitative research (Krefting, 1991; Creswell, 2011; Carter *et al.*, 2014). Further, triangulation of the findings of different qualitative studies increases the generalisability of the findings (Finfgeld-Connett, 2010; Leung, 2015). Given that the data triangulation applied in the first stage of this research (Chapter 6), yielded convergent and consistent findings from the two qualitative studies (Chapter 7 and Chapter 8) as discussed in the present chapter, this provides evidence for the validity of the findings of the first stage of this research (Krefting, 1991; Creswell, 2011; Carter *et al.*, 2014), and increases the generalisability of the findings (Finfgeld-Connett, 2010; Leung, 2015).

However, although this study developed a framework of key EHR adoption factors, due to the nature of qualitative research, it could not determine to what extent these factors are associated with EHR adoption behaviours. In addition, due to the nature of qualitative research, the relationships between the factors cannot be determined. An essential next step in this line of enquiry is to formulate hypotheses about the mechanism by which these factors may shape EHR adoption behaviours. Next, measurement items should be developed and empirically validated in a large sample in order to quantitatively evaluate how strongly physicians hold beliefs about these factors and how variations in these beliefs are associated with variations in EHR adoption decisions. The aim is to develop a theoretical model that helps explain and predict EHR acceptance and use. Such theoretical models are particularly important in the unique context of healthcare IT (Yarbrough and Smith, 2007; Holden and Karsh, 2010; Venkatesh, Sykes and Zhang, 2011).

Chapter 10 Research Methodology for the Second Stage of This Research

10.1 Introduction

The qualitative study performed in the first stage of this research has shed the light into key factors that drive the acceptance and use of EHR systems by primary healthcare physicians in the KSA (Chapter 9). However, as discussed in the previous chapter, due to the nature of qualitative research, the interrelationships between these factors could not be determined. It is also unknown to what extent these factors are associated with EHR adoption behaviours. Therefore, developing an explanatory and prediction model on the basis of the validated framework is an essential next step in this line of inquiry.

The aim of the second phase of this research is to answer the following main research questions and sub-questions:

RQ3: What is the appropriate model for explaining and predicting the adoption decisions of EHR systems by primary healthcare physicians in the KSA?

RQ3.1: What are the most salient direct or indirect effects of the factors identified in response to RQ2 on EHR adoption decisions?

RQ3.2: What is the appropriate instrument to measure the factors identified in response to RQ2?

RQ3.3: Which relationships hypothesized in response to RQ3.1 will affect physicians' decisions to adopt EHR systems in Saudi public primary healthcare practices?

RQ4: Do the relationships between factors in the model vary between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR?

To answer these research questions, a multiphase methodology was applied. Structural Equation Modelling (SEM) was selected as the main statistical technique in the second stage of this research. The following section explains the rationale for selecting SEM and provides an overview of this technique. Following this, a description of the phases taken to construct the model using structural equation modelling is provided.

10.2 Structural Equation Modelling (SEM)

The major objective of the second phase of this research is to understand the relationships between the factors confirmed in the first stage of this research and to develop an explanatory and prediction model of EHR adoption behaviours by primary healthcare physicians in the KSA. Structural Equation Modelling (SEM) is a complex form of statistical analysis that is used to test interrelationships among multiple variables (O'Rourke and Hatcher, 2013; Hair *et al.*, 2014). This method was selected for many reasons. First, SEM is a highly recommended approach for complex models that include multiple constructs. Unlike other statistical methods such as multiple regression, SEM can be used to analyse complex relationships between several dependant and independent variables simultaneously, while the other methods do that separately for each dependant variable at a time (Streiner, 2005). Therefore, SEM can provide a better global model fit compared to the other methods (Byrne, 2016; Gefen et al., 2000). Second, SEM is a widely used method in behavioural science research for the modelling of complex, multivariate data sets. It is particularly popular in Information Systems (IS) research. The literature suggests that SEM has become de rigueur in validating research instruments and testing the relationships between factors, which is highly popular in empirical studies in major IS journals (Gefen, Straub and Boudreau, 2000).

Structural Equation Modelling (SEM) is an extension of path analysis that allows us to examine the relations both among latent variables and measured variables, and among latent variables themselves. It does this by combining path analysis with a form of factor analysis called Confirmatory Factor Analysis (CFA) (Streiner, 2006). Developing SEM follows a two-phase procedure: the measurement model analysis and the structural model analysis (Anderson & Gerbing, 1988). The *measurement model* describes the relationships among latent variables and their measurement variables. In this phase, the relationships between latent variables are not investigated. The measurement model must provide an acceptable fit to the data in order to perform the second step which involves developing a *structural model* (O'Rourke and Hatcher, 2013). The structural model describes the relationships among the latent variables (O'Rourke and Hatcher, 2013). At this phase, the directional relationships between latent variables are examined. Therefore, a SEM model is a combined model that actually consists of a measurement model and a structural model.

10.3 Research Methodology Designed for the Second Stage of This Research

A multiphase methodology was applied to answer the research questions established for the second phase of this research as illustrated in Figure 10-1. The following subsections provide a brief overview on each phase.

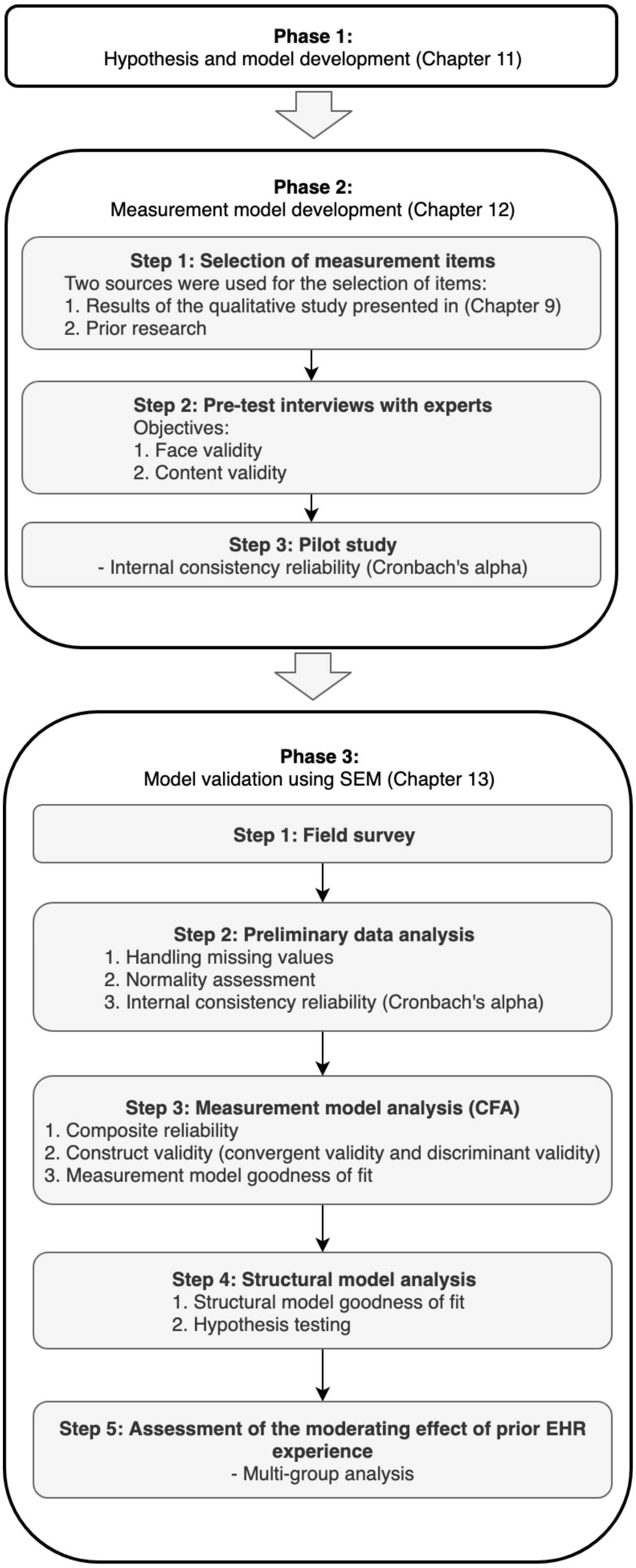


Figure 10-1 Phases conducted to answer the research questions for the second stage of this research

10.2.1 Phase 1: Hypothesis and Model Development

The first phase in SEM development is to hypothesize the relationships between the factors. This step is a requirement in SEM development as it puts the factors into a structural form or "model" which explains how these factors interact in determining EHR adoption behaviours. This structural model will be used to perform SEM analysis in the subsequent phases. The hypotheses forming the structural model are usually specified based on theories and/or empirical results from prior studies (O'Rourke and Hatcher, 2013; Hair *et al.*, 2014; Kline, 2015). According to Kline (2015), "the model should be as parsimonious as possible while respecting theory and results of prior empirical studies".

In this research, the development of the hypothesis and the formulation of the model were informed by the knowledge acquired through the qualitative study performed in the first stage of this research (Chapters 7-9) as well as relevant academic literature. The aim of this phase was to answer research question (RQ 3.1). The hypothesised relationships between the factors and the proposed model are discussed in detail in chapter 11.

10.2.2 Phase 2: Measurement Model Development

Measurement variables provide the fundamental connection between the real-world observations and mathematical expression of quantitative relationships between latent variables. Therefore, ensuring the trustworthiness of the findings depends mainly on the measurement instrument used. Two key requirements of a measurement instrument must be met (Recker, 2013):

1. Validity – the measurement variables must indeed measure the latent variable that they are supposed to measure (i.e. the measurement variables are valid).
2. Reliability – the measurement variables must indeed measure the latent variable consistently and precisely (i.e. the measurement variables are reliable). Reliability implies that the operations of a study can be repeated in equal settings with the same results.

Validity and Reliability are called the psychometric properties of measurement variables. A measure can be reliable but not valid, if it is measuring something very consistently but is measuring the wrong construct (Considine, Botti and Thomas, 2005; Bhattacherjee, 2012; Recker, 2013). However, for a measure to be valid, it should be reliable. That is, reliability is in fact a condition for - but it does not guarantee – validity (Hair *et al.*, 2014; Kline, 2015).

In order to ensure validity and reliability of the measurement instrument before it was used for the main data collection for SEM analysis (i.e. Phase 3), the following steps were taken, which were based on the established recommendations in the literature (Hinkin, Tracey and Enz, 1997;

Bhattacherjee, 2012; Recker, 2013): (1) selection of measurement variables, (2) pre-test interviews with a panel of experts, and (3) a pilot study with primary healthcare physicians.

The aim of the first step is to generate a set of candidate measurement variables for each latent variable (i.e factor). The selection of measurement items in this research was based on the findings of the qualitative study performed in the first phase of this research (Chapter 9) as well as prior research. Then pre-test interviews with a panel of expert judges were performed in order to establish face validity (i.e. ensuring that the structure, design, clarity and language of the instrument are appropriate), and content validity (i.e. ensuring the content adequacy of the measurement items). The third step was performing a pilot study with primary healthcare physicians in order to confirm the reliability of the instrument. A detailed explanation of these steps and the outcomes of each step is provided in Chapter 12.

10.2.3 Phase 3: Model Validation Using SEM

After the instrument has been developed and validated using pre-test interviews with experts and a pilot study with primary healthcare physicians, it was used for the main data collection (Chapter 13). Data was collected using a nationwide survey of physicians working in public primary healthcare practices in the KSA. The sampling procedure utilised a combination of random, snowball and convenience sampling approaches (Section 13.3, Chapter 13). After excluding incomplete and irrelevant responses, a total of 243 valid responses were retained, deemed appropriate for factor analysis and structural equation modelling (Everitt, 1975; Velicer and Fava, 1998; Schreiber *et al.*, 2006; Hair *et al.*, 2014; Kline, 2015). Before performing SEM analysis, a preliminary data analysis was performed in order to handle missing values, and to evaluate the data for normality and internal consistency reliability using Cronbach's alpha.

As reported earlier, the SEM analysis is a two-phase approach (Anderson & Gerbing, 1988). The first phase is concerned with the assessment of the measurement model using Confirmatory Factor Analysis (CFA). The objective of CFA is to obtain statistical evidence for reliability and validity of the measurement model and to examine how well the data match or fit the factor structure specified in advance (Streiner, 2006). Three main tests were performed in CFA, mainly (Bagozzi and Yi, 1988; O'Rourke and Hatcher, 2013; Hair *et al.*, 2014; Kline, 2015):

1. Composite Reliability (CR) – the degree to which the measurement variables measure the latent variable consistently and precisely (Hair *et al.*, 2014).
2. Construct validity – the degree to which a set of measured items actually reflects the latent theoretical construct that these items are designed to measure. Construct validity was assessed in CFA phase using two assessments:

2.1. Convergent validity – the degree to which measured variables of the same construct are correlated (Hair *et al.*, 2014).

2.2. Discriminant validity – the extent to which a construct and its indicators differ from another construct and its indicators (Bagozzi, Yi and Phillips, 1991).

3. Goodness-of-fit – the aim of this test is to assess whether the measurement model provides a good fit to the data (O'Rourke and Hatcher, 2013).

The second step of SEM analysis is the structural model assessment. This step involved assessing the goodness of fit of the hypothesized model proposed in Phase 1 (Chapter 11), and evaluating the hypothesised relationships between the latent variables in the model (Bagozzi and Yi, 1988; O'Rourke and Hatcher, 2013; Hair *et al.*, 2014; Kline, 2015). Steps 1-4 of Phase 3 illustrated in Figure 10-1 answer research question (RQ3.3), hence by the end of Step 4, research question (RQ3) has been answered.

The last step in Phase 3 illustrated in Figure 10-1 aimed at answering the last research question (RQ4). This step involved assessing the moderating effect of prior EHR experience on the relationships between factors in the model, which was performed using multi-group analysis (Kline, 2015; Farooq and Vij, 2017; Hair et al., 2017).

A detailed explanation of each step carried out in Phase 3 as well as the results of each step is provided in Chapter 13.

The analysis in Chapters 12-13 was performed using two widely used statistical applications: Statistical Parcel for the Social Sciences (SPSS v25) and Analysis of a Moment Structures (AMOS v25).

10.4 Ethical Approval

Prior to collecting data from participants in the second stage of this research, ethical approval was sought and obtained from the University of Southampton's ethics committee. The reference for the ethics approval is ERGO/FPSE/30517. All participants were made aware of the aim and purpose of this study and their informed consent was obtained prior to participation in the study. All participants were assured of strict confidentiality of responses.

10.5 Summary

This chapter explained the research methodology designed for the second stage of this research. Three main phases were performed in order to answer research questions (RQ3-RQ4): (1)

hypothesis and model development (Chapter 11), (2) measurement model development (Chapter 12), and (3) model validation using structural equation modelling (Chapter 13). The aim of the second stage of this research is to develop a theoretical model that explains and predicts EHR adoption behaviours by primary healthcare physicians in the KSA. Details of the processes performed to accomplish phases 1, 2, and 3 described in the present chapter and the outcomes of each phase are presented in Chapters 11, 12, and 13, respectively.

Chapter 11 Hypothesis Development and the Proposed Model

11.1 Introduction

The present chapter presents the development of the hypothesis and the formulation of the proposed structural model to form the basis for the statistical examination in the second stage of the research. In this chapter, the author seeks to understand which of the factors in the validated framework determine other factors, and which of these factors have a direct effect on EHR adoption decisions. This chapter addresses research question (RQ3.1). To answer this research question, the eight factors of the validated framework were linked to EHR adoption decision by a set of research hypotheses. The hypotheses were developed by building on the knowledge acquired through the qualitative study performed in the first stage of this research (Chapters 7-9) as well as relevant academic literature. The following sections discuss how the hypotheses were developed and present the proposed structural model.

11.2 Hypotheses development

This section discusses the hypotheses developed to construct the proposed structural model as a basis for statistical investigation in the second phase of this research. The following subsections explain the hypotheses developed relating to each factor in the validated framework (Figure 9-1, Chapter 9).

11.2.1 Hypotheses Related to “Attitude Toward EHR"

According to TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991) and TAM (Davis, 1986), attitude toward using technology is the immediate determinant of technology acceptance. In e-health acceptance research, the significant direct influence of attitude on technology acceptance, referred to as behavioural intention to use technology, has received a substantial empirical evidence (Holden and Karsh, 2010). Studies on physicians’ acceptance of EHR have also acknowledged the importance of attitude in determining the behavioural intention to use EHR (Seeman and Gibson, 2009; Steininger and Stiglbauer, 2015). In their analysis of 68 studies to identify critical adoption factors of EHRs by physicians, Castillo et al. (2010) reported that physicians’ attitude toward EHR is the most critical adoption factor, and indicated that EHR adoption can be predicted based on it. Because physicians who form positive attitudes toward EHR have a stronger intention toward using it, they are more likely to employ it in their clinical practice. Therefore, the author proposes the following hypothesis:

H1: Attitude toward using the EHR will have a significant direct effect on physicians' intentions to use an EHR system

11.2.2 Hypotheses Related to "Perceived Usefulness"

According to TAM (Davis, 1986) and UTAUT (Venkatesh et al., 2003) an individual's intention to use a new technology in the workplace is determined by his or her perceptions of the usefulness of the technology. Likewise, prior studies support the critical influence of perceived usefulness on physicians' attitudes toward EHR systems (Morton and Wiedenbeck, 2009; Steininger and Stiglbauer, 2015), and intention to use these systems (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda et al., 2015; Steininger and Stiglbauer, 2015). In their review of over 100 studies on healthcare professionals' adoption of e-health, Gagnon et al., (2012) concluded that successful cases of EHR adoption were usually characterized by a clear understanding of the benefits of the technology by the users. As long as physicians perceive EHR as a source of performance enhancement and healthcare quality improvement they become more willing to use the system. Furthermore, the findings of qualitative study performed in the first stage of this research (Chapter 9) suggest that perceived usefulness and perceived ease of use (to be discussed in the next section) are the most important beliefs affecting physicians' attitudes and adoption of EHR systems. This is evidenced by the size of the themes assigned to these factors, which show that these two factors received the greatest attention and discussion by both experts and primary healthcare physicians interviewed (see Table 9-1, Chapter 9). Therefore, based on the findings of these studies, the researcher establishes the following hypothesis:

H2a: Preceived usefulness will have a significant positive effect on physicians' attitudes toward using an EHR system

H2b: Preceived usefulness will have a significant positive effect on physicians' intentions to use an EHR system

11.2.3 Hypotheses Related to "Perceived Ease of Use"

As discussed in the previous section, the findings of the qualitative study performed in the first stage of this research suggest that perceived usefulness and perceived ease of use are the most important factors affecting the outcome of the EHR adoption decisions. According to TAM (Davis, 1986), perceived ease of use determines attitude toward technology adoption. The study by Seeman and Gibson (2009) supports the significant effect of perceived ease of use on physicians' attitudes toward EHR. Therefore, based on these findings, the following hypothesis is established:

H3: Preceived ease of use will have a significant positive effect on physicians' attitudes toward using an EHR system

11.2.4 Hypotheses Related to "Computer Self-Efficacy"

Computer self-efficacy refers to an individual's judgment of his or her capability to use a system (Compeau and Higgins, 1995b, 1995a). This belief "is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses" (Bandura, 1977). The significance of computer self-efficacy in predicting IT usage behaviour has been supported by many studies in IS adoption literature (Compeau and Higgins, 1995b; Igbaria and Iivari, 1995). Compeau & Higgins (1995b) suggest that computer self-efficacy affects an individual's perceptions about the usefulness and ease of use of technology. This is because perceived outcomes (e.g. usefulness in terms of job performance) derive largely from one's judgement as to how well he or she can use the system (Compeau and Higgins, 1995b). Furthermore, individuals with higher computer-self efficacy have little difficulty in using the system and thus have greater perceptions of ease of use (Compeau and Higgins, 1995b).

In the e-health adoption context, many studies reported lack of healthcare providers' ability and familiarity with e-health systems such as an EHR as a major obstacle hindering their acceptance and use of these systems (Boonstra and Broekhuis, 2010; McGinn *et al.*, 2011; Gagnon *et al.*, 2012; Li *et al.*, 2013; Najaftorkaman *et al.*, 2015). The significance of computer self-efficacy in affecting EHR adoption behaviours was highly supported by experts and physicians interviewed in the qualitative study performed in the first stage of this research (Chapters 7-9). Previous studies in the e-health adoption context have shown that computer self-efficacy affects perceived usefulness and ease of use (Wu, Wang and Lin, 2007; Rho, young Choi and Lee, 2014). In the context of physician adoption of EHR, Gagnon et al. (2014) have shown that computer self-efficacy is a significant predictor of perceived ease of use. Based on the results of these studies, it is suggested that physicians with higher computer self-efficacy will be more likely to endorse greater usefulness and usability of the system. Consequently, the author proposes the following hypothesis:

H4a: Computer self-efficacy will have a significant positive effect on perceived usefulness of an EHR system by physicians

H4b: Computer self-efficacy will have a significant positive effect on perceived ease of use of an EHR system by physicians

11.2.5 Hypotheses Related to "Social Influence"

Social influence refers to the degree to which an individual perceives that most people who are important to him think he or she should use the new system (Venkatesh *et al.*, 2003). Theories of TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), and UTAUT (Venkatesh *et al.*, 2003) identify social norms or social influence as a critical factor affecting technology adoption by users. According to the Innovation Diffusion Theory (IDT) (Moore and Benbasat, 1991), social norms and interpersonal communication networks play a significant role in determining an individual's decision to adopt a new innovation. The more an individual perceives that important others think that he or she should adopt the new innovation, the greater his or her motivation to comply. Based on the findings of the qualitative study performed in the first stage of this research (Chapters 7-9), major sources of social influence important for a primary health physician include: senior management support and peers influence. Other important sources include: other medical staff's influence (e.g. nurses) and perceptions of patients' attitudes. Many studies on healthcare professional's acceptance of e-health technologies and EHR systems have shown that social influence has a significant direct effect on usage intentions (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016; Kim *et al.*, 2016).

Furthermore, it is suggested that social influence is particularly important in the context of physicians' decisions to adopt health IT/IS. Due to the high professionalism and specialization in the medical practice, physicians tend to hold the opinions and suggestions of their superiors and colleagues in high regard (Mun *et al.*, 2006; Venkatesh, Sykes and Zhang, 2011). The opinions of important referents could form the basis for an individual's perceptions about the utility and usability of technology. This effect means that if a superior or colleague says that a particular innovation is effective in their work, and is easy to use, this suggestion could affect the person's perceptions about the usefulness and ease of use of an innovation (Mun *et al.*, 2006). Evidence for this claim is illustrated in the qualitative study (e.g. see Expert 2's comment, page 94, and Expert 3's comment, page 95). Furthermore, several studies in the context of healthcare professionals' adoption of e-health technologies have shown that social influence has a significant positive effect on perceived usefulness (Mun *et al.*, 2006; Yu, Li and Gagnon, 2009; Basak, Gumussoy and Calisir, 2015), and perceived ease of use (Yu, Li and Gagnon, 2009).

In addition, prior research in IS adoption literature have shown that social influence has a significant positive effect on computer self-efficacy (Compeau and Higgins, 1995b). This is because support and encouragement to use the system by important referents represent "verbal persuasion" on one's ability to use the system. Indeed, the fact that respondents in the qualitative study performed in the first stage of this research (Chapters 7-9) stressed that strategies to improve computer self-efficacy such as training and IT support should focus on employing "super-users" suggest that social influence plays an important role in affecting computer self-efficacy. Furthermore, management support as a major dimension of social influence has been shown to impact individuals' judgments of computer self-efficacy (Compeau and Higgins, 1995b; Henry and Stone, 1995). This is because management support implies increased availability of assistance to individuals who require it, and thus increases the ability of those individuals and hence, their perceptions of their ability (Compeau and Higgins, 1995b). Therefore, it is expected that social influence viewed as high management support and professional norms will have a significant positive effect on computer self-efficacy. Based on the above discussion, the following hypothesis are proposed:

H5a: Social influence will have a significant positive effect on physicians' intentions to use an EHR system

H5b: Social influence will have a significant positive effect on perceived usefulness of an EHR system by physicians

H5c: Social influence will have a significant positive effect on perceived ease of use of an EHR system by physicians

H5d: Social influence will have a significant positive effect on computer self-efficacy.

11.2.6 Hypotheses Related to "Physician Participation"

User participation in system development and implementation is considered to be a critical factor in achieving information system's success. Prior research in IS adoption literature suggests that user participation increases perceptions of personal relevance of the system to users and leads to more positive attitudes toward using the system (Hartwick and Barki, 1994). Lorenzi and Riley (2000) remarked that successful cases of e-health implementation are usually characterized by a direct involvement of users. Tasks of system development and implementation such as identifying and specifying needs of users, organizational implementation of the system, and system evaluation and assessment, are difficult to carry out in a valid way without direct involvement of end users (Iivari, Isomäki and Pekkola, 2010).

Participants in the qualitative study (Chapters 7-9) stressed the importance of involving physicians from the early stages of EHR implementation. Major forms of physician participation reported by participants include requirements analysis, selection and customisation of the system, workflow re-design, usability testing, and continuous feedback evaluation. Furthermore, participants stressed the significance of identifying local champions from the physicians' group leading the implementation of the system. This is particularly significant in the EHR adoption context, as IT-led projects are considered as a change enforced by the IT department, and thus resistance is likely to increase (see experts' comments in Section 7.4.5, page 96, and physicians' comments in Section 8.4.7, page 118). Therefore, it is expected that physician participation will lead to increased perceptions about compatibility of the system with physicians' values, practice needs and processes.

Furthermore, the study by Morton and Wiedenbeck (2009) has shown that physicians' attitudes toward EHR are strongly and significantly affected by their perceptions of involvement in system selection and implementation, regardless of the utility or usability of the system selected. This is because physicians' participation leads to perceived ownership of the system. This perceived ownership decreases resistance to change and increases commitment to the new system (Ives and Olson, 1984). As noted by Lorenzi and Riley (2000), when implementing complex systems, the major challenges to systems success are often behavioral rather than technical. A ''technically best" system can be brought to failure by people who have low psychological ownership in the system and who vigorously resist its implementation. This is in line with the comments received from participants in the qualitative study (e.g. see expert 7's quote, page 96). Therefore, it is expected that perceptions of physician participation will have a significant positive effect on attitudes toward using the system. Consequently, the following considerations are expected:

H5a: Physician participation will have a significant positive effect on compatibility perceptions of an EHR system by physicians

H6b Physician participation will have a significant positive effect on physicians' attitudes toward using an EHR system.

11.2.7 Hypotheses Related to "Perceived Threat to Physician Autonomy"

Many studies reported that a barrier to the implementation of EHR was the negative perceptions by physicians that the EHR system acted as a control mechanism allowing management to infringe on their professional autonomy (McGinn *et al.*, 2011). Campbell et al. (2006) remarked that EHR systems enforce specific practice procedures, while at the same time monitor physicians' behaviours, which may affect power structure and culture in a medical practice. Traditionally, physicians have enjoyed a high degree of autonomy in patient care and management and in service decision-making due to their role as the main providers of care as well as their professional expertise (Walter and Lopez, 2008). Professional autonomy is defined as “professionals having control over the conditions, processes, procedures, or content of their work” (Walter and Lopez, 2008). The implementation of EHR systems may pose threat to this professional autonomy by increasing control mechanisms over their work practices and introducing new tasks that were previously carried out by others (Campbell *et al.*, 2006; Jensen and Aanestad, 2006, 2007). For example, the EHR system necessitates more precision when typing data into it, more standardized processes and new routines of documentation, which limits the flexibility that physicians traditionally had with the free-text documentation in paper records (Campbell *et al.*, 2006; Jensen and Aanestad, 2007). These ‘inbuilt’ controls may take extra time for the physicians to complete certain work tasks (Campbell *et al.*, 2006; Jensen and Aanestad, 2007). Physicians may resent the requirement to type orders into the EHR system, especially when they view it as a “clerical” work, and nurses may object to take any verbal orders from physicians except in emergencies, or insist that the physician types orders into the EHR system before they can be carried out (Campbell *et al.*, 2006). This means that the traditional social relations to the other groups of clinicians may also be subject to change (Jensen and Aanestad, 2007). In general, physicians may perceive that an EHR system represents a threat to their control over regular practice patterns (Walter and Lopez, 2008). It has been suggested that professional autonomy is the most important professional value provided for physicians (Esmaeilzadeh & Sambasivan 2012). The study by Exworthy et al. (2003) to understand the views and reactions by primary healthcare physicians to the adoption of performance indicators identified that perceived loss of autonomy was central to physicians’ objections to performance indicators.

Hu et al. (1999) suggests that physicians differ from the other types of IT users investigated in the literature with regard to IT acceptance due to their specialized training, autonomous practices, and professional work arrangements. Walter and Lopez (2008) proposed *perceived threat to professional autonomy* factor and examined its effect on physicians’ decisions to use EHR and clinical decision support systems. Perceived threat to professional autonomy was defined as “the degree to which a person believes that using a particular system would decrease his or her control over the conditions, processes, procedures, or content of his or her work” (Walter and Lopez, 2008). The results of their study (Walter and Lopez, 2008) have shown that perceived threat to professional autonomy has a significant negative effect on perceived usefulness of both EHR and decision support systems. In addition, the study by Abdekhoda et al. (2015) has shown that perceived threat to professional autonomy negatively effects physicians’ perceptions of ease of use of EHR systems. Based on the findings of these studies, the following hypothesis are proposed:

H7a: Perceived threat to physician autonomy will have a significant negative effect on perceived usefulness of an EHR system by physicians

H7b: Perceived threat to physician autonomy will have a significant negative effect on perceived ease of use of an EHR system by physicians

11.2.8 Hypotheses Related to "Compatibility"

Compatibility was a new factor emerged from the interviews of both groups of participants in the qualitative study performed in the first stage of this research (Chapters 7-9). Compatibility is one of the important innovation characteristics and refers to the degree to which the system matches users' prior experience, existing values, practice needs and individual requirements (Moore and Benbasat, 1991). A major concern shared by participants in the qualitative study (Chapters 7-9) is that EHR systems implemented or piloted in primary healthcare practices are mostly systems designed for hospital settings, thus lacking the business value for primary healthcare (e.g. see expert 6's quote, page 101). Primary healthcare physicians who participated in the qualitative study shared concerns that EHR systems piloted in their medical practices were not compatible with the work process or priorities of primary healthcare (e.g. see physician 10's and physician 8's quotes, page 120). Karahanna et al. (2006) posits that an innovation cannot be viewed as advantageous if it does not meet the needs of potential users. Therefore, compatibility with potential users' needs is expected to be an important determinant of perceived usefulness. The study by Moore and Benbasat (1991) showed a significant positive association between compatibility and perceived advantage which is similar to perceived usefulness in the context of TAM. Likewise, Chau and Hu (2001) asserted that physicians would be more likely to take the usefulness of an IT/IS into account when it is considered to be compatible with their current healthcare practices. The findings of their studies (Chau and Hu, 2001; Chau and P. J. Hu, 2002) suggested that compatibility appears to be a significant predictor of perceived usefulness. In addition, the decomposed theory of planned behaviour (Taylor and Todd, 1995) suggests that compatibility is a significant predictor of an individual's attitude toward using technology. Another study in the context of physician adoption of healthcare IT, (Wu et al. 2007), found that compatibility has a significant positive effect on perceived ease of use. According to Wu et al. (2007), physicians would prefer an easy-to-use IT/IS without radical changes in their work processes, thus it is expected that compatibility will have a significant positive effect on perceived ease of use.

Moreover, Wu et al. (2007) suggested that the more the IT/IS is compatible with healthcare professionals' existing values, prior experiences and practice needs, the more they will feel comfortable and confident in using it, not needing to take a lot of efforts to learn or to reach familiarity with it, which will result in higher perceptions of computer self-efficacy. Therefore, compatibility is expected to have significant positive influence on computer self-efficacy.

Moreover, as discussed in the previous section, the more the IS/IT is perceived to interfere with the power or status of physicians, slow down procedures or increase workloads, the more physician will perceive loss of control over regular practice procedures, and hence patterns of resistance can emerge which would diminish the potential benefits of the system and lead to project failure (Campbell *et al.*, 2006). Therefore, it is expected that the more the technology is consistent with physicians' existing values, prior experiences and practice needs, not requiring radical changes or significant adaptations to new processes, the more the perceived control over practice procedures and hence the less the perceived threat to professional autonomy. Therefore, it is expected that compatibility will have a significant negative effect on perceived threat to professional autonomy. This expectation is grounded on the findings of the qualitative study, in which experts stressed the importance of not introducing significant changes in the work processes with the introduction of EHR (e.g. see Expert 9's and Expert 3's quotes, page 100). Further, Chau and Hu (2001) argued that physicians usually develop a particular practice style and get entrenched in it over time. Thus, it is unlikely that a physician will accept technology that is incompatible with his or her longstanding work practices, which further supports the argument that the more the compatibility of the system with the current practice routines and processes, the less the perceived threat to physician autonomy. Consequently, the following hypotheses are proposed:

H8a: Compatibility will have a significant positive effect on perceived usefulness of EHR by physicians

H8b: Compatibility will have a significant positive effect on physicians' attitudes toward using an EHR system

H8c: Compatibility will have a significant positive effect on perceived ease of use of EHR by physicians

H8d: Compatibility will have a significant positive effect on physicians' computer self-efficacy

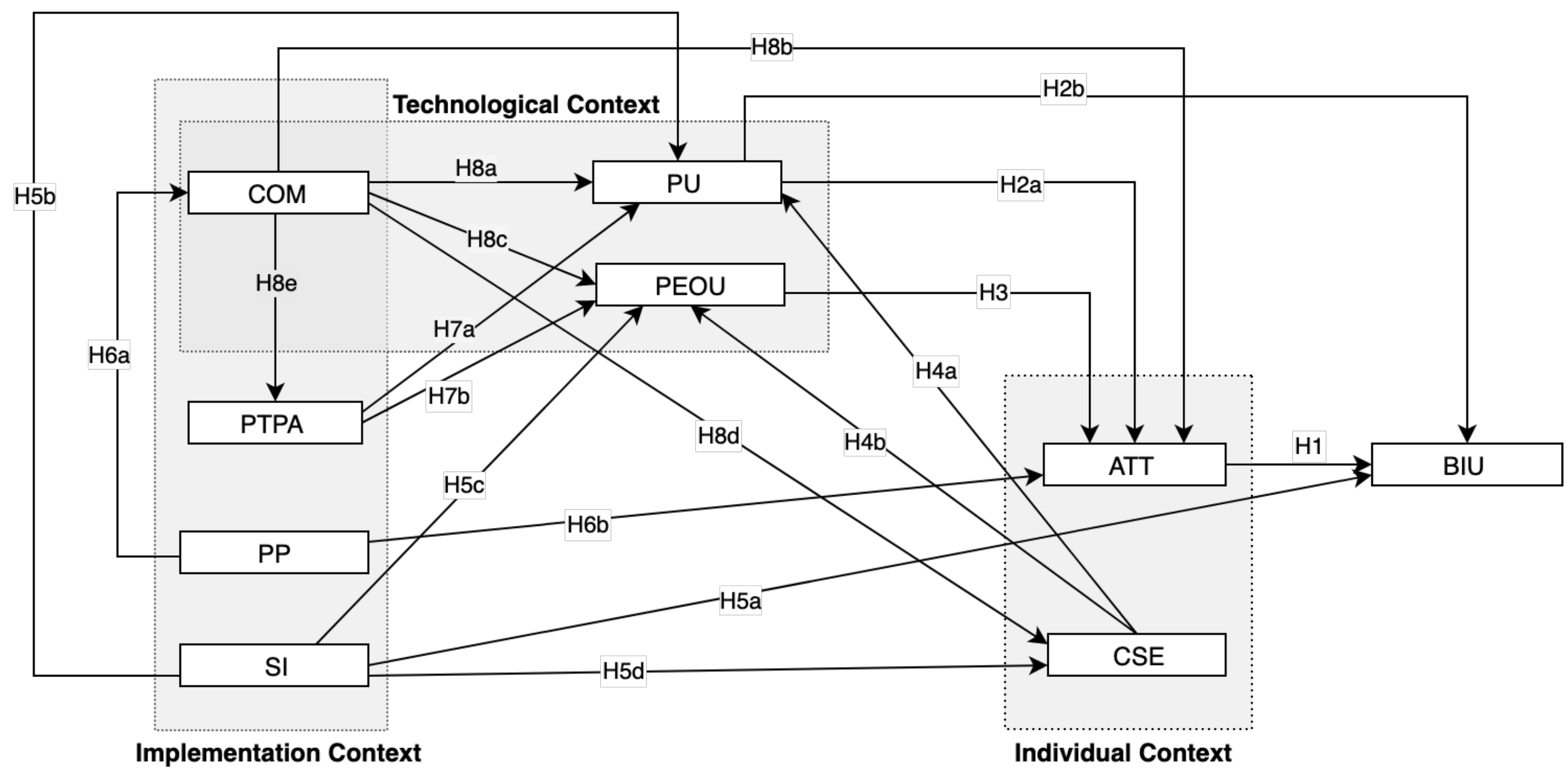
H8e: Compatibility will have a significant negative effect on perceived threat to professional autonomy

11.3 The Proposed Model of EHR Adoption

Based on the discussion presented in the previous section, the relationships between the key factors identified in the first phase of this research (Figure 9-1, Chapter 9) are illustrated in Figure 11-1.

Behavioural Intention to Use (BIU), defined as a person's subjective probability to perform a specified behaviour, was chosen as the main dependent variable in the model for theoretical and practical reasons. First, there is a substantial evidence in the literature showing a significant causal relationship between BIU and the behaviour in question (e.g. (Sheppard, Hartwick and Warshaw, 1988; Venkatesh, Sykes and Zhang, 2011)). According to Ajzen and Fishbein (1980), intention has a major effect on behaviour in mediating the effect of the other determinants on behaviour. Therefore, applying BIU as a dependent variable to examine user's adoption of IT is theoretically justifiable. Most studies on physicians' adoption of EHR have used BIU instead of actual behaviour (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon et al., 2014, 2016; Abdekhoda et al., 2015; Steininger and Stiglbauer, 2015). Second, EHR is still considered an emerging technology in the KSA, and only rare primary healthcare centres in KSA have applied it. Thus, the choice of intention over actual usage as a dependent variable was desirable, allowing a timely investigation of physician's acceptance when a growing number of primary healthcare centres are adopting EHR.

In addition, Hu et al. (1999) and Chau and Hu (2002) suggested three different contexts for classifying factors affecting individuals' adoption of IT/IS on the job: (a) individual, (b) technological, and (c) implementation contexts. The individual context refers to characteristics of an individual that are related to system usage. The technological context refers to the characteristics of the system that effects usage behaviour. The implementation context refers to the specific environment in which the individual works and the technology is implemented. In order to encourage usage behaviour, organisations need to develop a favourable environment to support system adoption. This classification of factors was used in the current research to improve the readability of the proposed model. In this study, the individual context contains two factors: attitude and computer self-efficacy. The technological context contains three factors: perceived usefulness, perceived ease of use and compatibility, while the implementation context contains four factors: social influence, physician participation, perceived threat to professional autonomy and compatibility. Compatibility was considered to belong to both technological and implementation contexts based on the explanations provided by participants in the first stage of this research (Chapters 7-9), which were also explained in section 11.2.8 in the current chapter. According to participants interviewed in the first stage of this research, compatibility not only involves the characteristics of the system, and whether it supports the requirements and priorities of primary healthcare (i.e. technological context), but also the amount of change required by individual users to adapt to new processes and procedures enforced by the system (i.e. implementation context). Therefore, compatibility is both a technological and an implementation contextual factor.



COM = Compatibility
PTPA = Perceived threat to professional autonomy
PP = Physician participation
SI = Social influence
PU = Perceived usefulness
PEOU = Perceived ease of use
ATT = Attitude toward EHR
CSE = Computer self-efficacy
BIU = Behavioural intention to use EHR "Acceptance"

Figure 11-1 The proposed model of EHR adoption

11.4 Conclusion

Building on the findings of the first stage of this research and the findings of relevant academic literature, this chapter proposed a model for explaining and predicting the adoption of EHR by primary healthcare physicians in the KSA. That is, the factors validated in the first stage of this research were linked to EHR adoption decision (i.e. BIU) by a set of research hypotheses. The following chapters include the development of the measurement instrument to measure the factors in the proposed EHR adoption model, and the SEM analysis conducted to validate the model.

Chapter 12 The Results of the Development and Validation of the Instrument

12.1 Introduction

The present chapter presents the development and validation of the measurement instrument, which was used for the main data collection for the second stage of this research. The instrument development process in this research went through three steps as explained in Chapter 10. The first step was selecting the appropriate measurement variables for each factor in the EHR adoption model of this study. The selection of measurement variables depended mainly on the findings of the qualitative study performed in the first stage of this research (Chapters 7-9), as well as prior research. Then, pre-test interviews were conducted with experts in order to ensure face and content validity of the instrument. After the pre-test interviews, a pilot study was performed with a convenient sample of 32 primary healthcare physicians in order to confirm the reliability of the scales used to measure factors in the EHR adoption model. The following sections explain the result of each step in detail.

12.2 Selection of Measurement Items

Research instruments are tools for measuring, observing, or documenting quantitative data on a topic of interest in order to answer a research question (Creswell, 2011). Examples include questionnaires, standardized tests, and checklists. Instruments should be designed carefully to ensure they measure what they are intended to measure, and that they collect reliable data from the chosen sample. Self-administered questionnaires are an excellent tool for measuring a wide variety of unobserved variables such as the factors of the EHR adoption model. They are also an ideal method for collecting data remotely about a population that is too large to observe directly. In addition, they allow for a comparative analysis between the population subgroups (Bhattacherjee, 2012).

The development of a measurement instrument was the second phase of stage two of this research (as described in Chapter 10). The more attention given to the development of the instrument, the easier it is to ensure that the findings are valid and reliable. In this research, the instrument was designed to collect data regarding the factors that affect the adoption of EHRs by primary healthcare physicians in the KSA.

The research model proposed in Chapter 11 (Figure 11-1) includes 9 factors, namely: *Perceived usefulness, Perceived ease of use, Computer self-efficacy, Social influence, Compatibility, Physician participation, Perceived threat to physician autonomy, Attitude, and Behavioural intention to use EHR.*

Researchers emphasize the importance of building the validity of a research instrument from the outset (Davis, 1989). As reported by Nunnally (1978, p.258): "Rather than testing the validity of measures after they have been constructed, one should ensure the validity by the plan and procedures for construction". Careful selection of the initial measurement items helps ensuring the content validity of constructs (Davis, 1989). Content validity is the degree to which the scale being used represents the concept being examined (Bohmstedt, 1970). A common method for selecting measurement items is the domain sampling method (Davis, 1989), which assumes that there is a domain of content for each construct being examined. Candidate measurement items representative of the domain should be selected.

It is generally recommended to adopt previously validated measurement items from existing literature and to refine them based on the context of the study (Bhattacherjee, 2012; O'Rourke and Hatcher, 2013; Recker, 2013). However, the findings of the qualitative study performed in the first stage of this research revealed new findings about the dimensions of many factors (Chapter 9, Figure 9-1), which should be incorporated into the measurement model. Therefore, the decision regarding the selection of measurement items for this research was as follows:

- For perceived usefulness: the findings of the qualitative study (Chapter 9, Figure 9-1) revealed six dimension that define perceived usefulness of EHR by primary healthcare physicians. Some of these dimensions correspond to previously validated measures in the literature (Davis, 1989; Gagnon *et al.*, 2014), which were adapted for this research. Specifically, one measure corresponding to *improved job performance* was adapted from (Davis, 1989), (PU1, Table 12-2). Three measures corresponding to *improved quality of care for patients* (PU4, Table 12-2)*, improved communication between healthcare providers* (PU5, Table 12-2), *and enhanced patient safety* (PU6, Table 12-2), were adapted from (Gagnon *et al.*, 2014). Three measures corresponding to *quick and easy access to information* (PU2-3, Table 12-2) and *empowering patients* (PU7, Table 12-2) were added by the researcher.

- For perceived ease of use: the findings of the qualitative study (Chapter 9, Figure 9-1) revealed five dimension that define perceived ease of use of EHR by primary healthcare physician. Some of these dimensions correspond to previously validated measures in the literature (Davis, 1989; Gagnon *et al.*, 2014; Abdekhoda *et al.*, 2015), which were adapted for this research. Specifically, two measures corresponding to *time to master the system* (PEOU1, PEOU5, Table 12-2) were adapted from (Davis, 1989; Gagnon *et al.*, 2014), two measures corresponding to *ease of navigation* (PEOU2, PEOU3, Table 12-2) were adapted from (Davis, 1989; Abdekhoda *et al.*, 2015), one measure corresponding to *interference with physician-patient communication* (PEOU4, Table 12-2) was adapted from (Gagnon *et al.*, 2014). Two measures corresponding to *time required for data entry* (PEOU6, Table 12-2) and *workload impact* (PEOU7, Table 12-2) were added by the researcher. Also, one measure (PEOU8, Table 12-2) was adapted from (Davis, 1989).

- For social influence: the findings of the qualitative study (Chapter 9, Figure 9-1) revealed four sources of social influence that affect physician adoption of EHR. Some of these dimensions correspond to previously validated measures in the literature (Venkatesh *et al.*, 2003; Gagnon *et al.*, 2014), which were adapted for this research. Specifically, one measure corresponding to *senior management support* (SI2, Table 12-2) was adapted from (Venkatesh *et al.*, 2003). Three measures corresponding to *peers influence* (SI3, Table 12-2), *other medical staff's influence* (SI4, Table 12-2), and *perceptions of patients' attitudes* (SI5, Table 12-2) were adapted from social norms factor studied by (Gagnon *et al.*, 2014). In addition, one measure (SI1, Table 12-2) was adapted from management support factor studied by (Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015) to better fit the explanations provided by participants in the first stage of this research (Chapters 7-8).

- For compatibility: three measures (COM3-5, Table 12-2) were adapted from (Moore and Benbasat, 1991), and two measure (COM1-2, Table 12-2) were added by the researcher to better fit the aspects of compatibility identified in the first stage of this research (Chapter 9, Figure 9-1).

- For computer self-efficacy: seven measures were adapted from (Compeau and Higgins, 1995b).

- For physician participation and perceived threat to physician autonomy: the measures were adapted from (Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015).

- For attitude toward using EHR: four measures were adapted from (Seeman and Gibson, 2009).

- For behavioural intention to use EHR: three measures were adapted from (Gagnon *et al.*, 2014).

Items adapted from prior studies were improved to fit the EHR adoption context. Table 12-1 illustrates the number of constructs and their measurement items as well as the sources from which these items were adapted.

Table 12-1 The measurement items of the research variables

Construct	Code	Number of Item	Sources
Perceived Usefulness	PU	7 items	Author (based on the qualitative study, Chapter 9), (Davis, 1989; Gagnon *et al.*, 2014)
Perceived Ease of Use	PEOU	8 items	Author (based on the qualitative study, Chapter 9), (Davis, 1989; Gagnon *et al.*, 2014; Abdekhoda *et al.*, 2015)
Computer Self Efficacy	CSE	7 items	(Compeau and Higgins, 1995b)
Social Influence	SI	5 items	(Venkatesh *et al.*, 2003; Morton and Wiedenbeck, 2009; Gagnon *et al.*, 2014; Abdekhoda *et al.*, 2015)
Physician Participation	PP	5 items	(Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015)
Compatibility	COM	5 items	Author (based on the qualitative study Chapter 9), (Moore and Benbasat, 1991)
Perceived Threat to Physician Autonomy	PTPA	5 items	(Morton and Wiedenbeck, 2009; Abdekhoda *et al.*, 2015)
Attitude	ATT	4 items	(Seeman and Gibson, 2009)
Behavioural Intention to Use	BIU	3 items	(Gagnon *et al.*, 2014)

The design of the instrument began with a welcome statement providing a brief introduction to the aim of the research, the contact information of the researcher and supervisors and the consent information for participants. The instrument was divided into two parts:

Part 1: Demographic Information: this part included socio-demographic questions such as the area of medical specialty, years in medical practice, experience with EHR and experience with computers. This part is important as it allows the researcher to determine the characteristics of physicians participating in this research as well as to perform group evaluation.

Part 2: Instrument measuring EHR adoption factors: this part included measurement items of the EHR adoption model. The questions in this part aim to establish the extent to which the respondent agrees or disagrees with the measurement items of the EHR adoption model. Most studies use five or seven-point Likert scale to measure attitudes and behaviours (Shaw and Wright, 1967; Peter, 1979). According to Johns, (2010), data collected from rating scales, including Likert scales, becomes significantly less accurate when the number of scale points drops below five or above seven. In addition, five or seven point Likert scale have been shown to create the variance that is necessary to examine the relationships between items and scales and to obtain an adequate internal consistency reliability estimates (Hinkin, Tracey and Enz, 1997). In this research, a seven-point Likert scale was initially selected to measure the instrument items, with anchors from ‘‘strongly agree’’ to ‘‘strongly disagree’. This is because a seven-point Likert scale offers a wider range of response categories in comparison to a five-point scale. This helps preventing response bias in selecting a neutral value (Dwivedi, Choudrie and Brinkman, 2006). However after the pilot study, which was the last stage of the instrument development process discussed in the present chapter, the measurement scale changed from seven-point to five-point Likert scale for the field survey, which was conducted in the next chapter. This is to save respondents’ time and to increase response rate as explained in Section 12.4.2 later in the present chapter.

12.3 Pre-test Interviews with Experts

Pretesting the research instrument is an important part of the questionnaire development process (Hinkin, Tracey and Enz, 1997). It is conducted to ensure that the structure and language of the instrument is appropriate, and to ensure the content validity of research instrument (Hinkin, Tracey and Enz, 1997; Reynolds and Diamantopoulos, 1998). Therefore, pre-testing the instrument allows the researcher to detect problems in the questionnaire before it is used for the main data collection.

Pre-testing the research instrument can be performed using personal methods (e.g. face to face or telephone interviews) or impersonal methods (e.g. mail surveys) (Reynolds and Diamantopoulos, 1998). However, the literature recommends personal interviews as the most effective way of performing a pre-test (Hunt, Sparkman Jr and Wilcox, 1982; Peterson, 1988; Reynolds and Diamantopoulos, 1998). Personal interviews are considered superior in terms of the accuracy and completeness of the information they generate (Reynolds and Diamantopoulos, 1998).

In this research, pre-testing interviews were conducted with experts for two objectives: (1) Face validity assessment, and (2) Content validity assessment. Each of these objectives is explained in the following subsections.

12.3.1 Face Validity Assessment

Face validity is concerned with the appearance of the instrument and includes issues such as design, clarity, readability, and ease of administration (Considine, Botti and Thomas, 2005; Bhattacherjee, 2012). An expert panel is usually employed to establish face validity of the instrument and to confirm an acceptable level of readability, clarity of contents, wording adequacy, consistency of style, and to identify errors in spelling, grammar, punctuation or abbreviation (Considine, Botti and Thomas, 2005; Bhattacherjee, 2012).

To fulfil this objective, first, an expert panel consisting of three computer science researchers at the University of Southampton was employed to review the design of the instrument. Those experts were interviewed face-to-face, and were asked to review the instrument and to identify errors relating to the clarity of questions, wording adequacy, spelling, grammar and the overall design and structure of the instrument. Following experts' recommendations slight changes to the instructions of the instrument and the grammar and phrasing of some questions and measurement items were made.

Then, to ensure that the instrument has high readability by the survey respondents, a second panel of experts consisting of five physicians working in KSA's healthcare organisations and who have an extensive knowledge in survey research was invited to review the instrument. The panel members included four primary healthcare physicians and one general surgeon. The panel included the following experts:

- The director of Medical Informatics Department at a major Saudi university.
- The director of Health Informatics Department at a major healthcare organisation
- The supervisor of Primary Healthcare Sector at a major province of the KSA
- Two medical directors of primary healthcare centres at the Ministry of Health.

The panel commented on the introduction section of the instrument, the demographics questions, the phrasing of some questions and measurement items, the sequence of instrument sections, the sequence of measurement items and the formatting of some sections. The instrument was improved based on experts' recommendations.

12.3.2 Content Validity assessment

Content validity refers to the degree to which the scale being used represents the concept being examined (Bohmstedt, 1970). It provides assurance that the instrument's items are relevant, appropriate and representative of the construct being examined, and thus ensures that instrument measures the content area it is expected to measure (Considine, Botti and Thomas, 2005). Therefore, it reduces the need for subsequent scale modification (Hinkin, Tracey and Enz, 1997).

According to Straub et al. (2004), content validity can be accomplished through a literature review and/or expert advice. This research utilized the two strategies in order to confirm the content validity of the instrument. First, as described previously (Section 12.2), most items employed in this research have been validated in prior research, and all selected items are consistent with the findings of the qualitative study performed in the first stage of this research (Chapters 7-9). Second, a panel of expert judges was employed to review the instrument for content validity. The literature recommends at least three experts in evaluating content validity of an instrument (Considine, Botti and Thomas, 2005). According to Fink and Litwin, (2003), content validity is not quantified with statistics. Rather, it is presented as an overall opinion of a group of expert judges.

In this research, the same expert panel consisting of five physicians who evaluated the face validity of the instrument was employed to evaluate the content validity of the instrument. For each construct, the experts were provided with the definition of the construct and were requested to indicate how well each measurement item represents a reasonable measure of the associated construct. The experts were also asked to review the overall scale for each construct and to indicate whether some items should be deleted or new items should be added. Overall, all selected measurement items were judged to be relevant and reasonable measures of their underlying constructs by all experts, with modifications applied to 33/49 measures (67% of the measures in the instrument) to improve their accuracy and content validity, and no new measures were added by the experts. Table 12-2 illustrates the measurement items after experts' validation.

Table 12-2 Instrument's items after validation of face and content validity by experts

Construct		Measurement items
Perceived Usefulness (PU)	PU1	I think that using the EHR will improve my job performance (e.g. by supporting my clinical decisions, improving my documentation of patients' encounters)
	PU2	I think that using the EHR will allow me to have an easy access to patients' data
	PU3	I think that using the EHR will help me to retrieve the information that I need quickly
	PU4	I think that using the EHR will improve the quality of care
	PU5	I think that using the EHR will facilitate communication and data sharing between various healthcare providers (e.g. between primary care centres and hospitals)
	PU6	I think that using the EHR will reduce the risk of errors
	PU7	I think that using the EHR will help empower my patients to actively take part in their own health (e.g. by allowing them an access to their lab results online, or providing them educational resources)
Perceived Ease of Use (PEOU)	PEOU1	I think that learning to use the EHR will be easy for me
	PEOU2	I think that interaction with EHR will be clear and understandable for me
	PEOU3	I believe navigation of EHRs will be easy for me
	PEOU4	I think that using the EHR during my consultations with patients will be simple and easy for me
	PEOU5	I think that learning to use the EHR will require much time (inverted)
	PEOU6	I think that using the EHR will require much time for data entry from me (inverted)
	PEOU7	I think using the EHR will add much extra workload (inverted)
	PEOU8	Overall, EHR will be easy for me to use
	CSE1	I feel confident I could use the EHR in my clinical activities if someone showed me how to use it first

Construct		Measurement items
Computer Self-Efficacy (CSE)	CSE2	I feel confident I could use the EHR in my clinical activities if someone else had helped me get started
	CSE3	I feel confident I could use the EHR in my clinical activities if I had seen someone else using it before trying it myself
	CSE4	I feel confident I could use the EHR in my clinical activities if I could call someone for help if I got stuck
	CSE5	I feel confident I could use the EHR in my clinical activities if there is no one around to tell me what to do as I go
	CSE6	I feel confident I could use the EHR in my clinical activities if I just have the software manuals for reference
	CSE7	I feel confident I could use the EHR in my clinical activities if I have just the built-in help facility for assistance
Social Influence (SI)	SI1	The senior management expects me to use the EHR when it becomes available in my practice
	SI2	I expect that the senior management will be helpful in the use of EHR when it becomes available in my practice
	SI3	I think that the other doctors would recommend that I use the EHR in my practice
	SI4	I think that the other healthcare professionals (nurses, pharmacists) would support that I use the EHR
	SI5	I think that most of my patients would welcome that I use the EHR
Compatibility (COM)	COM1	Compatibility of the EHR with the priorities of primary healthcare will increase my acceptance and use of the system
	COM2	Compatibility of the EHR with the needs and requirements of my medical profession will increase my acceptance and use of the system
	COM3	Compatibility of the EHR with work process in my medical practice will increase my acceptance and use of the system
	COM4	Compatibility of the EHR with the way I like to work will increase my acceptance and use of the system
	COM5	Compatibility of the EHR with my work style will increase my acceptance and use of the system
Physician Participation (PP)	PP1	My (or a representative group of primary healthcare physicians) involvement in EHR selection and implementation will be effective
	PP2	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase is a must
	PP3	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will make the system more useful for me
	PP4	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will make the system easier for me to use
	PP5	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will positively affect my attitude toward EHR
Perceived Threat to Physician Autonomy (PTPA)	PTPA1	I think that using EHR may increase the ability of the higher authority to control and monitor my clinical practices and decision making
	PTPA2	I think that using EHR may result in legal or ethical problems for me
	PTPA3	I think that using EHR may limit my autonomy in making clinical decisions or judgements
	PTPA4	I think that using EHR may threaten my personal and professional privacy
	PTPA5	Overall, I perceive that using EHR may negatively affect my professional autonomy

Construct		Measurement items
Attitude toward EHR (ATT)	ATT1	The EHR is an appropriate tool for physicians to use
	ATT2	I like the idea of using EHR
	ATT3	I think using the EHR will be advantageous for managing the medical care for my patients
	ATT4	Overall, my attitude about EHR usage is positive
Behavioural Intention to Use EHR (BIU)	BIU1	When available in my medical practice, I intend to use the EHR for all my clinical activities
	BIU2	The chances that I use the EHR in all my clinical activities when available in my medical practice are very high
	BIU3	Whatever the circumstances, I don't intend to use the EHR when it becomes available in my organization (inverted)

12.4 The Results of the Pilot Study

The pilot study was conducted for two reasons. The first was to get an initial indication of the reliability of the instrument. Reliability is the degree to which an instrument produces the same results with repeated trials (Considine, Botti and Thomas, 2005). It indicates the accuracy or precision of the statements used in the measuring instrument (Norland, 1990). According to Considine et al. (2005), reliability is one of the conditions for validity. That is, for an instrument to be valid, it must be reliable. Therefore, it is essential to test the reliability of the instrument before using it for the field survey.

The second reason for conducting the pilot study was to ensure that the instrument items are clear to participants, and that there is no inappropriateness of wording in the measures. This was performed to increase the validity of the instrument to the targeted sample.

The pilot study was performed by collecting data from a convenient sample of 32 physicians working in public primary healthcare practices. Respondents were asked to indicate the extent to which they agree or disagree with the measurement items. Items were measured using a seven-point Likert scale with anchors from ‘‘strongly agree’’ to ‘‘strongly disagree’’. At the end of the instrument, respondents were asked to make comments on any item that was not clear to them and to provide their suggestions for instrument improvement.

12.4.1 The Results of the Reliability Test

One of the most widely used estimates of reliability is internal consistency, which was measured in this pilot study using Cronbach's alpha coefficient (Hinkin, Tracey and Enz, 1997; Bhattacherjee, 2012). Cronbach's alpha tells how well the items measure the same construct (Hinkin, Tracey and

Enz, 1997). The value of Cronbach's alpha can range between 0 and 1, with values closer to 1 indicate high internal consistency reliability (Takona, 2002; Pallant, 2010). According to (Robinson, Shaver and Wrightsman, 1991; Sekaran and Bougie, 2016), reliability values less than 0.6 are considered poor, acceptable if they are between 0.60 – 0.69, good if they are between 0.70 – 0.79 and very good if they are at 0.80 or better.

To examine the reliability of the instrument, the responses received from the 32 participants were coded and analysed using SPSS v25. The results of the reliability test are shown in Table 12-3. The obtained Cronbach's alpha values for Perceived Ease of Use (PEOU), Physician Participation (PP), Compatibility (COM) and Attitude Toward Using an EHR (ATT) were well above 0.80, which indicates a very good internal consistency (Robinson, Shaver and Wrightsman, 1991; Sekaran and Bougie, 2016). Cronbach's alpha values for Perceived Usefulness (PU), Social Influence (SI), and Perceived Threat to Physician Autonomy (PTPA) ranged from 0.741 to 0.790, which indicates a good internal consistency reliability (Robinson, Shaver and Wrightsman, 1991; Sekaran and Bougie, 2016). Two constructs, namely: Computer Self-Efficacy (CSE), and Behavioural Intention to Use EHR (BIU) produced acceptable scores of Cronbach's alpha (Robinson, Shaver and Wrightsman, 1991; Sekaran and Bougie, 2016). In brief, all constructs have adequate internal consistency scores. This means that the measurement items of each construct are measuring the same content universe (i.e. construct) (Hinkin, Tracey and Enz, 1997).

Table 12-3 Cronbach's α reliability analysis results based on the pilot study

Construct being measured	Code	Number of items	Cronbach's α	Reliability Results
Perceived Usefulness	PU	7 items	0.790	Good
Perceived Ease of Use	PEOU	8 items	0.871	Very good
Computer Self Efficacy	CSE	7 items	0.687	Acceptable
Social Influence	SI	5 items	0.780	Good
Physician Participation	PP	5 items	0.893	Very good
Compatibility	COM	5 items	0.804	Very good
Perceived Threat to Physician Autonomy	PTPA	5 items	0.741	Good
Attitude	ATT	4 items	0.904	Very good
Behavioural Intention to Use	BIU	3 items	0.693	Acceptable

To further improve the reliability level, results of item-total correlations and scale if item deleted were analysed. According to (Ladhari, 2010), item-total correlation can serve as a criterion for initial assessment and purification of the scales. A cut-off point of item-total correlation of 0.30 was recommended by the literature (Cristobal, Flavián and Guinaliu, 2007). In Table 12-4, items that have an item-total correlation of less than 0.30 are highlighted. Also, items will result in a significant increase in scale reliability when deleted are highlighted. The decisions regarding each of these items were as follows:

- For item CSE6: this item had an item-total correlation coefficient of 0.131, which indicates a very small correlation (Cohen, 1988). Also, the deletion of CSE6 will improve the reliability of the scale from 0.678 to 0.731. Therefore, item CSE6 was removed from the instrument.
- For item SI5: the result of the qualitative study performed in the first stage of this research (Chapter 9) shows that the perceptions of patients' attitude is an important dimension of social influence affecting physicians' adoption of EHR. The item representing this dimension was SI5, and the statement used to operationalize this dimension was: "I think that most of my patients would welcome that I use the EHR". However, according to the reliability test, SI5 had a very small item-total correlation coefficient (0.109) (Cohen, 1988), and the deletion of this item will significantly increase the reliability of the scale from 0.780 to 0.853. A possible explanation for this result is that the statement used to operationalize this dimension was not very adequate. Therefore, the decision regarding item SI5 was to change the statement used to operationalize it to the following: "I think that my patients would become more satisfied when I use the EHR" as suggested by one participant in Section 12.4.2.
- For COM5: this item had a medium item-total correlation (Cohen, 1988). However, the deletion of this item will significantly improve the reliability of the scale. A possible explanation for this is that COM5 might not be a precise measure in the context of the study, which may have resulted in different interpretations by different participants as suggested by one participant in Section 12.4.2. To increase the reliability of the scale, item COM5 was removed from the instrument.
- For BIU3: The deletion of BIU3 will significantly improve the reliability of the scale from 0.693 to 0.832. However, the deletion of BIU3 will result in having only two items for measuring BIU factor. Although BIU factor can take one or two measures according to many studies (e.g. (Constantiou, Damsgaard and Knutsen, 2006; Ortega Egea and Román González, 2011)), it is always recommended to have at least three items in each scale (O'Rourke and Hatcher, 2013). Therefore, the decision regarding item BIU3 was to revise it. BIU3 was a reverse worded item, which may have caused respondents' inattention and confusion as suggested by (Van Sonderen, Sanderman and Coyne, 2013). Therefore, BIU3 was replaced by the following non-reverse worded item, which is adapted from (Venkatesh *et al.*, 2003): "*I predict to use the EHR in my clinical activities when it becomes available in my medical practice*".

Table 12-4 Results of item-total correlation and scale if item deleted of the pilot study

Construct	Cronbach's α	Item	Item-total correlation	Cronbach's α if item deleted
Perceived Usefulness (PU)	0.790	PU1	0.648	0.738
		PU2	0.386	0.791
		PU3	0.696	0.745
		PU4	0.675	0.729
		PU5	0.545	0.765
		PU6	0.635	0.738
		PU7	0.329	0.825
Perceived Ease of Use (PEOU)	0.871	PEOU1	0.803	0.841
		PEOU2	0.839	0.838
		PEOU3	0.310	0.881
		PEOU4	0.643	0.854
		PEOU5	0.490	0.875
		PEOU6	0.656	0.853
		PEOU7	0.628	0.860
		PEOU8	0.850	0.836
Computer Self-Efficacy (CSE)	0.687	CSE1	0.453	0.639
		CSE32	0.451	0.645
		CSE23	0.617	0.584
		CSE54	0.488	0.633
		CSE15	0.340	0.680
		CSE6	0.131	0.731
		CSE7	0.451	0.644
Social Influence (SI)	0.780	SI1	0.789	0.661
		SI2	0.796	0.654
		SI3	0.447	0.782
		SI4	0.706	0.683
		SI5	0.109	0.853
Compatibility (COM)	0.804	COM1	0.732	0.727
		COM2	0.763	0.729
		COM3	0.804	0.719
		COM4	0.777	0.730
		COM5	0.308	0.941
Physician Participation (PP)	0.893	PP1	0.806	0.856
		PP2	0.763	0.869
		PP3	0.805	0.855
		PP4	0.698	0.882
		PP5	0.754	0.889

Construct	Cronbach's α	Item	Item-total correlation	Cronbach's α if item deleted
Perceived Threat to Physician Autonomy (PTPA)	0.741	PTPA1	0.329	0.759
		PTPA2	0.436	0.719
		PTPA3	0.483	0.703
		PTPA4	0.659	0.631
		PTPA5	0.627	0.646
Attitude toward EHR (ATT)	0.904	ATT1	0.776	0.895
		ATT2	0.752	0.889
		ATT3	0.835	0.862
		ATT4	0.832	0.860
Behavioural Intention to Use EHR (BIU)	0.693	BIU1	0.484	0.630
		BIU2	0.797	0.167
		BIU3	0.304	0.832

12.4.2 Comments Added by Participants

The instrument contained an open-ended question at the end of the survey, which requests the participants to provide their comments and suggestions. One participant provided the following comment on many obstacles physicians faced with an EHR system previously implemented in the primary healthcare centre he/she works in, but the implementation was not successful. The first barrier indicates that the system was not fulfilling users' needs, which shows the importance of perceived usefulness and compatibility investigated in this research. The second and third barriers were relating to computer-self efficacy and the fourth barrier was about lack of perceived ease of use:

> "*For me, I tried the EHR in the primary healthcare centre…there was a lot of barriers that resulted in the abandonment of the system and it is no longer used at all. The most important barriers were: (1) inefficient system lacking a lot of required functions, (2) training only a small group of healthcare practitioners and relying on self-training for the remaining of practitioners, and lack of technical support in the [primary healthcare] centre, (3) lack of computer experience by many healthcare practitioners, and (4) complexity of the system for many healthcare practitioners*" (Participant P54)

Another participant commented on a number of success factors for the implementation of EHR. These factors were related to perceived usefulness, compatibility, physician involvement in the implementation of EHR, and providing adequate training (which is a dimension of computer self-efficacy), which confirms the importance of these factors, as follows:

> "*The success of EHR depends largely on designing a system that has all required components and features, and making users testing and evaluating it before implementation, maybe several times, and paying attention to the training of users*" (Participant P48)

Regarding the items in the instrument, one participant provided the following comment about item COM5, indicating that the item was not clear, which confirms the suggestion that this item might have been interpreted differently by different participants, and thus affected the reliability of the scale:

> "*Q [question] about [work] style I think [it] should be specified and [be made] more clear*" (Participant P97)

Another participant suggested adding measures about the impact of EHR on patient's waiting time for consultation, and the impact of EHR on improving patients' satisfaction, as follows:

> "*In my view you can add about patient' feedback…and also [you] can add about the impact of EHR on patient's waiting time for consultation and patient' satisfaction in it*" (Participant P55)

Based on this suggestion, two measurement statements were added to the instrument. One statement was added under social influence factor as an improvement of SI5 item as discussed in Section 12.4.1. And the other measurement statement was added as a new measure under perceived usefulness factor based on the participant's suggestion, which is "I think that EHR will help reducing my patient's waiting time for consultation".

Finally, after the instrument was improved based on the results of the pilot study, it was reviewed again by two experts, one primary healthcare physician and one researcher, both have expertise in survey research. The experts were asked to review the instrument after changes were made based on the pilot study, and to provide suggestions for improvement as a final step before starting the main data collection. One expert suggested breaking SI3 into the following two items in order to increase the preciseness of the statement: "I think that my doctor colleagues would recommend that I use the EHR in my practice" and "I think that the consultants in my medical area would recommend that I use the EHR". Also, one expert recommended changing the level of scale used to collect responses regarding measurement items from a seven-point level to a five-point level for the field survey. According to the expert, a five-point scale is simple and easier for participants to decide their judgements, thus would increase the response rate. Assessment of survey completion times by participants in the pilot study revealed that participants spent between 9 to 50 minutes to complete the survey, with an average of 15 minutes. Therefore, responses in the final instrument were collected through a five-point Likert scale with anchors from “strongly agree” to “strongly disagree”.

The final instrument measures used for the main data collection is illustrated in Table 12-5. The content validity and reliability of all scales have been confirmed in this chapter. The complete instrument, including the welcome statement and demographic questions, is presented in Appendix E.

Table 12-5 The final measurement items after the pilot study conducted in the present chapter, which was used for the main data collection in Chapter 13

Construct		Measurement items
Perceived Usefulness (PU)	PU1	I think that using the EHR will improve my job performance (e.g. by supporting my clinical decisions, improving my documentation of patients’ encounters)
	PU2	I think that using the EHR will allow me to have an easy access to patients’ data
	PU3	I think that using the EHR will help me to retrieve the information that I need quickly
	PU4	I think that using the EHR will improve the quality of care
	PU5	I think that using the EHR will facilitate communication and data sharing between various healthcare providers (e.g. between primary care centres and hospitals)
	PU6	I think that using the EHR will reduce the risk of errors
	PU7	I think that using the EHR will help empower my patients to actively take part in their own health (e.g. by allowing them an access to their lab results online, or providing them educational resources)
	PU8	I think that EHR will help reducing patient’s waiting time for consultation
Perceived Ease of Use (PEOU)	PEOU1	I think that learning to use the EHR will be easy for me
	PEOU2	I think that interaction with EHR will be clear and understandable for me
	PEOU3	I believe navigation of EHRs will be easy for me
	PEOU4	I think that using the EHR during my consultations with patients will be simple and easy for me
	PEOU5	I think that learning to use the EHR will require much time (inverted)
	PEOU6	I think that using the EHR will require much time for data entry from me (inverted)
	PEOU7	I think using the EHR will add much extra workload (inverted)
	PEOU8	Overall, EHR will be easy for me to use
Computer Self-Efficacy (CSE)	CSE1	I feel confident I could use the EHR in my clinical activities if someone showed me how to use it first
	CSE2	I feel confident I could use the EHR in my clinical activities if someone else had helped me get started
	CSE3	I feel confident I could use the EHR in my clinical activities if I had seen someone else using it before trying it myself
	CSE4	I feel confident I could use the EHR in my clinical activities if I could call someone for help if I got stuck
	CSE5	I feel confident I could use the EHR in my clinical activities if there is no one around to tell me what to do as I go

Construct		Measurement items
	CSE6	I feel confident I could use the EHR in my clinical activities if I have just the built-in help facility for assistance
Social Influence (SI)	SI1	The senior management expects me to use the EHR when it becomes available in my practice
	SI2	I expect that the senior management will be helpful in the use of EHR when it becomes available in my practice
	SI3	I think that the consultants in my medical area would recommend that I use the EHR
	SI4	I think that my doctor colleagues would recommend that I use the EHR in my practice
	SI5	I think that the other healthcare professionals (nurses, pharmacists) would support that I use the EHR
	SI6	I think that my patients would become more satisfied when I use the EHR
Compatibility (COM)	COM1	Compatibility of the EHR with the priorities of primary healthcare will increase my acceptance and use of the system
	COM2	Compatibility of the EHR with the needs and requirements of my medical profession will increase my acceptance and use of the system
	COM3	Compatibility of the EHR with work process in my medical practice will increase my acceptance and use of the system
	COM4	Compatibility of the EHR with the way I like to work will increase my acceptance and use of the system
Physician Participation (PP)	PP1	My (or a representative group of primary healthcare physicians) involvement in EHR selection and implementation will be effective
	PP2	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase is a must
	PP3	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will make the system more useful for me
	PP4	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will make the system easier for me to use
	PP5	My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will positively affect my attitude toward EHR
Perceived Threat to Physician Autonomy (PTPA)	PTPA1	I think that using EHR may increase the ability of the higher authority to control and monitor my clinical practices and decision making
	PTPA2	I think that using EHR may result in legal or ethical problems for me
	PTPA3	I think that using EHR may limit my autonomy in making clinical decisions or judgements
	PTPA4	I think that using EHR may threaten my personal and professional privacy
	PTPA5	Overall, I perceive that using EHR may negatively affect my professional autonomy
Attitude toward EHR (ATT)	ATT1	The EHR is an appropriate tool for physicians to use
	ATT2	I like the idea of using EHR
	ATT3	I think using the EHR will be advantageous for managing the medical care for my patients
	ATT4	Overall, my attitude about EHR usage is positive

Construct		Measurement items
Behavioural Intention to Use EHR (BIU)	BIU1	When available in my medical practice, I intend to use the EHR for all my clinical activities
	BIU2	The chances that I use the EHR in all my clinical activities when available in my medical practice are very high
	BIU3	I predict to use the EHR in my clinical activities when it becomes available in my medical practice

12.5 Summary and Conclusion

This chapter reported the results of steps undertaken for constructing and validating the research instrument to be used for the main data collection for the second stage of this research. The processes followed for instrument development and validation were described in order to define the accuracy of the outcomes that the researcher was attempting to measure. The construction of the instrument was informed by the findings of the qualitative study performed in the first stage of this research (Chapter 9), as well as prior research. This helped ensuring that the items selected are representative measures of the content area of factors under examination. Based on the EHR adoption model, 9 factors were selected, and 49 items were generated for further consideration.

Following this, pre-test interviews were conducted with two expert panels in order to validate instrument for face and content validity. After that, a pilot study was performed on a convenient sample of 32 primary healthcare physicians in order to confirm the reliability of the instrument. Reliability was assessed using internal consistency reliability, which was calculated using Cronbach's alpha. The results of the reliability analysis have shown adequate internal consistency reliability for all scales. The reliability of scales was further improved by analysing the item-total correlation and Cronbach's alpha if item deleted for each scale. In addition, slight modifications to the final design of the instrument were made upon receiving the feedback from participants. Finally, two experts further reviewed the final instrument after the modifications made based on the results of the pilot study. Based on these steps, the final instrument was developed (Table 12-5).

The next chapter will present the details of Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) to validate the measurement model developed in the present chapter with a large sample and to validate the proposed EHR adoption model developed in Chapter 11.

Chapter 13 Results of the Model Validation Using Structural Equation Modelling (SEM)

13.1 Introduction

The previous chapter presented the results of the instrument development and validation process. Following on, the current chapter discusses the results of the model validation using Structural Equation Modelling (SEM). Before data was examined using SEM, a preliminary data analysis was conducted primarily to evaluate the data for missing values, normality, and internal consistency reliability using Cronbach's alpha criteria. Then SEM analysis was conducted in two main phases: (1) measurement model analysis, in which factor analysis was performed in order to establish construct validity and reliability of the factors examined in this research as well as the goodness of fit of the research instrument developed by this research, and (2) structural model analysis, in which the goodness of fit of the proposed model developed in Chapter 11 was examined and the relationships between the factors were evaluated. The final output of these steps is a model explaining how the adoption decisions of EHR systems by primary healthcare physicians in the KSA are affected by the factors identified in the first stage of this research. Finally, the moderating effect of EHR experience on all model relationships was examined to evaluate whether there are statistically significant differences in the model relationships between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR.

13.2 Overview of the Study Setting

As described previously, the Ministry of Health (MOH) is the major governmental provider of healthcare services in the KSA, providing 60% of healthcare services, through 282 hospitals (43,080 beds) and 2361 primary healthcare centres. The remaining 40% of provision is divided between other entities in the governmental sector (combined total of 47 hospitals, 12,279 beds), and the private sector with 158 hospitals (17,622 beds) (Ministry of Health, 2017). Under the other governmental sector are grouped the health facilities of the military (e.g. National Guard Health Affairs, Security Forces Medical Services and Army Forces Medical Services), universities' healthcare facilities (e.g. King Saud University Medical City), specialist hospitals (e.g. King Faisal Specialist Hospital and Research Centre) and other institutions such as ARAMCO oil company health facilities and Royal Commission for Jubail and Yanbu health services. Apart from the specialist hospitals, the health facilities in this sector provide health care services to a defined population, usually employees of different establishments and members of their families (Al Yousuf, Akerele and Al Mazrou, 2002).

The MOH supervises 20 regional directorates of health affairs in various regions of the kingdom. Each regional health directorate has a number of hospitals and health sectors, and each health sector has a number of primary healthcare centres (Almalki, Fitzgerald and Clark, 2011). The healthcare system at MOH is a three-tier system: primary, secondary and tertiary, corresponding respectively to primary healthcare centres, general hospitals and specialist hospitals. Primary healthcare centres form the basis of the KSA's healthcare system. They are distributed throughout the KSA and serve as first point of contact for the patient with the healthcare system. By 2017, there were 2361 primary healthcare centres in the KSA (Ministry of Health, 2017). The primary healthcare centres are linked to the general hospitals, and the general hospitals are linked to the specialist hospitals by a referral and feedback system. The primary healthcare centres implement the various components of primary healthcare. Services provided include: health promotion, disease prevention, counselling, maternal and child health, management of chronic diseases (e.g. hypertension and diabetes), immunization, provision of essential drugs and health education (Al Yousuf, Akerele and Al Mazrou, 2002).

Most physicians working in primary healthcare centres are family physicians, followed by general practitioners (Ministry of Health, 2017). In the KSA, the term *general practitioner* refers to physicians who have completed an undergraduate degree in a medical school plus one year internship, while the term *family physician* refers to physicians who have received an additional training and specialized in family medicine. In the UK, the term *general practitioner* is equivalent to the term family physician used in the KSA, that is, a general practitioner in the UK is required to specialize in family medicine in order to practice as a general practitioner (Doran *et al.*, 2006). The MOH is currently implementing national strategic plans, policies and programs to improve the healthcare services in primary healthcare centres. One of the major objectives is to improve family medicine practice as the major specialty in primary healthcare (Al-Khaldi *et al.*, 2017). This has resulted in a significant increase in family medicine programs and the number of family physicians in primary healthcare centres during the last five years (Al-Khaldi *et al.*, 2017). Based on the annual statistical reports produced by MOH in the years 2012 (Ministry of Health, 2012) and 2017 (Ministry of Health, 2017), the number of family physicians in primary healthcare centres has doubled between the years 2012 (2,034) and 2017 (3,892), and this number is expected to continue increasing. In addition to family physicians and general practitioners, a small percentage of other physicians such as general internists, general paediatrics and general obstetricians/gynaecologists are available in a number of primary healthcare centres. Furthermore, many primary healthcare centres provide dental services through general dentists (Ministry of Health, 2017).

13.3 Population and Sampling Procedure

The total study population is primary healthcare physicians at the Ministry of health (MOH) as the major governmental provider of healthcare services in the KSA. The study used a combination of random, snowball and convenience sampling approaches. The random sampling was achieved by soliciting the support of the Deputy Minister for Primary Healthcare for a nationwide survey. An email letter was sent to the Deputy Minister for Primary Healthcare, which briefly descripted the aim and the purpose of the study with a link to the online survey. The letter received approval, and the link to the online survey was populated to the General Assistants of Public Health at the General Directorates of Health Affairs in all regions in order to be populated to primary healthcare physicians. After five weeks, another letter was sent by the Deputy Minister to the General Assistants of Public Health to send reminders to primary healthcare physicians. To increase the response rate, snowball and convenience sampling approaches were used. For the snowball sampling, email invitations were sent to supervisors of primary healthcare sectors and centres requesting them to participate and to populate the survey to the primary healthcare physicians under their supervision. Contact information of those supervisors was obtained through snowball sampling, that is, supervisors recommend other supervisors to be contacted. In convenience sampling, the Board of Directors of the Saudi Society for Family and Community Medicine (SSFCM), which includes over 5000 members representative of family physicians in the KSA, was contacted by email and invited to populate the survey link to the members of the SSFCM. The email invitation was accepted and an invitation in addition to a link to the survey was published on the official page of the SSFCM on Twitter. The data collection lasted from April to November 2018. The response rate cannot be calculated, as it is not known how many potential participants received the invitation and how many neglected to participate.

13.4 Sample Size

The sample size in quantitative research should be sufficient in order to produce reliable findings. Several recommendations for the minimum sample size have been provided by the literature. According to MacCallum et al. (1999), the sample size should be at least 100 participants in order to perform factor analysis. However, in order to perform a SEM analysis, Kline (2015) recommended 200 participants as the typical sample size, while others argued that it can be less than 200 (Wolf *et al.*, 2013). Other recommendations depend on the number of factors to be measured. This includes the rule of 10, which recommends having a sample size of at least ten times the number of factors (Everitt, 1975; Schreiber et al., 2006; Velicer & Fava, 1998). Although there is no agreement among researchers about the optimum sample size for SEM analysis (Hair et al., 2014; Kline, 2015; Muthén & Muthén, 2002; Wolf et al., 2013), it is agreed that 200 cases and above is considered adequate when performing SEM analysis (Hair *et al.*, 2014; Kline, 2015).

In this study, over 500 participants opened the survey, and a total of 365 responses were received. Of these responses, 80 responses were missing data over the minimum acceptable rate (5%) (Acuna and Rodriguez, 2004), and thus were excluded. Also, because the focus of this study is primary healthcare physicians affiliated to the MOH, responses received from other healthcare authorities (39 responses) were excluded. Also, two responses were removed because their affiliation was not provided. Finally, one response was judged to be an unengaged response with an evidence of giving the exact same answer for every single item. Because such outliers can provide misleading findings (Tabachnick and Fidell, 2007), this response was excluded. The final dataset contains 243 valid responses, deemed appropriate for factor analysis and structural equation modelling according to previously mentioned recommendations (the rule of 10 and the size of 200) (Everitt, 1975; Schreiber et al., 2006; Velicer & Fava, 1998, Hair et al., 2014; Kline, 2015). The obtained sample size is larger than or similar to the sample sizes commonly reported in prior research that used SEM to investigate physicians' adoption of EHR (Abdekhoda et al., 2015; Archer & Cocosila, 2011; Gagnon et al., 2016; Gagnon et al., 2014; Morton & Wiedenbeck, 2009; Seeman & Gibson, 2009; Steininger & Stiglbauer, 2015; Venkatesh et al., 2011). Table 13-1 shows the number of the responses received and the numbers of the deleted cases next to their category.

Table 13-1 The obtained sample size after removing incomplete and irrelevant responses

Total responses	365
Incomplete responses (>5% missing values)	80
Non MOH responses	39
Affiliation not known	2
Unengaged responses	1
Total valid responses	**243**

13.5 Preliminary Data Analysis

Preliminary data analysis is an essential step before performing SEM analysis in order to ensure the completeness and normality of data (Hair *et al.*, 2014; Kline, 2015). In the following sections, techniques used for handling missing values were explained, then an assessment of data for normality was conducted. Following this, descriptive statistics of demographic data of respondents were provided. Finally, a preliminary assessment of the reliability of scale measures using was performed.

13.5.1 Handling Missing Data

Missing data is a common problem in survey research, which can cause difficulties in performing any statistical test, and in the case of SEM analysis missing data can lead to inability of achieving model-fit (Hair *et al.*, 2014; Kline, 2015). Because SEM and multivariate analysis methods require complete data, it is essential to handle missing data before any statistical test can be performed (Hair *et al.*, 2014; Kline, 2015). The first step in handling missing data is to check cases (i.e. participants) and variables for the extent of missing values. The literature suggests that 1-5% of missing data is manageable and can be imputed without affecting the outcomes of the analysis (Acuna and Rodriguez, 2004; Hair *et al.*, 2014). In this research, of the 365 responses received, a total of 80 cases were missing over the acceptable rate of 5%. The literature suggests that one approach would be to follow the complete case approach, in which the cases with missing values are excluded from the analysis, especially when the sample size remains large enough to conduct the statistical test determined (Hair *et al.*, 2014). As explained in Section 13.4, cases with missing data over 5% were excluded from any further analysis (80 cases), and after removing responses received from participants not affiliated to MOH and unengaged responses, the final dataset consisted of 243 responses, which is appropriate for SEM analysis (Hair *et al.*, 2014; Kline, 2015). After analysing cases (rows) for missing data and excluding those with over 5% missing values, variables (columns) were then checked for missing values to identity those having over 5% of missing values (Hair *et al.*, 2014; Kline, 2015). Only one variable (PU8) was missing over 5% of data (7%). Because there were seven other indicators for perceived usefulness in the instrument, which is over the minimum number of items that should be provided for each construct (O'Rourke and Hatcher, 2013; Hair *et al.*, 2014; Kline, 2015), PU8 was excluded from any further analysis.

Furthermore, because the pattern of missing data in the final dataset was random (i.e. the data missing was not concentrated on specific questions throughout the dataset) and the missing values in any given variable were not associated with the values of any other variable, the missing data pattern was judged to be Missing Completely at Random (MCAR) (Hair *et al.*, 2014; Kline, 2015), and therefore any imputation method can be applied without affecting the results (Hair *et al.*, 2014). One of the most widely used methods for handling missing values is *mean substitution,* in which missing values for a variable are substituted with the mean value of that variable calculated from all valid responses. The rationale for this approach is that the mean is the best single replacement value. This approach is best used when the rate of missing data is relatively low (Hair *et al.*, 2014). Since the rate of missing data in the final dataset is below 5%, this approach was considered adequate in the present study and hence was applied.

13.5.2 Normality Assessment

After handling missing values, all variables in the dataset were assessed for normality. In order to perform SEM analysis, the data should be normally distributed, and any violation to the normality assumption would lead to underestimation in the statistical findings (Hair *et al.*, 2014; Kline, 2015). Although the effect non-normality tends to diminish and becomes negligible in sample sizes of 200 observations or more (Altman & Bland, 1995; Hair et al., 2014), it is always recommended to assess variables for normality before conducting the analysis (Hair *et al.*, 2014; Kline, 2015). There are many tests for assessing the normality of data such as Mardia' (1985) test, Cox–Small test (Cox and Small, 1978), and z-test (Field, 2009; Kim, 2013; Hair *et al.*, 2014; Kline, 2015). However, all such tests are not helpful in large sample sizes as minor departure from normality could be reported as statistically significant (Field, 2009; Kim, 2013; Hair *et al.*, 2014; Kline, 2015). An alternative is to interpret the absolute values of skewness and kurtosis (Kim, 2013; Kline, 2015; West, 1995). Skewness refers to the symmetry of a distribution. The skew value of a normal distribution is zero, implying symmetric distribution. A positive skew value indicates that the distribution tails off to the right and that the bulk of the data values lie to the left of the mean, and vice versa for a negative skew value (Kim, 2013). Kurtosis measures the peakedness or flatness of a distribution when compared with a normal distribution. A positive kurtosis value indicates a relatively peaked distribution, and a negative value indicates a relatively flat distribution (Hair *et al.*, 2014). Kline (2015) suggested that absolute values of skewness and kurtosis exceeding 3 and 10, respectively, may indicate non-normal distribution. Other researchers suggested an absolute value of 2 for skewness and 7 for kurtosis as maximum limits for satisfactory departures from normality (Kim, 2013; West et al., 1995). As shown in Appendix F, all variables in the dataset have skewness and kurtosis values well below two and seven, respectively, which means that the data meets the normality assumption (Kim, 2013; West et al., 1995). An exception is *Speciality* variable, which has an absolute skewness value greater than 2 but below 3, and hence it still meets the normality assumption (Kline, 2015).

13.5.3 Demographic Data

After the preliminary data analysis, the final sample consisted of 243 physicians. The characteristics of respondents are presented in Table 13-2. The proportions of male and female were about 57% and 43%, respectively. Most respondents (56%) were in the age range of 30-39. The majority of respondents were family physicians forming about 46% of the sample followed by general physicians forming around 44% of the sample. Other physicians who participated include: 3 general internists, 2 general paediatricians, 8 general dentists, 4 public health and preventive medicine physicians, 1 emergency physician and 3 others did not specify their medical domain. The majority of participants (65.4%) have over five years of work experience after the internship. Most participants (70.8%) work in urban areas, while around 17% work in rural areas and around 12% work in semi-urban areas. Approximately, 39% of the respondents have prior experience in EHR. Of those, 45.3% have less than one year of EHR experience while 50% have between 1 and 5 years. Experience of EHR use is mostly associated with basic functions of the EHR, particularly electronic prescribing (71.3%), viewing laboratory results/radiology images (69.1%), making orders to the laboratory/radiology (58.5%) and clinical notes (56.4%). The survey respondents included three different groups in terms of the current use of the EHR: users who are currently having an EHR system in their medical practices (9.5%), users who had an EHR system piloted in their medical practices but the implementation was discontinued (10.3%), and users who did not have an EHR system at all in their medical practices (80.2%).

Table 13-2 Demographics of the respondents

Characteristics	Frequency (N=243)	
	N	%
Gender		
Male	138	56.8%
Female	105	43.2%
Age		
<30	32	13.3%
30-39	137	56.4%
40-49	55	22.6%
50-59	17	7%
≥60	2	0.8%
Medical domain		
Family physician	112	46.1%
General physician	110	44.9%
Other physicians	21	9%
Years in practice after internship		
<1	11	4.5%
1-5	73	30%
6-10	68	28%
11-15	52	21.4%
16-20	18	7.4%
>20	21	8.6%
Average daily use of computer/Internet		
< 30 minutes	8	3.3%
30-60 minutes	15	6.2%
1-2 hours	60	24.7%
2-5 hours	107	44%
>5 hours	53	21.8%
EHR experience		
Yes	94	38.7%
No	149	61.3%
(If Yes)		
Functions used in the EHR		
Viewing laboratory results/ radiology images	65	69.1%
Making orders (laboratory, radiology)	55	58.5%
Electronic prescribing	67	71.3%

Medication alerts and reminders	**21**	**22.3%**
Clinical notes	**53**	**56.4%**
Generating reports	**36**	**38.3%**
Years of experience in the EHR		
<1	**43**	**45.3%**
1-5	**47**	**50%**
>5	**4**	**4.3%**
EHR status in the primary healthcare center		
The EHR system is currently implemented	**23**	**9.5%**
The EHR system has been piloted but discontinued	**25**	**10.3%**
The EHR system is not currently implemented	**195**	**80.2%**
Work settings		
Urban	**172**	**70.8%**
Semi-Urban	**29**	**11.9%**
Rural	**42**	**17.3%**

13.5.4 Reliability of Scale Measures

Reliability of scale measures was examined using the Cronbach's alpha values. As shown in Table 13-3, all of the values were above 0.70, the acceptable range recommended by the literature and most were above the 0.80, which is considered very good (Robinson et al., 1991; Sekaran & Bougie, 2016). As performed in Chapter 12, the results of item-total correlation and scale reliability if item deleted were also analysed. As shown in Table 13-4, all items have an item-total correlation above the minimum value of 0.30 as recommended by the literature (Cristobal et al., 2007). The results of scale reliability if item deleted show that only one item (PTPA1) will result in a significant increase the reliability of the scale when deleted, and hence was deleted from the subsequent analysis.

Table 13-3 Cronbach's alpha reliability analysis for the field survey data

Construct being measured	Code	Number of items	Cronbach's α	Deleted items	Revised Cronbach's α	Reliability Results
Perceived Usefulness	PU	7 items	0.856			Very good
Perceived Ease of Use	PEOU	8 items	0.880			Very good
Computer Self Efficacy	CSE	6 items	0.729			Good
Social Influence	SI	6 items	0.840			Very good
Physician Participation	PP	5 items	0.904			Very good
Compatibility	COM	4 items	0.924			Very good
Perceived Threat to Physician Autonomy	PTPA	5 items	0.797	PTPA1	0.894	Very good
Attitude	ATT	4 items	0.941			Very good
Behavioural Intention to Use	BIU	3 items	0.909			Very good

Table 13-4 Results of item-total correlation and scale if item deleted

Construct	Cronbach's α	Item	Item-total correlation	Cronbach's α if item deleted
Perceived Usefulness (PU)	0.856	PU1	0.679	0.828
		PU2	0.678	0.836
		PU3	0.677	0.832
		PU4	0.755	0.816
		PU5	0.559	0.846
		PU6	0.647	0.839
		PU7	0.548	0.855
Perceived Ease of Use (PEOU)	0.880	PEOU1	0.717	0.862
		PEOU2	0.692	0.864
		PEOU3	0.689	0.864
		PEOU4	0.609	0.868
		PEOU5	0.625	0.870
		PEOU6	0.728	0.857
		PEOU7	0.639	0.869
		PEOU8	0.669	0.864
Computer Self-Efficacy (CSE)	0.729	CSE1	0.563	0.682
		CSE2	0.598	0.674
		CSE3	0.488	0.684
		CSE4	0.471	0.690
		CSE5	0.400	0.729
		CSE6	0.477	0.694
Social Influence (SI)	0.840	SI1	0.589	0.820
		SI2	0.573	0.826
		SI3	0.745	0.788
		SI4	0.717	0.794
		SI5	0.651	0.806
		SI6	0.464	0.843
Compatibility (COM)	0.924	COM1	0.830	0.900
		COM2	0.878	0.884

Construct	Cronbach's α	Item	Item-total correlation	Cronbach's α if item deleted
		COM3	0.815	0.905
		COM4	0.779	0.918
Physician Participation (PP)	0.904	PP1	0.719	0.892
		PP2	0.792	0.877
		PP3	0.840	0.866
		PP4	0.797	0.877
		PP5	0.667	0.903
Perceived Threat to Physician Autonomy (PTPA)	0.797	PTPA1	0.020	0.894
		PTPA2	0.732	0.704
		PTPA3	0.693	0.720
		PTPA4	0.746	0.701
		PTPA5	0.761	0.700
Attitude toward EHR (ATT)	0.941	ATT1	0.839	0.930
		ATT2	0.873	0.919
		ATT3	0.860	0.923
		ATT4	0.868	0.920
Behavioural Intention to Use EHR (BIU)	0.909	BIU1	0.814	0.876
		BIU2	0.797	0.907
		BIU3	0.874	0.831

13.6 Structural Equation Modelling

To analyse the collected data using Structural Equation Modelling (SEM), the two-step procedure suggested by Anderson and Gerbing (1988) was followed. First, the measurement model was examined, in which the relationships between each construct and its measurement items were evaluated. Second, the structural model was examined, in which the relationships between the constructs were examined. The following subsections explain both phases in detail.

13.6.1 Measurement Level Analysis

As mentioned earlier, the measurement model describes the relationships among the latent variables (unobserved variables) and their measurement variables (observed variables). It is important to ensure the quality of the measurement instrument in order to ensure the validity of the findings.

As mentioned earlier, this study uses 9 latent variables, which were measured using 47 measurement variables as shown in Table 13-5. The underlying structure among the measurement variables and the latent variables has been informed by both the results of the first stage of this research (Chapter 9) and the literature, which was then confirmed by the experts interviewed and the pilot study performed during the instrument development and validation process explained in Chapter 12. Therefore, a Confirmatory Factor Analysis (CFA) approach was performed in the current phase to assess the degree to which the data meets the expected structure. The CFA assesses the goodness of the measurement variables and how well they represent the latent variables. This is performed by verifying the composite reliability, construct validity, and model fit. The following subsections describe these criteria in detail.

Table 13-5 Latent and observed variables in the measurement model

Latent variable	Items Code	Observed variables	Number of items
Perceived Usefulness	PU	PU1, PU2, PU3, PU4, PU5, PU6, PU7	7 items
Perceived Ease of Use	PEOU	PEOU1, PEOU2, PEOU3, PEOU4, PEOU5, PEOU6, PEOU7, PEOU8	8 items
Computer Self Efficacy	CSE	CSE1, CSE2, CSE3, CSE4, CSE5, CSE6	6 items
Social Influence	SI	SI1, SI2, SI3, SI4, SI5, SI6	6 items
Physician Participation	PP	PP1, PP2, PP3, PP4, PP5	5 items
Compatibility	COM	COM1, COM2, COM3, COM4	4 items
Perceived Threat to Physician Autonomy	PTPA	PTPA2, PTPA3, PTPA4, PTPA5	4 items
Attitude	ATT	ATT1, ATT2, ATT3, ATT4	4 items
Behavioural Intention to Use	BIU	BIU1, BIU2, BIU3	3 items
Total items			**47**

13.6.1.1 Composite Reliability

Composite reliability or construct reliability refers to the degree to which the measurement variables measure the latent variable consistently and precisely. It is another measure of internal consistency reliability and is different than Cronbach's alpha measure in that it takes into account the factor loadings of individual items when calculating the reliability score of the construct. High reliability of a construct indicates that its measurement variables are highly interrelated, which means that they are measuring the same thing (Hair *et al.*, 2014). Although reliability has been assessed in this study using internal consistency reliability coefficient Cronbach's alpha (Cronbach, 1951), construct reliability need to be assessed in CFA analysis as it provides more reliable results (Raykov, 1997). Researchers suggest that ignoring construct reliability tests in SEM analysis would produce misleading findings (Bentler, 2007). The following equation has been suggested by Hair et al. (2014) for calculating construct reliability:

$$\text{Composite Reliability (CR)} = \frac{(\sum_{i=1}^{n} l_i)^2}{\left(\sum_{i=1}^{n} l_i\right)^2 + \sum_{i=1}^{n} e_i} \qquad \text{Eq. 1}$$

Where l_i is the standardised factor loading for item i, n is the number of items in the scale, and e_i is the error variance of the item i in the scale.

Construct reliability scores between 0.6 and 0.7 are considered acceptable and good if they are above 0.7 (Hair et al., 2014, Nunnally and Bernstein, 1994). Table 13-6 presents the construct reliability scores for all the constructs. The results show that the composite reliability scores for all constructs were good as they exceed the threshold of 0.7. Therefore, all constructs are considered reliable and the analysis can proceed to the following steps as described in the next sections.

Table 13-6 Composite Reliability results

Construct	**Observed variables**	**Standardised factor loadings**	**Composite Reliability (CR)**
Perceived Usefulness (PU)	PU1	0.765	0.878
	PU2	0.753	
	PU3	0.760	
	PU4	0.819	
	PU5	0.644	
	PU6	0.669	
	PU7	0.560	
Perceived Ease of Use (PEOU)	PEOU1	0.811	0.895
	PEOU2	0.834	
	PEOU3	0.841	
	PEOU4	0.726	
	PEOU5	0.590	
	PEOU6	0.615	
	PEOU7	0.563	
	PEOU8	0.727	
Computer Self-Efficacy (CSE)	CSE1	0.868	0.776
	CSE2	0.870	
	CSE3	0.586	

Construct	Observed variables	Standardised factor loadings	Composite Reliability (CR)
	CSE4	0.583	
	CSE5	0.303	
	CSE6	0.329	
Social Influence (SI)	SI1	0.630	0.851
	SI2	0.613	
	SI3	0.818	
	SI4	0.820	
	SI5	0.740	
	SI6	0.544	
Compatibility (COM)	COM1	0.911	0.926
	COM2	0.939	
	COM3	0.837	
	COM4	0.790	
Physician Participation (PP)	PP1	0.762	0.908
	PP2	0.844	
	PP3	0.895	
	PP4	0.857	
	PP5	0.702	
Perceived Threat to Physician Autonomy (PTPA)	PTPA2	0.777	0.896
	PTPA3	0.762	
	PTPA4	0.879	
	PTPA5	0.881	
Attitude toward EHR (ATT)	ATT1	0.868	0.941
	ATT2	0.910	
	ATT3	0.887	
	ATT4	0.912	
Behavioural Intention to Use EHR (BIU)	BIU1	0.894	0.918
	BIU2	0.836	
	BIU3	0.933	

13.6.1.2 Construct Validity

Assessing the construct validity is an essential step in CFA that increases the precision of the research. Construct validity refers to the degree to which a set of measured items actually reflects the latent theoretical construct that those items are designed to measure (Hair *et al.*, 2014). It is recommended to assess construct validity using a variety of measures in order to avoid random error and method variance (Bagozzi, Yi and Phillips, 1991). Straub et al. (2004) suggests that construct validity should be evaluated using convergent and discriminant validity. A detailed explanation of each of these types and their results are provided in the following subsections.

13.6.1.2.1 Convergent Validity

Convergent validity is the degree to which measured variables of the same construct are correlated. A high correlation between measured variables of the same construct means that they are measuring their intended construct quite well (Straub, Boudreau and Gefen, 2004; Hair *et al.*, 2014). An important indicator of convergent validity is Average Variance Extracted (AVE), which was calculated in this research using the following formula as suggested by Hair et al. (2014):

$$\text{Average Variance Extracted (AVE)} = \frac{\sum_{i=1}^{n} {l_i}^2}{n} \qquad \text{Eq. 2}$$

Where l_i represents the standardised factor loading and n is the number of items
Standardised factor loading is an estimate of the strength of the path between a measured variable and the construct. The literature suggests that standardised estimates for factor loadings should be used rather than unstandardized estimates. This is because standardised estimates are constrained to range between -1 and +1 whereas unstandardized estimates have no upper or lower bound (Hair *et al.*, 2014).

In brief, the AVE represents the average of squared standardised factor loadings for all items loading on a construct. Standardised factor loading is an indicator of the strength of the path between the item and its construct. According to Bagozzi and Yi (1988) and Hair et al. (2014), standardised factor loadings should be 0.5 or higher, and ideally 0.7 or higher. A rule of thumb according to Hair et al. (2014), when calculating AVE for a construct, is to delete items that have loadings below 0.5 to improve AVE when needed.

In this study, standardised factor loadings for all measured items as well as the AVE for the corresponding latent variables are presented in Table 13-7. The AVE values of most of the constructs exceed the suggested threshold of 0.50 (Bagozzi and Yi, 1988; Hair *et al.*, 2014). However, the AVE values of Computer Self-Efficacy (CSE) and Social Influence (SI) were below 0.5, therefore, items with the lowest standardised factor loadings were deleted to improve AVE as shown in the Table 13-7. After these items have been deleted, the improved AVE values for all constructs are above 0.5, thus achieving good convergent validity of the constructs (Bagozzi and Yi, 1988; Hair *et al.*, 2014).

Table 13-7 Convergent validity results

Construct	Observed variables	Standardised factor loadings	AVE	Deleted items	Improved AVE
Perceived Usefulness (PU)	PU1	0.765	0.511		
	PU2	0.753			
	PU3	0.760			
	PU4	0.819			
	PU5	0.644			
	PU6	0.669			
	PU7	0.560			
Perceived Ease of Use (PEOU)	PEOU1	0.808	0.520		
	PEOU2	0.830			
	PEOU3	0.844			
	PEOU4	0.729			
	PEOU5	0.588			
	PEOU6	0.617			
	PEOU7	0.563			
	PEOU8	0.729			
Computer Self-Efficacy (CSE)	CSE1	0.867	0.399	CSE5, CSE6	0.553
	CSE2	0.870			
	CSE3	0.588			
	CSE4	0.584			
	CSE5*	0.301			
	CSE6*	0.328			
Social Influence (SI)	SI1	0.635	0.493	SI6	0.540
	SI2	0.626			
	SI3	0.807			
	SI4	0.813			
	SI5	0.741			
	SI6	0.552			
Compatibility (COM)	COM1	0.911	0.759		
	COM2	0.939			
	COM3	0.837			
	COM4	0.790			
Physician Participation (PP)	PP1	0.761	0.664		
	PP2	0.843			
	PP3	0.896			
	PP4	0.857			

Construct	Observed variables	Standardised factor loadings	AVE	Deleted items	Improved AVE
	PP5	0.703			
Perceived Threat to Physician Autonomy (PTPA)	PTPA2	0.777	0.683		
	PTPA3	0.762			
	PTPA4	0.879			
	PTPA5	0.881			
Attitude toward EHR (ATT)	ATT1	0.868	0.800		
	ATT2	0.910			
	ATT3	0.887			
	ATT4	0.913			
Behavioural Intention to Use EHR (BIU)	BIU1	0.894	0.790		
	BIU2	0.836			
	BIU3	0.933			

* Items with a standardised factor loading < 0.5.

13.6.1.2.2 Discriminant Validity

Discriminant validity refers to the extent to which a construct and its indicators differ from another construct and its indicators (Bagozzi, Yi and Phillips, 1991). A commonly used test for assessing discriminant validity is Fornell and Larcker's (1981) criterion. According to Fornell and Larcker (1981), the square root of the AVE of a construct should be greater than the correlation estimate between this construct and any other construct.

Table 13-8 shows the initial assessment of discriminant validity based on the Fornell-Lacker's criterion, with the square root of AVE values shown on the diagonal and the correlation estimates below them. It can be seen that two discriminant validity problems existed: (1) between Perceived Usefulness (PU) and Attitude toward using EHR (ATT), and (2) between Attitude toward using EHR (ATT) and Behavioural Intention to Use EHR (BIU). A discriminant validity problem could indicate the presence of cross loadings in the items measuring those constructs (Mulaik, 2009; Hair *et al.*, 2014). To identify items with cross loadings, an Exploratory Factor Analysis (EFA) was performed with items measuring PU and ATT (the results are shown in Table 13-9), and with items measuring ATT and BIU (the results are shown in Table 13-10). Specifically, maximum likelihood analysis method was used with promax rotation because the factors examined are expected to be correlated (Hair et al., 2014; Kline, 2015; O'Rourke & Hatcher, 2013).

The results shown in Table 13-9 show that there are no cross loadings between PU and ATT. Therefore, as performed with convergent validity, items with the lowest loading on PU can be deleted to improve the AVE of the construct, and thus improving the discriminant validity. In this case, PU7 was deleted. For the second discriminant validity problem, the results shown in Table 13-10 show that BIU1 has a secondary loading value of (0.30) on ATT. According to (Kline (2015), when an item has a secondary loading of 0.30 or more on a factor other than the factor on which it has the primary loading (i.e. >0.50), this often results in high proportions of shared variance between the two factors. A further inspection revealed that the issue of secondary loading can only be resolved by the removal of ATT4. This is because the largest correlations among items measuring BIU and ATT were associated with ATT4. Therefore, ATT4 was removed which resulted in the extraction of two distinct factors without secondary loadings, as shown in Table 13-11.

The assessment of discriminant validity of the revised model shown in Table 13-12 shows that all diagonal values (AVEs of the constructs) exceeded the inter-construct correlations, and thus the results indicate satisfactory discriminant validity based on Fornell-Lacker's criterion (Fornell and Larcker, 1981).

Table 13-8 Assessment of discriminant validity of the initial model based on Fornell-Lacker's criterion

	PU	**PEOU**	**CSE**	**SI**	**PP**	**COM**	**PTPA**	**ATT**	**BIU**
PU	0.715								
PEOU	0.532	0.721							
CSE	0.625	0.634	0.744						
SI	0.478	0.571	0.477	0.735					
PP	0.523	0.388	0.506	0.386	0.815				
COM	0.668	0.516	0.599	0.571	0.649	0.871			
PTPA	-0.419	-0.400	-0.282	-0.248	-0.274	-0.360	0.826		
ATT	**0.736**[a]	0.634	0.647	0.547	0.511	0.674	-0.449	0.894	
BIU	0.698	0.610	0.598	0.571	0.482	0.650	-0.423	**0.891**[b]	0.888

Diagonal values: square root of construct AVE; Off-diagonal values: inter-construct correlation
[a] The square root of AVE of PU is less than the correlation between PU and ATT
[b] The square root of AVE of BIU is less than the correlation between BIU and ATT

Table 13-9 Pattern matrix resulting from Exploratory Factor Analysis (EFA) with items measuring PU and ATT showing that the items represent two distinct constructs

	1	2
PU1	.688	
PU2	.812	
PU3	.876	
PU4	.745	
PU5	.538	
PU6	.517	
PU7	.437	
ATT1		.790
ATT2		.922
ATT3		.886
ATT4		.893

Table 13-10 Pattern matrix resulting from Exploratory Factor Analysis (EFA) with items measuring ATT and BIU to diagnose the discriminant validity issue between the two constructs

	1	2
ATT1	.820	
ATT2	.840	
ATT3	.828	
ATT4	.781	
BIU1	.303	.622
BIU2		.812
BIU3		.897

Table 13-11 Pattern matrix resulting from Exploratory Factor Analysis (EFA) with items measuring ATT and BIU after deleting ATT4 showing that the items represent two distinct constructs

	1	2
ATT1	.868	
ATT2	.744	
ATT3	.835	
BIU1		.664
BIU2		.809
BIU3		.910

Table 13-12 Assessment of discriminant validity of the revised model using Fornell-Lacker's criterion, showing that the model has satisfactory discriminant validity

	PU	PEOU	CSE	SI	PP	COM	PTPA	ATT	BIU
PU	0.739								
PEOU	0.522	0.721							
CSE	0.624	0.634	0.744						
SI	0.467	0.571	0.476	0.735					
PP	0.521	0.388	0.506	0.386	0.815				
COM	0.657	0.516	0.598	0.571	0.649	0.871			
PTPA	-0.424	-0.400	-0.282	-0.249	-0.274	-0.360	0.827		
ATT	0.734	0.618	0.653	0.555	0.510	0.691	-0.459	0.891	
BIU	0.683	0.610	0.598	0.571	0.481	0.649	-0.423	0.878	0.889

Diagonal values: square root of construct AVE; Off-diagonal values: inter-construct correlation

A further assessment of discriminant validity of the revised measurement model was performed using the heterotrait-monotrait ratio (HTMT) (Henseler, Ringle and Sarstedt, 2015). HTMT ratio is the average of item correlations across constructs relative to the average correlations of items measuring the same construct (Henseler, Ringle and Sarstedt, 2015). The HTMT ratio has been reported to have superior sensitivity in detecting the lack of discriminant validity compared to the standard methods of the Fornell-Lacker's criterion and the cross-loadings assessment (Henseler, Ringle and Sarstedt, 2015; Hair *et al.*, 2017). An HTMT ratio between two constructs Y_1 and Y_2 can be calculated using the following formula (Hair *et al.*, 2017):

$$\text{HTMT}\,(Y_1, Y_2) = \frac{Average\ of\ item\ correlations\ across\ Y_1\ and\ Y_2}{\sqrt{\text{Average correlations of items measuring } Y_1 \times \text{Average correlations of items measuring } Y_2}} \quad \text{Eq. 3}$$

According to Henseler et al. (2015), HTMT ratio values smaller than 0.90 are an indication of sufficient discriminant validity. As shown in Table 13-13, all values of HTMT ratio are less than 0.90, which further confirms that the model has sufficient discriminant validity.

Table 13-13 Discriminant validity results of the revised model using the heterotrait-monotrait ratio (HTMT), showing that the model has a satisfactory discriminant validity

	PU	PEOU	CSE	SI	PP	COM	PTPA	ATT	BIU
PU	1								
PEOU	0.542	1							
CSE	0.632	0.571	1						
SI	0.487	0.575	0.478	1					
PP	0.540	0.384	0.555	0.407	1				
COM	0.685	0.491	0.648	0.606	0.683	1			
PTPA	-0.425	-0.427	-0.256	-0.235	-0.277	-0.337	1		
ATT	0.748	0.613	0.637	0.559	0.518	0.694	0.449	1	
BIU	0.699	0.595	0.578	0.600	0.510	0.659	0.407	0.878	1

Off-diagonal cells: HTMT index between each pair of constructs

13.6.1.3 Measurement Model Goodness of Fit (GoF)

Goodness of Fit (GoF) is a measure used to examine how well the proposed model fits the collected data (Kline, 2015). GoF indices are estimated through the comparison of the collected data (sample covariance matrix) with the proposed model (estimated covariance matrix) (Hair *et al.*, 2014). It is suggested that multiple fit indices should be used to provide a sufficient evidence of model fit (Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014; Kline, 2015). Fit indices are classified into three categories: absolute fit, incremental fit and parsimony fit. While absolute and incremental fit indices are common in the literature, the use of parsimony fit indices is still controversial (Hair et al. 2014). This is because they are strongly biased against complex models, and therefore they are less frequently used in the literature (Hair et al., 2014; Hooper et al., 2008). Moreover, because there are no threshold levels for parsimony fit indices recommended in the literature, their values are difficult to interpret (Hooper, Coughlan and Mullen, 2008). Therefore, this research will focus on absolute and incremental fit indices to assess model fit.

Following the recommendations of the literature (Hu and Bentler, 1998; Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014; Kline, 2015), six common fit indices, including both absolute and incremental fit measures are reported in this research. These include the following absolute fit indices: Chi-square (χ^2), Normed Chi-square (χ^2/df), Root Mean Square Error of Approximation (RMSEA), Standardised Root Mean Square Residual (SRMR). Incremental fit indices reported include: Tucker Lewis Index (TLI) and Comparative Fit Index (CFI).

Absolute fit indices are direct measures of assessment on how well the proposed model fits the collected data. The most fundamental fit index in this category is Chi-square (χ^2), which is a function of the sample size and the difference between the proposed model and the collected data. However, Chi-square is sensitive to the sample size and the complexity of the model. That is, as the sample size becomes large or the number of observed variables becomes large, the resulting p-value of the Chi-square test tends to indicate a significant difference between the collected data and the proposed model (Bagozzi and Yi, 1988; Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014). Therefore, reporting other fit indices is recommended to address the limitations of Chi-square test (Hu and Bentler, 1998; Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014; Kline, 2015).

Normed Chi-square is an absolute fit measure, which is simply calculated by dividing χ^2 by the degrees of freedom (*df*) (Kline, 2015). Degrees of freedom refer to the amount of mathematical information available to estimate model parameters. In SEM models, the value of degrees of freedom is calculated by subtracting the number of estimated (free) parameters from the total number of variance and covariance parameters. Each estimated parameter reduces the value of degrees of freedom by 1. Therefore it is desirable to maximize degrees of freedom while still obtaining a good model-fit (Hair *et al.*, 2014). Typically, a normed chi-square value of 3 or less indicates a good fitting model (Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014).

Root Mean Square Error of Approximation (RMSEA) is one of the most widely used fit indices that attempt to correct the bias of χ^2 against larger sample sizes or complex models. It does this by including the sample size and the complexity of the model in its computation. A value of RMSEA less than 0.08 indicates a good fit, and the model has a better fit as the value becomes close to zero (Browne and Cudeck, 1993; Hooper, Coughlan and Mullen, 2008).

Root Mean Square Residual (RMR) and Standardised Root Mean Square Residual (SRMR) are the square root of the difference between the residuals of the sample covariance matrix and the estimated covariance matrix (Hooper et al., 2008). The RMR values are calculated based upon the scales of the observed variables, therefore, when the instrument uses multiple scales (e.g. some observed variables have a scale from 1-7 while others from 1-3) the value of RMR becomes difficult to interpret. This problem was resolved by SRMR, which is computed with standardized variables (Hair *et al.*, 2014; Kline, 2015). As with RMSEA, lower values of RMR and SRMR indicate a better fit and higher values indicate a bad fit, which puts RMSEA, RMR and SRMR in a type of fit indices known as badness-of-fit indices, in which high values represent a poor fit. It is suggested that a value of RMR of 0.05 or less indicates a good fit (Gefen, Straub and Boudreau, 2000). In addition, a value of SRMR less than or equal to 0.08 represents a good fit (Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014).

Incremental fit indices, also known as comparative or relative fit indices (Hooper, Coughlan and Mullen, 2008), are different from absolute fit indices in which they assess how well the estimated model fits with an a alternative baseline model. The most common baseline model is known to as a null model, which assumes all observed variables are uncorrelated. The null model contains no multi-item factors or relationships between them. The most commonly used fit indices in this category are Tucker Lewis Index (TLI) and Comparative Fit Index (CFI) (Hair *et al.*, 2014).

Tucker Lewis Index (TLI) is an incremental fit index that compares the normed chi-square of the estimated model with the normed chi-square of the null model, which means that it takes into account model complexity. According to Hair et al. (2014) and Bagozzi and Yi (1988), a value of 0.9 for TLI indicates a good fit, while higher values represent a better fit

Comparative Fit Index (CFI) is the most widely used incremental fit index, which is the ratio of the difference between the value of (χ^2-*df*) of the estimated and the null model divided by the value of (χ^2-*df*) of the null model. It is an improvement of the original fit index known as Normed Fit Index (NFI), which uses the same formula of CFI without including *df,* meaning that it does not take the complexity of the model into account. This drawback was resolved with TLI and CFI. However, CFI is more favourable than TLI because its values are normed, which means that they range from 0 to 1. Typically, a CFI value of 0.90 or above indicates a well-fitted model (Bagozzi and Yi, 1988; Hair *et al.*, 2014).

Table 13-14 presents the values of fit indices of the measurement model together with recommended values of common model fit indexes. As shown in the table, all the indices exceeded their respective common acceptance levels, suggesting that the measurement model provided a reasonably good fit to the data.

Table 13-14 Goodness of Fit indices for the measurement model

Fit index category	**Fit indices**	**Recommended value**	**Results**	**References**
Absolute Fit Indices	Chi-square (χ^2)	N/A	1333.113	
	df	N/A	775	
	P-value	N/A	<0.001	
	Normed Chi-square (χ^2/df)	≤3	1.720	(Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014)
	RMSEA	≤0.08	0.055	(Browne and Cudeck, 1993; Hooper, Coughlan and Mullen, 2008)
	SRMR	≤0.09	0.061	(Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014)
Incremental Fit Indices	CFI	≥0.90	0.927	(Bagozzi and Yi, 1988; Hair *et al.*, 2014)
	TLI	≥0.90	0.918	(Bagozzi and Yi, 1988; Hair *et al.*, 2014)

13.6.2 Structural Level Analysis

As explained previously, the second step of SEM analysis is structural model analysis. After the quality of the measurement model has been established (through construct validity, reliability and model fit), the structural model will be evaluated. The structural model involves path analysis in which the hypothesized paths between the constructs are examined. That is, the analysis in this phase focuses on the relationships among the constructs themselves instead of the relationships between the constructs and their measured variables. As discussed in Chapter 11, there are 19 hypothesized relationships in the proposed model of this study. Table 13-15 summarises these relationships. The analysis of the structural model starts by evaluating the goodness-of-fit of the model. Following this, the 19 hypothesised relationships between the constructs will be assessed. These steps are described in detail in the following subsections.

Table 13-15 Hypothesised relationships to be assessed in the structural model

Construct	**Hypotheses**	**Hypothesised path**
Attitude toward using EHR (ATT)	H1	ATT → BIU*
Perceived Usefulness (PU)	H2a	PU → ATT
	H2b	PU → BIU*
Perceived Ease of Use (PEOU)	H3	PEOU → ATT
Computer Self-Efficacy (SCE)	H4a	CSE → PU
	H4b	CSE → PEOU
Social Influence (SI)	H5a	SI → BIU*
	H5b	SI → PU
	H5c	SI → PEOU
	H5d	SI → CSE
Physician Participation (PP)	H6a	PP → COM
	H6b	PP → ATT
Perceived Threat to Physician Autonomy (PTPA)	H7a	PTPA → PU
	H7b	PTPA → PEOU
Compatibility (COM)	H8a	COM → PU
	H8b	COM → ATT
	H8c	COM → PEOU
	H8d	COM → CSE
	H8e	COM → PTPA

* BIU: Behavioural Intention to use EHR "*EHR acceptance*"

13.6.2.1 Structural Model Goodness of Fit (GoF)

As discussed previously, Goodness of Fit (GoF) is a crucial step in SEM analysis in order to assess how well the proposed model fits the collected data (Kline, 2015). It is an essential indicator of model validity that should be reported at both the measurement and the structural level analysis (Hair *et al.*, 2014). A detailed discussion of GoF measures commonly used to evaluate the validity of SEM models has been provided earlier in this chapter (Section 13.6.1.3).
Table 13-16 presents the goodness of fit statistics for the structural model. As shown in the table, the results indicate that the structural model is well-fitted with the collected data.

Table 13-16 Goodness of Fit indices for the structural model

Fit index category	Fit indices	Recommended value	Results	References
Absolute Fit Indices	Chi-square (χ^2)	N/A	1389.092	
	df	N/A	791	
	P-value	N/A	<0.001	
	Normed Chi-square (χ^2/df)	≤3	1.756	(Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014)
	RMSEA	≤0.08	0.056	(Browne and Cudeck, 1993; Hooper, Coughlan and Mullen, 2008)
	SRMR	≤0.09	0.080	(Hooper, Coughlan and Mullen, 2008; Hair *et al.*, 2014)
Incremental Fit Indices	CFI	≥0.90	0.921	(Bagozzi and Yi, 1988; Hair *et al.*, 2014)
	TLI	≥0.90	0.914	(Bagozzi and Yi, 1988; Hair *et al.*, 2014)

13.6.2.2 Construct Relations Assessment (Hypothesis Testing)

After confirming the validity of the structural model in the previous section, the next step is to examine the hypothesized relationships between the constructs (Hair *et al.*, 2014). The 19 hypotheses presented in Table 13-15 will be assessed in this section. These hypotheses will be evaluated by examining the following parameters: standardized path coefficient β (regression coefficients), Critical Ratio (C.R.) and p-value (Hair *et al.*, 2014; Kline, 2015).

The standardized path coefficient (β) indicates the strength of the effect of the independent variable on the dependent variable. Generally, a value of standardized path coefficient less than 0.10 indicates a small effect, while values around 0.30 indicate a "typical" or medium effect and values greater than 0.50 indicate a large effect (Suhr, 2008; Kline, 2015). Standardized path coefficients are used instead of unstandardized path coefficients because they allow for the direct comparison between coefficients as to their relative explanatory power of the dependent variable.

This allows for the identification of the "best" independent variable based on the standardized path coefficients, because the higher the standardized path coefficient, the stronger the effect (Hair *et al.*, 2014).

Critical Ratio (C.R.) is also referred to as t-value, which is obtained by dividing the unstandardized regression coefficient by standard error (S.E.) (Kline, 2015). According to Hair et al. (2014), if the C.R. value is greater than 1.96 (or lower than -1.96), the regression coefficient is considered statistically significantly different from zero at the 0.05 level. The p-value is commonly referred to as the level of statistical significance, and indicates the probability of being wrong about whether the regression coefficient is significantly different from zero. A p-value of 0.05 is the most widely used level of significance (Hair et al. 2014).

In addition to the above estimates, the squared multiple correlations (R^2), or the explanatory power, of the dependent variables in the model were analysed. R^2 values range between 0 and 1, and refer to the proportion of variance in the dependent variable that is explained by the predictors of the variable in question (Gefen, Straub and Boudreau, 2000). According to (Kline, 2015), values of R^2 about 0.10 indicate a "typical" or medium effect, while values greater than 0.30 indicate a large effect.

The results of hypotheses testing are shown in Table 13-17. In addition, Table 13-18 shows the squared multiple correlations (R^2) of the dependent variables in the model. The full results of model analysis are shown in Figure 13-1.

The results indicate that physicians' intention to use an EHR system (BIU) was jointly predicted by their attitudes toward using the system (ATT) ($\beta = 0.79$, $p<0.001$) and social influence (SI) ($\beta = 0.13$, $p<0.01$) and these two factors together directly explained 77% of the variance in physicians intentions to use an EHR system ($R^2_{BIU} = 0.77$). Attitude toward using an EHR system appeared to have contributed more to the explanatory power of intention than social influence. Jointly, PU, PEOU and COM explained 66% of the variance in ATT ($R^2_{ATT} = 0.66$). PU had the strongest direct effect among these factors on ATT (H2a, $\beta = 0.40$, $p<0.001$). However, the hypothesized direct link between PU and BIU (H2b) was not statistically significant ($p= 0.425$), which means that PU affected BIU indirectly through ATT. PEOU had the second strongest direct effect on ATT (H3, $\beta = 0.29$, $p<0.001$). The direct effect of COM on ATT was strongly supported (H8b, $\beta = 0.28$, $p<0.01$).

In addition to its direct effect on ATT, COM was the strongest predictor of two important factors, PU (H8a, $\beta = 0.41$, $p<0.001$) and CSE (H8d, $\beta = 0.56$, $p<0.001$). This result is interesting because the later was the strongest predictor of PEOU (H4b, $\beta = 0.47$, $p<0.001$), which was another direct determinant of ATT as described previously. Moreover, COM had a direct negative effect on PTPA

(H8e, β = -0.37, p<0.001). However, the hypothesized direct effect of COM on PEOU was not supported (H8c, p=943). This means that the effect of COM on PEOU was completely mediated by CSE.

The results also revealed that COM was strongly and significantly affected by PP (H6a, β = 0.69, p<0.001). However, the direct effect of PP on ATT was not supported (H6b, p = 0.920), suggesting that PP affects ATT indirectly through its effect on COM.

As noted previously, CSE had a strong direct effect on PEOU (H4b). In addition, CSE had a medium direct effect on PU (H4a, β = 0.29, p<0.001). All the hypothesized links related to SI, except (H5b), were statistically significant. These include a direct effect on BIU (H5a, as indicated previously), PEOU (H5c, β = 0.31, p<0.001) and CSE (H5d, β = 0.20, p<0.01). However, the hypothesized relationship between SI and PU (H5b) was not statistically significant (p= 0.217). This means that SI did not have a direct effect on PU. The results of the hypotheses related to PTPA (H7a, H7b) indicated that PTPA had a direct negative effect on PU (H7a, β = -0.20, p<0.001) and PEOU (H7b, β = -0.18, p<0.01).

Jointly, COM, CSE and PTPA explained 56% of the variance in physicians' perceptions about the usefulness of an EHR system (R^2_{PU} =0.56) while, CSE, SI and PTPA explained 51% of the variance in physicians' perceptions about the ease of use of an EHR system (R^2_{PEOU} =0.51). COM and SI explained 41% of the variance in physicians' perceptions about computer self-efficacy (R^2_{CSE} =0.41), and physician participation alone explained 48% of the variance in compatibility perceptions (R^2_{COM} =0.48). The explanatory power of BIU, ATT, PU, PEOU and COM were all around or above 0.50, which indicates a large explanatory power (Kline, 2015). That is, the predictor factors explain a large amount of variance in each of these factors.

Table 13-17 Summary of hypotheses testing results

Hypotheses	Hypothesised path	β	CR	p-value	Supported
H1	ATT → BIU	0.79	10.348	<0.001	Yes
H2a	PU → ATT	0.40	5.285	<0.001	Yes
H2b	PU → BIU	0.05	0.798	0.425	Not supported
H3	PEOU → ATT	0.29	5.068	<0.001	Yes
H4a	CSE → PU	0.28	3.470	<0.001	Yes
H4b	CSE → PEOU	0.47	5.096	<0.001	Yes
H5a	SI → BIU	0.13	2.792	0.005	Yes
H5b	SI → PU	0.07	1.234	0.217	Not supported
H5c	SI → PEOU	0.31	4.672	<0.001	Yes

Hypotheses	Hypothesised path	β	CR	p-value	Supported
H5d	SI → CSE	0.20	2.877	0.004	Yes
H6a	PP → COM	0.69	10.737	<0.001	Yes
H6b	PP → ATT	0.01	0.100	0.920	Not supported
H7a	PTPA → PU	-0.20	-3.400	<0.001	Yes
H7b	PTPA → PEOU	-0.18	-3.080	0.002	Yes
H8a	COM → PU	0.41	5.186	<0.001	Yes
H8b	COM → ATT	0.28	3.247	0.001	Yes
H8c	COM → PEOU	0.01	0.071	0.943	Not supported
H8d	COM → CSE	0.56	6.371	<0.001	Yes
H8e	COM → PTPA	-0.37	-5.309	<0.001	Yes

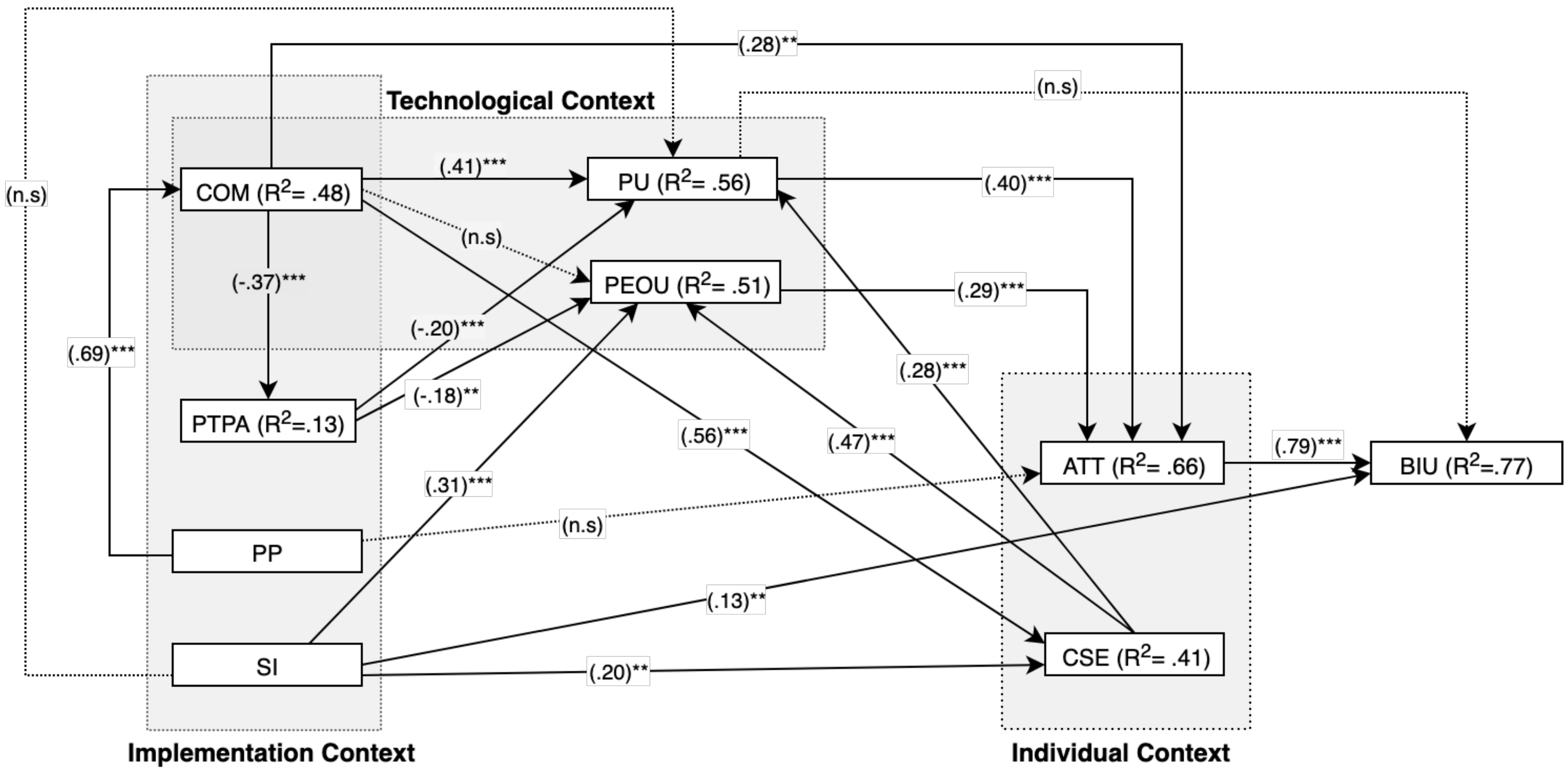
Table 13-18 the explanatory power of dependent factors

Construct	R^2
Behavioural intention to use (BIU)	0.77
Attitude toward EHR use (ATT)	0.66
Perceived Usefulness (PU)	0.56
Perceived Ease of Use (PEOU)	0.51
Compatibility (COM)	0.48
Computer Self-Efficacy (CSE)	0.41
Perceived Threat to Professional Autonomy (PTPA)	0.13

The indirect and total effects of the investigated factors on BIU are illustrated in Table 13-19. Bollen (1989) and Chau and Hu (2001) strongly recommend reporting not only the direct effects but also the indirect and total effects of the predictor constructs when interpreting results in SEM models. The indirect effect of one factor on another via relevant intervening factors is the product of the direct effects that comprise them. Total effect of one factor on another is obtained by summing up its direct and indirect effects via the intervening factors (Kline, 2015). As shown in Table 13-19, ATT followed by COM appeared to have the strongest total effects on BIU. In addition, SI, PEOU and CSE had smaller total effects on BIU than those of PU and PP. SI appeared to have a larger total effect on BIU than that of PEOU or CSE. PTPA had the smallest total effect on BIU. In general, Table 13-19 gives useful information on the priority of the investigated factors based on their total effects on BIU.

Table 13-19 The direct, indirect and total effect of the investigated factors on EHR acceptance

Predictors	Effect on Behavioural intention (BIU)		
	Direct effect	Indirect effect	Total effect
Attitude toward EHR use (ATT)	0.79	--	0.79
Perceived Usefulness (PU)	0.05	0.32	0.37
Perceived Ease of Use (PEOU)	--	0.22	0.22
Compatibility (COM)	--	0.53	0.53
Computer Self-Efficacy (CSE)	--	0.21	0.21
Perceived Threat to Professional Autonomy (PTPA)	--	- 0.11	- 0.11
Social influence (SI)	0.13	0.14	0.27
Physician Participation (PP)	--	0.37	0.37



COM = Compatibility
PTPA = Perceived threat to professional autonomy
PP = Physician participation
SI = Social influence
PU = Perceived usefulness
PEOU = Perceived ease of use
ATT = Attitude toward EHR
CSE = Computer self-efficacy
BIU = Behavioural intention to use EHR "Acceptance"

*** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$, n.s = not significant

Figure 13-1 Model testing results

13.6.2.3 Assessing the Moderating Effect of EHR Experience

The aim of this section is to answer the fourth main research question stated in Chapter 1 (RQ4). This research question was answered by assessing the moderating effect of EHR experience in the model presented in Figure 13-1. Moderation effect occurs when the strength of the relationship between an independent variable and a dependent variable changes based on the value of a third variable (moderator, in this research prior EHR experience). In other words, a moderator variable can cause an amplifying or weakening effect between an independent variable and a dependent variable (Kline 2015). In this research, 39% (N=94) of participants have prior experience in EHR systems. Understanding if the model relationships vary between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR can provide significant insights.

To examine whether the model relationships vary across groups, Kline (2015) and Hair et al. (2014) reported that perhaps the simplest way is to split the data into groups based on the value of the moderating variable (e.g. physicians who have prior experience in EHR and physicians who do not have prior experience in EHR) and then estimate the model within each group. However, this method has a major limitation in that it is not possible to understand how statistically significant is the difference between the groups. Obtaining different numerical values in path coefficients is almost always the result when the model is examined within different groups (Hair *et al.*, 2014).

Therefore it is recommended to assess the moderation effect through multi-group analysis, in which the path coefficients within groups are estimated simultaneously and then Chi-square difference test is used to evaluate differences between the groups (Hair *et al.*, 2014; Kline, 2015; Farooq and Vij, 2017). Technically, a multi-group model, referred to as an unconstrained model, is estimated with path coefficients calculated separately for each group. Then a second multi-group model, referred to as a constrained model, is estimated where the path estimate of interest is constrained to be equal between the groups. A significant difference in Chi-square between the unconstrained and the constrained model indicates that the strength of the path coefficient in fact differs between the groups and that moderation does exist (Okazaki and Mendez, 2013; Hair *et al.*, 2014; Kline, 2015; Farooq and Vij, 2017).

In this research, the moderating effect of prior EHR experience was performed using multi-group analysis in Amos v25. Two groups were created, participants who have prior EHR experience (N=94) and those who do not have prior experience in EHR (N=149). For each group, the standardised path coefficient, C.R., and the p-value for each relationship in the model were estimated. Then, the p-value of the Chi-square difference ($\Delta X^2/\Delta df$) was evaluated for each relationship in the model to find out whether the path coefficients are significantly different between the groups. The results are shown in Table 13-20.

Overall, the results shown in Table 13-20 indicated no statistically significant difference between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR in all model relationships except in one relationship, which is H8a (COM→PU). The results of H8a indicated that the effect of COM on PU was stronger for physicians who have prior experience in EHR systems. This result suggests that physicians who have been exposed to and tried EHR systems have stronger beliefs about the importance of compatibility of the system with their work routines and requirements. Hence, it can be concluded that EHR experience has a statistically significant moderating effect on H8a, and no statistically significant moderating effect on all other model relationships.

Some differences, although not statistically significant, were noticed in the model relationships, which will be discussed below:

- The effect of PEOU on ATT (H3) appeared to be stronger for physicians who do not have prior experience in EHR. This means that physicians who do not have prior experience in EHR put a strong emphasis on the usability of the system more than physicians who have prior experience in EHR. However, given that Chi-square difference test revealed no statistically significant difference between the two groups in this hypothesis, it cannot be concluded that this relationship is different between the groups.

- The effect of CSE on PU and PEOU (H4a and H4b, respectively) appeared to be stronger for physicians who do not have prior experience in EHR. This might indicate that physicians who have no prior experience in EHR tend to take perceptions of CSE into account when evaluating the usefulness and ease of use of an EHR system more than physicians who have prior experience in EHR. However, given that Chi-square difference test revealed no statistically significant difference between the two groups in the effect of CSE on PU or PEOU, it cannot be concluded that there is a difference between the groups in these relationships.

- The result of H5a may suggest that SI had a small direct effect on BIU for physicians who do not have prior experience in EHR, and no direct effect for physicians who have prior experience in EHR. However, the result of Chi-square difference test indicated that this difference is in fact not statistically significant. Hence, it cannot be concluded that this relationship is moderated by EHR experience.

- The results of H5c and H5d may indicate that the effect of SI on PEOU was completely a direct effect for physicians who have prior experience in EHR, and a completely indirect effect, through CSE, for physicians who do not have prior experience in EHR. However, because there is no statistically significant difference between the two groups according to the Chi-square difference test in the mentioned hypotheses, it cannot be concluded that there is a difference between the groups in these relationships.

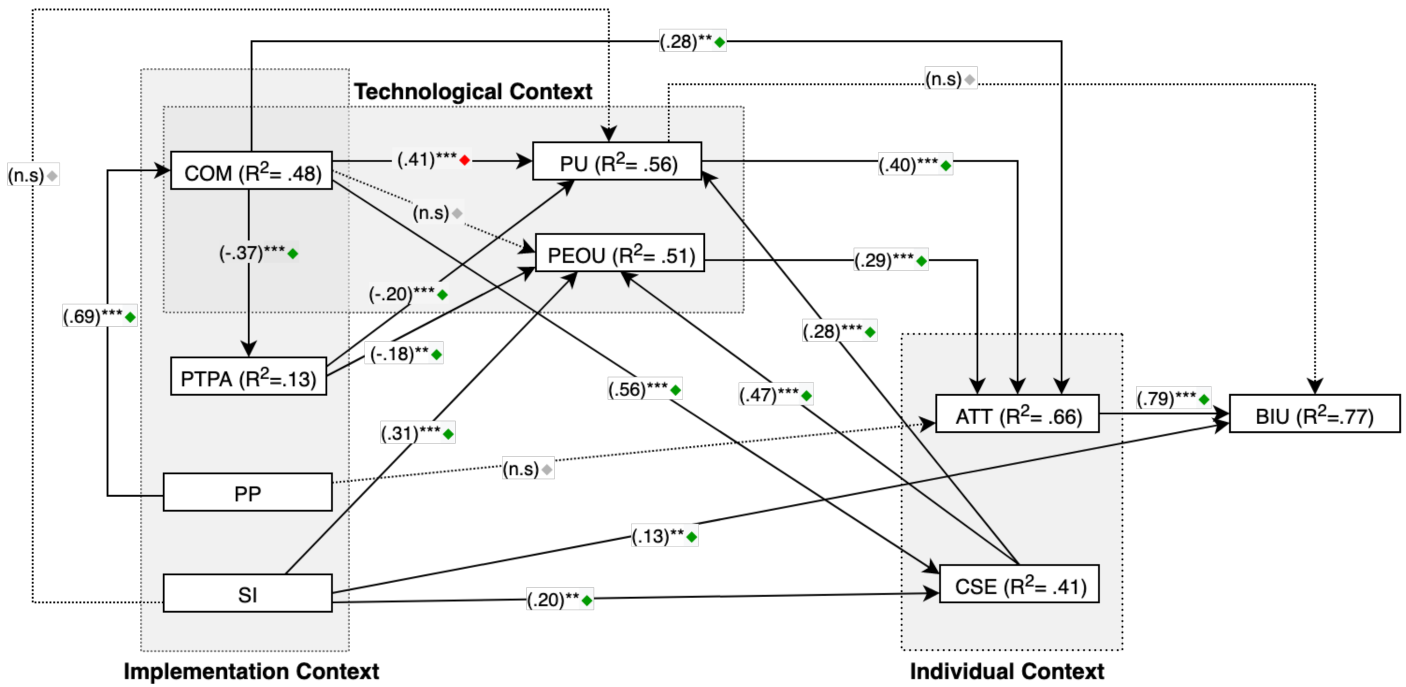
- The result of H8b may indicate that COM had a direct effect on ATT for physicians who have prior experience in EHR, while its effect on ATT was indirect for physicians who do not have prior experience in EHR. However, the Chi-square difference test revealed no statistically significant difference between the two groups in this in this relationship.
- The result of H8d may indicate that the effect of COM on CSE was stronger for physicians who do not have experience in EHR. This is probably because physicians who have experience in EHR already have high perceptions of CSE, and hence the effect of external variables, such as COM, on their perceptions of CSE may not be as strong as that for physicians who do not have prior experience in EHR. However, the Chi-square difference test revealed no statistically significant difference between the two groups in this hypothesis.

In general, the results presented in Table 13-20 show that only one relationship in the model was affected by prior experience in EHR systems, H8a, while all the other relationships were not significantly different between the groups. The model testing results including the moderating effect of EHR experience are shown in Figure 13-2.

Table 13-20 EHR experience moderation assessment results

Hypotheses	Hypothesised path	Prior EHR experience (N=94)			No prior EHR experience (N=149)			$\Delta X^2/\Delta df$
		β	CR	p-value	β	CR	p-value	p-value
H1	ATT → BIU	0.92	8.676	<0.001	0.73	7.204	<0.001	0.080
H2a	PU → ATT	0.47	4.163	<0.001	0.39	3.580	<0.001	0.685
H2b	PU → BIU	-0.002	-0.020	0.984	0.07	0.708	0.479	0.583
H3	PEOU → ATT	0.18	2.371	0.018	0.36	4.454	<0.001	0.080
H4a	CSE → PU	0.22	2.164	0.030	0.40	3.257	0.001	0.655
H4b	CSE → PEOU	0.25	2.189	0.029	0.60	4.376	<0.001	0.124
H5a	SI → BIU	0.07	1.140	0.254	0.15	2.467	0.014	0.156
H5b	SI → PU	0.12	1.307	0.191	-0.01	-0.086	0.932	0.415
H5c	SI → PEOU	0.53	4.496	<0.001	0.11	1.391	0.164	0.094
H5d	SI → CSE	0.18	1.538	0.124	0.21	2.458	0.014	0.322
H6a	PP → COM	0.58	5.241	<0.001	0.74	9.480	<0.001	0.078

Hypotheses	Hypothesised path	Prior EHR experience (N=94)			No prior EHR experience (N=149)			$\Delta X^2/\Delta df$
		β	CR	p-value	β	CR	p-value	p-value
H6b	PP → ATT	0.11	1.236	0.217	-0.06	-0.578	0.563	0.216
H7a	PTPA → PU	-0.19	-2.102	0.036	-0.18	-2.495	0.013	0.775
H7b	PTPA → PEOU	-0.16	-1.684	0.092	-0.20	-2.751	0.006	0.647
H8a	COM → PU	0.53	4.856	<0.001	0.37	3.314	<0.001	0.042
H8b	COM → ATT	0.26	2.153	0.031	0.22	1.763	0.078	0.765
H8c	COM → PEOU	-0.01	-0.054	0.957	0.03	0.316	0.752	0.820
H8d	COM → CSE	0.36	2.747	0.006	0.63	5.579	<0.001	0.165
H8e	COM → PTPA	-0.32	-3.004	0.003	-0.39	-4.421	<0.001	0.731



COM = Compatibility
PTPA = Perceived threat to professional autonomy
PP = Physician participation
SI = Social influence
PU = Perceived usefulness
PEOU = Perceived ease of use
ATT = Attitude toward EHR
CSE = Computer self-efficacy
BIU = Behavioural intention to use EHR "Acceptance"

*** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$, n.s = not significant

◆ effect is stronger for physicians who have prior experience in EHR

◆ no statistically significant difference in this effect between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR

◆ effect is not significant neither at the aggregate level nor at the group level

Figure 13-2 Model testing results including the moderating effect of EHR experience

13.7 Summary and Conclusion

This chapter detailed the results of Structural Equation Modelling (SEM) analysis conducted to test the proposed model. To assess the proposed model, responses were collected from primary healthcare physicians working in public primary healthcare centres in the KSA. After removing partially completed responses, irrelevant and unengaged responses, a total of 243 valid responses were retained for analysis. Before SEM was conducted, preliminary data analysis was performed, including missing data analysis, normality assessment and internal consistency reliability assessment of the measurement items. The analysis in this chapter was conducted using SPSS v25 and Amos v25.

The first part of the instrument was the demographics information section. The purpose of which was to determine the characteristics of physicians participating in this research. The results of the descriptive and frequency analysis of the demographics information show that over 65% of respondents have over 5 years in medical practice after the internship. Also, around 39% of respondents have prior experience in EHR, and around 55% of them have over 1 year of experience in EHR. However, only 9% of the respondents have an EHR system currently implemented in the medical practices where they work, while 10% reported that the EHR system was tried as a pilot system but discontinued. These statistics are clearly reflective of the adoption rates of EHR systems in public primary healthcare centres in the KSA.

The assessment of internal consistency reliability in the preliminary data analysis was conducted using Cronbach's alpha. The results indicated that Cronbach's alpha values for all constructs exceeded the 0.7, and most were above 0.80, thus indicating very good internal consistency of the items' rating scores. Structural Equation Modelling (SEM) was conducted in two main phases: (1) measurement model analysis, and (2) structural model analysis. In measurement model analysis, Confirmatory Factor Analysis (CFA) was performed in order to assess the hypothesized structure between the observed variables (i.e. measurement items) and latent variables (i.e. EHR adoption factors). Numerous steps were undertaken in CFA, including: assessment of composite reliability, construct validity and model fit. The results of composite reliability assessment showed that all constructs had reliability scores above 0.7, and most scores were above 0.80, indicating very good composite reliability. Validity of the constructs was confirmed in terms of both convergent and discriminant validity. The results of the fit statistics, which sought to establish whether the measurement model was fit to the data were as follows: (χ^2/df)=1.72, RMSEA=0.055, SRMR=0.061, CFI=0.927, TLI=0.918. These fit indices in fact show that the model fits the data well.

In terms of structural model analysis, the outcome, as presented in this chapter, showed that most hypothesized relationships between the EHR adoption factors were supported. The hypothesised model was effective and was able to explain 77% of the variance in physicians' intentions to use an EHR system. The results of the fit statistics of the structural model were: (χ^2/df)=1.756, RMSEA=0.056, SRMR=0.08, CFI=0.921, TLI=0.914, indicating that the model fits the data well.

The final step performed in this chapter was assessing the moderating effect of EHR experience on all relationships in the model. This was performed by first, estimating the model within two groups: physicians who have prior experience in EHR, and physicians who do not have prior experience in EHR. Then, multi-group analysis was performed to determine whether the strengths of the paths were different between the groups. The findings showed that only one relationship was moderated by EHR experience, which was COM→PU, specifically, the effect of COM on PU was stronger for physicians who have prior experience in EHR. This result means that physicians who have been exposed to and tried EHR systems have stronger beliefs about the importance of compatibility of the system with their work routines and requirements.

The main goal of conducting SEM analysis in this chapter was to provide predictive factors that could help healthcare organisations increasing the success rates of EHR implementation in primary healthcare practices. Following on from this, the next chapter will discuss practical and theoretical implications of the results of this research.

Chapter 14 Discussion of the Results

This Chapter provides a detailed discussion of the findings of the second stage of this research. The aim of the second stage of this research was to understand the relationships between the factors that were identified as key determinants of the adoption of EHR by primary healthcare physicians in the first stage of this research, namely: perceived usefulness, perceived ease of use, computer self-efficacy, social influence, physician participation, compatibility, perceived threat to physician autonomy and attitude toward using EHR. The research model for the second stage of this research was presented in Chapter 11.

The proposed model was empirically examined using responses from 243 physicians in public primary healthcare practices in the Kingdom of Saudi Arabia. Results obtained from the structural equation modelling analysis suggested that the research model exhibited a satisfactory overall fit to the collected data and was able to explain a large proportion of variance in primary healthcare physicians' decisions to adopt EHR systems (that is, 77 percent). Most of the hypothesised links specified by the model were supported, and all of which were strongly supported at either 0.001 or 0.01 significance levels. Various levels of strengths of the supported links were obtained, which points out the priority of the associated factor as to be discussed in the current chapter.

A detailed discussion of the findings related to each factor in relation to the empirical literature and theory as well as implications of the findings is provided in the following sections. Further, the discussion and implications of findings relating to the moderating effect of EHR experience are provided in the last section of this chapter.

14.1 The Significance of Attitude toward Using an EHR system (ATT)

Attitude toward using an EHR system was found to be the strongest determinant of physicians' intentions to use an EHR system. It fully mediated the effect of perceived usefulness on behavioural intention, which is contrary to the theoretical assumption of TAM (Davis, 1986) and the findings of a previous study (Steininger and Stiglbauer, 2015), but is inline with the findings of many previous studies in the IS and IT adoption literature (e.g. (Plewa *et al.*, 2012; ElKheshin and Saleeb, 2016; Harnadi, 2019; Rahman *et al.*, 2019). This highlights the crucial role of attitude in EHR acceptance by individual physicians, suggesting that the decision-making processes by physicians (i.e intention to use) depends mainly on their evaluative affect (i.e. positive and negative feelings) toward using the system.

The significance of attitude suggests that it is crucial for healthcare organizations to be attentive to individual attitudes, and to proactively cultivate and solidify positive individual attitudes toward EHR acceptance. Experiences by experts interviewed in the first stage of this research include the implementation of extensive awareness campaigns prior to system implementation. Experts strongly recommended using multiple methods to implement these campaigns in order to target different preferences of users (e.g. SMS, social media, orientation sessions, Conferences, etc). These campaigns should make it clear that the goal is not digitisation for digitisation's sake, but to improve healthcare quality and efficiency (Wachter, 2016). It is one of the lessons learned from the failure of the UK's National Programme for IT (NPfIT) that policy makers underestimated the power of the clinical community. Physicians and other healthcare professionals were not engaged properly to ensure they understood the reasons that NPfIT was being developed or implemented. Many clinicians viewed the programme as an IT project built around political priorities rather than as a means to improve the delivery healthcare services (Wachter, 2016). Another key consideration, which was emphasised by the experts interviewed in the first stage of this research (Chapter 7), is that it is critical to manage users' expectations, as very high expectations may lead to failure. As noted by Cresswell et al. (2013), expectations of users in many cases far exceed what can be achieved with technology in the short term. Therefore, managing expectations is essential as otherwise there is a danger that users may develop negative attitudes toward the technology and patterns of resistance may emerge. According to Wachter (2016), it could take 10 years or more before the benefits of healthcare IT are fully realised by organisations and individual users. Therefore, balancing the enthusiasm for digitisation with appropriate expectations amongst different user groups is important (Wachter, 2016). Furthermore, in order to keep users motivated, it is important to continuously celebrate success and share experiences (Cresswell, Bates and Sheikh, 2017). This also helps promoting learning across the organisation. This could be established by collecting data associated with success (e.g. better healthcare outcomes for chronic disease patients?) and establishing means through which to share lessons learned (e.g. by establishing collaborations with research centres and communications teams) (Cresswell, Bates and Sheikh, 2017).

14.2 The Significance of Perceived Usefulness (PU)

Perceived usefulness was found to be the most important factor in formulating physicians' attitudes toward using an EHR system. This finding is consistent with the findings of several studies of EHR and clinical IT adoption that suggest that perceived usefulness is more important than perceived ease of use in deciding whether or not to use a technology (Chau and Hu, 2001; Pare *et al.*, 2006; Morton and Wiedenbeck, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda *et al.*, 2015; Kim *et al.*, 2016), but is not congruent with other studies that suggest that perceived ease of use is more important in determining EHR and clinical IT acceptance (Gagnon *et al.*, 2014, 2016). Pare et al. (2006) stated that physicians tend to focus on the utility of technology when developing general attitudes toward using the technology.

The interviewed participants in this study reported that, for physicians to realize the benefits of the system, the implementation of the system should not only focus on automating work processes, rather it should address current work problems and demonstrate desirable utilities in the work practice, otherwise physicians are less likely to accept the change. Chau and Hu (2001) noted that physicians tend to view technologies as tools, acceptable only when demonstrating a desired or a proven utility in their practice. According to the interviewed experts and physicians in this study, the most desirable advantages of an EHR system that define what makes an EHR system useful by a primary healthcare physician include: improved job performance, quick and easy access to information, improved quality of care for patients, improved communication with healthcare providers (including the auxiliary departments in the same primary healthcare practice, regional labs, supervisory primary healthcare centres and general hospitals), enhanced patient safety and empowering patients. The standardised factor loadings in the measurement model (Table 13-7) confirmed that all of these dimensions are significant indicators of physicians' perceptions about system utility.

These findings have several important implications for healthcare organisations in the KSA. Foremost, healthcare organisations need to be aware that, in order for EHR systems to be perceived as useful by physicians, they should meet the identified dimensions of perceived usefulness as explained by participants in the first stage of this research (Chapters 7 and 8). In this regard, an essential starting point is ensuring compatibility and involving physicians heavily in the selection and implementation of the system, as evidenced by the developed model which showed a strong direct effect on Perceived Usefulness (PU) by Compatibility (COM), which in turn is strongly determined by Physician Participation (PP) (see Sections 14.4 and 14.5 on the discussion of the importance of COM and PP, respectively). In addition, healthcare organisations should put a strong emphasis on communicating the usefulness of EHR systems to the target physicians. Orientation and training sessions should focus mainly on *how the system can improve* the effectiveness and efficiency of physicians' job performance and improve the quality of care for patients rather than focusing on the sequence of steps to perform when using the system (Pare *et al.*, 2006).

14.3 The Significance of Perceived Ease of Use (PEOU)

Perceived ease of use was found to have the second strongest direct influence on the formation of physicians' attitudes toward using an EHR system. This is in line with the results of many previous studies, which found that perceived ease of use has a significant effect on physicians' adoption of EHR and clinical IT (Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Kim *et al.*, 2016), but is not consistent with other studies that suggest that perceived ease of use is not important in the context of healthcare professionals adoption of technology (P. J. Hu *et al.*, 1999; Chau and Hu, 2001; Chismar and Wiley-Patton, 2002). According to Venkatesh et al. (2011), perceived ease of use may be more important in the context of EHR systems than in other types of information technologies. EHRs are complex and multifaceted systems, and introducing these systems requires multiple changes into physicians' work routines and processes. Therefore, the more the physicians perceive a system to be easy to use, the more they are likely have more positive attitudes toward using the system.

According to the interviewed experts and physicians in this study, physicians' perceptions of ease of use of EHR are determined by following elements: the time required for data entry, the ease of using the system during patients' consultations, ease of system navigation, the initial workload increase, and the time required to learn and master the system. The standardised factor loadings in the measurement model (Table 13-7) confirmed that all of these dimensions are significant indicators of physicians' beliefs about ease of using the system. These findings have significant implications for EHR developers and healthcare organisations in the KSA. For EHR developers and/or healthcare organisations evaluating and selecting an EHR system, it is extremely important that EHR user-interface should be easy to learn. Specifically, the time required for a novice user to learn (or an experienced user to relearn) how to conduct tasks with the system is very important in the context of physician users. Physicians are busy professionals and may not be able to spend a considerable time for learning how to use the system, which may negatively affect their overall perception that using an EHR is easy. Second, the time required for data entry is possibly the most important element in perceived ease of use according to the qualitative investigation carried out in this research. Physicians may view the standardized documentation in EHR systems as a "clerical" work preventing them from focusing on the most important aspects of their work (Campbell et al., 2006). As recommended by experts and physicians interviewed in this study, data entry should be made in the form of closed-ended questions as much as possible rather than text. Ease of system navigation is another important issue affecting perceptions of system usability. It is extremely recommended that all system components, such as clinical documentation, computerized physician order entry and electronic prescribing, are accessible during one login, and that links to these components are easily accessible from one screen. Overall, the length of time required to complete tasks, the number of keystrokes and the number of screens visited to complete tasks is crucial in defining physicians' perceptions of system usability, which is inline with the recommendations in the literature of healthcare IT implementation (Wachter, 2016). In addition, adverse effects on physician-patient communication (i.e. non eye-to eye contact) resulting from the use of an EHR system during patient consultation should be mitigated with training sessions and increasing physicians' familiarity with the EHR. Moreover, for healthcare organizations, it was commonly reported by experts interviewed in this study that an EHR system is likely to increase physicians' workload at the beginning of implementation. Experts strongly recommend reducing the number appointments for individual physicians at the beginning of implementation by almost 30%-40% to help in the adoption. Because there is currently no appointment system in primary health system in the KSA, it is extremely crucial to implement an appointment system before introducing an EHR system. This will allow for a proper control of the workload of physicians and for reducing the negative effect of workload increase in early stages of system implementation. It is also strongly recommended avoiding running both electronic and paper systems parallelly, whenever possible, as this tends to increase end-users' workload and may introduce new threats to patients safety (Cresswell, Bates and Sheikh, 2013). Usability can also be affected by system infrastructure. Inappropriate infrastructure such as slow network connection can impact the speed of the system, which is an important determinant on the adoption of healthcare IT (Cresswell, Bates and Sheikh, 2013). Further, healthcare organisations need to be aware that poor system usability may not only slow down users' performance or decrease their satisfaction with the system, but can also increase the opportunities for errors and cause harms to patients (e.g. see (Magrabi, Ong and Coiera, 2016; Marcilly, Peute and Beuscart-Zéphir, 2016)). Therefore, EHR usability reviews from academic or other research partners should be supported to inform the organisations' decisions regarding healthcare IT (Wachter, 2016).

14.4 The Significance of Compatibility (COM)

The findings indicated that compatibility has a direct positive effect on attitudes toward using an EHR system, which is inline with the theoretical foundation of the decomposed theory of planned behaviour (Taylor and Todd, 1995). The findings also revealed that compatibility has a strong direct effect on perceived usefulness. This is consistent with the results of many previous studies (Chau & Hu 2001; Chau & Hu 2002; Wu et al. 2007). The findings also showed that compatibility has a strong direct effect on computer self-efficacy, which is in line with the findings of a previous study (Wu et al. 2007). The finding that compatibility has no direct effect on perceived ease of use is not congruent with the findings of the study by Wu et al. (2007), but is inline with the findings of other studies (Chau & Hu 2001; Chau & Hu 2002). In the current research, the effect of compatibility on perceived ease of use was indirect, i.e. through computer self-efficacy. This research also adds to the literature by examining the effect of compatibility on perceived threat to physician autonomy, which was found to be a significant negative effect. The analysis of indirect and total effects revealed that compatibility has the second largest total effect on physicians' intentions to use an EHR system, with comes directly after attitude toward using EHR in the strength of total effect among the investigated factors. This result is consistent with the findings of many previous studies (Horan *et al.*, 2004; Bhattacherjee and Hikmet, 2007; Wu, Wang and Lin, 2007), which found that compatibility has the largest total effect on physicians' intentions to use healthcare IT. The analysis of EHR experience moderating effect revealed that the effect of compatibility on perceived usefulness was stronger for physicians who have prior experience in EHR, suggesting that physicians who have tried an EHR system have stronger beliefs about the importance of EHR with their work routines and requirements. Subsequently, compatibility is a critical determinant of EHR success and must be taken into account while promoting and implementing an EHR system.

Compatibility of an EHR system is a concept that has received little attention in the EHR adoption context. The significance of compatibility is illustrated by a recent national survey in Finland (Kaipio *et al.*, 2017), which reported that two out of three physicians find that current EHR systems lack functionalities needed to perform key clinical tasks and that these systems require physicians to perform additional unnecessary tasks or adopt new inappropriate work processes. A recent systematic review identified workflow challenges as one of the most important barriers to EHR success (Kruse *et al.*, 2016). A major concern shared by participants in in the first stage of this research is that EHR systems implemented or piloted in primary healthcare practices in the KSA are mostly systems designed for hospital settings, that is, an extension of a hospital system, thus lacking the business value for primary healthcare. Moreover, a frequent reason reported by the physicians interviewed in the first stage of this research for the unsuccessful implementation of the pilot EHR systems was that those systems were not compatible with the work process or priorities of primary healthcare. As reported by (Karahanna, Agarwal and Angst, 2006) an innovation cannot be viewed as advantageous if it does not meet the needs of potential users. Further, experts interviewed in the first stage of this research reported that organisations sometimes use the technology as a way to changing existing work routines and that this is an extreme risk, which increases users' frustration and may lead to failure. The required changes in current work processes may diminish the potential value of a newly introduced clinical IT (Chau and Hu, 2002).

The findings of this study indicate that when an EHR system is more consistent with physicians' existing values, prior experiences and practice needs, they will not only feel more confident in using the system, but also have higher perception of EHR usefulness and have more positive attitudes toward EHR usage. Physicians will also have less negative perceptions about the effect of EHR on their professional autonomy. Consequently, compatibility will significantly increase the likelihood of EHR implementation success. These findings have several important implications. First, the healthcare organisations must evaluate the fit of the EHR system with the current work processes in primary healthcare practices before committing resources to EHR acquisition and implementation. In situations where large changes in current work processes and practices need to be implemented, areas of improvement should be identified and strategies should be developed to implement a gradual and smoothing transition toward the necessary changes (Chau and Hu, 2002). It is one of the key considerations for the successful implementing EHR systems to perform a thorough mapping of existing work processes before implementation. This is in order to identify problems in the current work processes (e.g. inefficiencies) and areas for improvement (Ahmad *et al.*, 2002; Martin, Mariani and Rouncefield, 2004; Lorenzi *et al.*, 2009; Ludwick and Doucette, 2009; Cresswell, Bates and Sheikh, 2013). Attempting to simply digitise ineffective and inefficient work processes will lead the digital transformation failing to meet its full potential (Wachter, 2016). Digitisation offers an opportunity to rethink the work and workflow in order to maximise efficiencies, enhance healthcare quality and safety and improve care coordination (Wachter, 2016). Moreover, analysing existing work processes before implementation helps defining the problem(s) to be addressed, and based on that a long-term strategic vision can be developed (Cresswell, Bates and Sheikh, 2013). Another key implication is that EHR developers should pay more attention to user requirements analysis and should thoroughly analyse their needs and requirements for an EHR system. This information can then be used to inform the design of an EHR system to be introduced to primary healthcare practices. It is essential that EHR systems are designed with the input of end-users. Without user-centred design, such systems have been shown to introduce opportunities for errors and creating risks for patient harm (Magrabi, Ong and Coiera, 2016; Wachter, 2016). Poorly designed and implemented systems also result in increased frustration by healthcare professionals, increased workload, and workarounds (Magrabi, Ong and Coiera, 2016; Wachter, 2016). One of the key reasons for EHR systems success in UK's GP practices is that those systems were built by GPs, for GPs, and solved important business problems (Benson, 2002b; Wachter, 2016). Additionally, as explained by experts in this study, allowing individual physicians to further customize the system to their own use can significantly increase their perceptions of compatibility of the system with their work routines. Only when physicians have higher perceptions of system compatibility with their existing values, prior experiences, practice needs and individual work routines there is a higher possibility to achieve successful EHR acceptance.

14.5 The Significance of Physician Participation (PP)

Physician participation was found to be a significant determinant of compatibility but not of attitude toward EHR usage. Judged by its 0.69 path coefficient at a 0.001 significance level, the link from physician participation to compatibility is the second most significant among all the causal links investigated. The insignificant direct effect of physician participation on physicians' attitudes toward EHR usage is contrary to the findings of a prior study (Morton and Wiedenbeck, 2009), but is inline with the results of other studies (Pare *et al.*, 2006; Abdekhoda *et al.*, 2015), which suggest an indirect effect of physician participation on attitudes toward health IT usage. The results reported herein indicate that through their participation, physicians feel they have a greater influence on the decision-making and development process, and thus developing more feelings of compatibility with their existing values, prior experiences and practice needs. The strong effect of physician participation factor on compatibility factor suggests that compatibility of a system is not possible without physician participation.

In fact, it often happens that a small group of users are only invited for consultation in a few meetings, without real involvement of users or any real openness of the implementers (Cucciniello *et al.*, 2015). It is essential to heavily involve physicians in the development and implementation process from the very beginning of implementation. This includes requirements analysis, selection of the system, workflow re-design, usability testing and continuous feedback evaluation (Chapters 7 and 8). Experts interviewed in the first stage of this research (Chapter 7) stressed the importance that the system should be perceived as a clinical project led by the clinical departments, not an IT project enforced by the IT department, otherwise resistance is likely to occur. The literature of healthcare IT implementation frequently emphasises that involving and gaining the buy-in of physicians and the other professional groups (e.g. nurses, administrative staff) is critical for system's success (Lorenzi *et al.*, 2009; Cresswell, Bates and Sheikh, 2013, 2017; Wachter, 2016). Hence, every effort should be made to gain the buy-in of physicians and other healthcare professionals from the very beginning, and to keep them engaged in optimising the system and rethinking ineffective and inefficient work processes (Wachter, 2016). As stated by Lorenzi and Riley (2000), "creating change starts with creating a vision for change and then empowering individuals to act as change agents to attain that vision". Doing so will not only increase physicians' perceptions about compatibility of the system with their existing values, prior experiences and practice needs, but will also foster their feelings of ownership of the system (Pare *et al.*, 2006). This perceived ownership decreases resistance to change and increases commitment to the new system (Ives and Olson, 1984). Furthermore, according to Cresswell et al. (2013) continuous feedback evaluation deserves a particular attention. It is crucial to assess users' feedback about the system and respond to the problems identified in a timely manner. This points out to the need for sustained engagement of end-users in order to identify, understand and respond to technical and usability concerns in a timely manner (Cresswell, Bates and Sheikh, 2017).

14.6 The Significance of Computer Self-efficacy (CSE)

Computer self-efficacy appeared to be a significant determinant of perceived ease of use with a path coefficient of 0.47 at a 0.001 significance level. In addition, CSE had a medium positive effect on perceived usefulness. Physicians with higher computer self-efficacy have little difficulty in using the system and thus more positive ease of use beliefs. In addition, physicians judge perceived outcomes (i.e. system usefulness) based on how well they can use the system. These findings are consistent with the results of previous studies in the IS adoption literature (Compeau and Higgins, 1995b), and the e-health adoption literature (Wu, Wang and Lin, 2007; Gagnon *et al.*, 2014; Rho, young Choi and Lee, 2014).

To healthcare providers, EHR services represent technologies that are both new and innovative. Therefore, self-efficacy is among the main concerns of providers (Boonstra and Broekhuis, 2010; McGinn *et al.*, 2011; Gagnon *et al.*, 2012; Li *et al.*, 2013; Najaftorkaman *et al.*, 2015). The systematic review study performed in Chapter 3 of this research has revealed that lack of computer experience was the top most frequently reported barrier to EHR adoption by healthcare professional in the KSA, with lack of user support also among the most frequently reported barriers (Alqahtani, Crowder and Wills, 2017). According to Cresswell et al. (2013), lack of training can negatively affect users' satisfaction with the system. This is because it leads to lack of knowledge and understanding of the system capabilities, and hence prevents users from realising the full potential of the system (Cresswell, Bates and Sheikh, 2013; Wachter, 2016). Lack of training and dissatisfaction could lead to workarounds, where the system is used in unintended ways, or even avoided completely (Cresswell, Bates and Sheikh, 2013). In addition, lack of knowledge and skills of users could lead to increased risks to the patients (Magrabi, Ong and Coiera, 2016). Concretely, training and IT support are crucial for successful EHR acceptance and use. They are important components and key success factors of any EHR implementation (Terry *et al.*, 2008). According to Cresswell et al. (2013), training and IT support should be typically allocated around 40% of the implementation budget. As reported by experts interviewed in the first stage of this research (Chapter 7), training programs should be tailored to the different clinical roles and specialities, and should be able to accommodate the needs of infrequent users (e.g. older users), which is inline with the key recommendations in the literature (Cresswell, Bates and Sheikh, 2013; Magrabi, Ong and Coiera, 2016). Furthermore, a crucial step in the implementation phase is to identify "super users", subject-matter experts, capable of training and providing technical support in early stages of implementation. This further emphasizes that user-involvement is critical to foster the adoption of the systems.

14.7 The Significance of Social Influence (SI)

The results showed that social influence not only has a direct positive effect on EHR acceptance, but also affects EHR acceptance indirectly through attitudinal beliefs, particularly computer self-efficacy and perceived ease of use. These findings are interesting because the direct effect on EHR acceptance, which is congruent with the results of many previous studies (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016; Kim *et al.*, 2016), means that when a physician perceives that important referents support the use of the system, he/she is more likely to accept the system. The findings also indicate that social influence has a significant positive effect on perceived ease of use, which is inline with the findings of previous studies (Yu, Li and Gagnon, 2009; Chiu and Tsai, 2014), and that this effect is partially explained by computer self-efficacy. The positive effect of social influence on computer self-efficacy is consistent with the findings of Compeau and Higgins (1995b), who stated that support and encouragement to use the system by important referents represent "verbal persuasion" on one's ability to use the system. The insignificant effect of social influence on perceived usefulness in this study is contrary to the findings of previous studies (Mun *et al.*, 2006; Yu, Li and Gagnon, 2009; Basak, Gumussoy and Calisir, 2015). In this study, this effect of social influence on perceived usefulness was indirect, i.e. through computer self-efficacy. In brief, these findings mean that encouragement by important referents is likely to increase an individual's perception of his/her ability to use the system (i.e. CSE, resulting in more positive usefulness and ease of use perceptions), his/her overall perceptions of system's usability, and most importantly his/her acceptance and adoption of the system.

Participants interviewed in this research identified four sources of social influence: (1) management support, (2) peer influence, (3) other medical staffs' (e.g. nurses) influence, and (4) perceptions of patient's attitudes. The standardised factor loadings in the measurement model (Table 13-7) confirmed that all of these dimensions are significant indicators of social influence. However, perceptions of patient's attitudes dimension (SI6), although had a significant factor loading on social influence, it had the smallest factor loading value and was removed from the measurement model to increase convergent validity of social influence, suggesting that this dimension may not be as significant as the other sources of social influence in affecting EHR adoption. These findings have several important implications. Senior management of healthcare organisations intending to adopt an EHR system should be aware that the support, involvement and commitment perceived by its affiliated healthcare professionals can significantly increase the awareness of the merits of the technology across the organisation and reduce resistance to change (Lapointe and Rivard, 2006; Kurnia, Karnali and Rahim, 2015). In addition, Venkatesh et al (2011) reported that peer influence is expected to be particularly important in the context of healthcare professionals' decisions to adopt a technology. Due to the high professionalism and specialization in the medical practice, physicians tend to hold the opinions of their peers and superiors in high regard. Accordingly, strategies using well-respected medical champions and super users for EHR implementation as essential for fostering positive social norms toward EHR adoption (Poon *et al.*, 2004; Lorenzi *et al.*, 2009; Gagnon *et al.*, 2014, 2016). It was one of the key enablers for the successful adoption of EHR systems in the UK's GP practices that leaders of the GP community created strong positive attitudes toward EHR adoption among GPs. Initiatives created by those leaders included conferences that encouraged EHR adoption, and most importantly, a united negotiating committee presenting the GPs voice to the government. The implementation initiatives led by the government in GP practices were performed in close consultation with this committee (Benson, 2002a; Wachter, 2016). Furthermore supporting the use of the system by the other medical groups in a primary healthcare practice, such as nurses, auxiliary departments' staffs and administrative staff, is important to streamline work processes in the practice. Physicians work cooperatively with the other healthcare professionals, and therefore, lack of technical skills or resistance to using the system leads to lack of support from these colleagues, which impedes physicians in further adopting the system (Boonstra and Broekhuis, 2010). On the other hand, support from these colleagues can increase physicians' acceptance of the system.

14.8 The Significance of Perceived Threat to Physician Autonomy (PTPA)

The findings of this research indicate that perceived threat to physician autonomy negatively affects physicians' perceptions of two system characteristics that have a strong influence in the formation of user attitudes, perceived usefulness and perceived ease of use. This is consistent with the findings of several prior studies (Walter and Lopez, 2008; Morton and Wiedenbeck, 2009; Esmaeilzadeh and Sambasivan, 2012; Abdekhoda et al., 2015) which suggest that physicians put more emphasis on whether or not an IT may threaten their professional autonomy. The implementation of EHR system involves substantial changes in the medical practice, including changes to job structure (Bhattacherjee, Davis and Hikmet, 2013), work routines (Campbell et al., 2006; Jensen and Aanestad, 2007), and positions or power relations (Campbell *et al.*, 2006; Jensen and Aanestad, 2007; Walter and Lopez, 2008). Traditionally, physicians have high professional autonomy, in which they have the freedom to practice their work based on their individual decisions or judgements and without assessment or oversight by others (Lapointe and Rivard, 2005; Walter and Lopez, 2008; Boonstra and Broekhuis, 2010; Alohali, O'Connor and Carton, 2018). This professional autonomy is associated with privileges linked to physicians' social status and economic outcome; hence physicians tend to be sensitive to changes that may impact their professional autonomy (Walter and Lopez, 2008; Alohali, O'Connor and Carton, 2018). Physicians may feel that EHR systems will decrease their control over how they make clinical decisions or that those decisions will be evaluated or challenged by others (Lapointe and Rivard, 2005; Boonstra and Broekhuis, 2010; Alohali, O'Connor and Carton, 2018).

These findings have several important implications. Foremost, as interviewed experts in this study reported, a strong and supportive management that have the capacity to implement the changes that come with implementation of a new EHR system is essential. The management in healthcare organizations is responsible for patient's safety and healthcare quality. It represents a key success factor in the implementation of large scale IT systems such as EHRs (Alohali, O'Connor and Carton, 2018). Management support includes motivating users to use the system and communicating openly and honestly with users (Shang, 2012; Grublješič, Coelho and Jaklič, 2015; Alohali, O'Connor and Carton, 2018). Moreover, as indicated by the findings, physician participation in system development and implementation is essential. Physician participation creates a feeling of control over the development and implementation of the system, thus increases perceptions of compatibility of the system not only with physicians' needs, requirements and expectations but also with their values of professional autonomy. By doing so, the chances of physician resistance will be minimized.

14.9 The Moderating Effect of EHR Experience

The moderating effect of EHR experience on all model relationships was examined in this research to find out whether there are differences in the model between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR. This consideration was grounded on the UTAUT theoretical model, which hypothesizes that experience will have a moderating effect on the model relationships (Venkatesh et al. 2003). However, the findings of this research indicate that EHR experience does not play a significant moderating role on most relationships in the model. This is consistent with, and adds another confirmation to, the findings of (Venkatesh, Sykes and Zhang, 2011) in the context of physician adoption of EHR. Venkatesh et al. (2011) performed a longitudinal study, in which survey responses and system logs were collected three times over a 7-month period in a hospital implementing a new EHR system. The findings of their study revealed that EHR experience has no significant moderating effect on all model relationships. It is important noting that the original UTAUT study (Venkatesh et al. 2003) was a longitudinal study over a 5-months period, and the moderating effect of system experience was significantly prevalent over this period. Venkatesh et al. (2011) concluded that "the systems studied in the original UTAUT study, and perhaps most systems in general, create less change in business processes and are significantly less disruptive to the typical routine than EHR systems have been for years now. Thus, the moderating effects of experience will not be prevalent among doctors and the effects observed in early stages of experience will continue to exist for months or even years after the implementation".

The only moderating effect that was found in this research was on the path between COM and PU, which was stronger for physicians who have prior experience in EHR. This indicates that physicians who have tried an EHR system have stronger believes about the importance of compatibility of the system with their work routines and requirements. Subsequently, and as discussed previously in the current chapter (Section 14.4), compatibility is a critical factor of EHR success and must be taken into account while promoting and implementing an EHR system. These findings add to the literature, as to the best of the author's knowledge, there has been no previous study assessing the moderating effect of EHR experience other than (Venkatesh, Sykes and Zhang, 2011), which lacks many of the factors and relationships examined in the current research.

Chapter 15 Conclusion and Future Work

While the previous chapter discusses the findings of the survey with primary healthcare physicians analysed using structural equation modelling, the present chapter delivers an overview of the research that has been conducted in in this thesis. It also provides conclusions about the work carried out in this research and how the research questions were answered. Moreover, this chapter outlines and discusses the main and useful theoretical and practical contributions of this research. Finally, this chapter recommends directions for future research.

15.1 Research Overview

Electronic Health Records (EHRs) have become a key enabler to improve quality of care, patient safety, and care efficiency. They are considered transformational and integral to healthcare reform. This research started by delivering an overview of medical records, paper-based medical records, and EHRs in order to explain the history of medical records as well as the importance, features and characteristics of EHRs as the new core information management tool in healthcare. Given the fragmented nature of healthcare delivery, the increasing concerns over healthcare quality and patient safety, and the advances in medical practice such as evidence-based medicine which are needed to be incorporated into practice, problems with paper-based medical records as a means of information management became significantly apparent.

Many governments have realized the importance of EHRs and have moved toward their implementation in their medical practices. Particularly, the implementation of EHRs in primary healthcare has been a priority by many governments during the last several decades (Schoen *et al.*, 2012). But developing countries such as the Kingdom of Saudi Arabia (KSA) have lagged behind significantly in this regard. In the KSA, only a small number of hospitals, most of which are large and specialised hospitals, have moved toward EHR systems (Altuwaijri, 2008, 2011; Bah *et al.*, 2011; Aldosari, 2014; Shaker, Farooq and Dhafar, 2015). Almost all public primary healthcare practices are completely manual (i.e. rely completely on paper-based records), and the uptake of information technology in these practices in general is rare (Altuwaijri, 2011; Almaiman *et al.*, 2014). However, current policy initiatives in the KSA are attempting major reforms in primary healthcare with EHRs as a key component (Ministry of Health, 2011). In fact, migrating to an EHR system is an uncertain and challenging process even in developed countries (Fraser *et al.*, 2005; Currie and Finnegan, 2011), with issues such as lack of end-users' adoption standing as a major barrier to comprehensive implementation and widespread adoption of these systems (Dowling, 1980; Lawler *et al.*, 1996; Weingart *et al.*, 2003; Doolin, 2004; Zhang, 2005; Lapointe and Rivard, 2006; Boonstra and Broekhuis, 2010). The problem of user resistance as a major barrier to EHRs' implementation success has also been raised by many studies conducted in the KSA (Nour El Din, 2007; Altuwaijri, 2008; Bah *et al.*, 2011; Shaker and Farooq, 2013; Alharthi *et al.*, 2014; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b). Because physicians are the main frontline user-group of EHRs, understanding factors that impact their adoption of EHRs is crucial for the successful implementation of these systems (Boonstra and Broekhuis, 2010). To support current policy initiatives in the KSA, the main aim of this research was to understand factors that impact primary healthcare physicians' adoption of EHR systems. The systematic literature review (Chapter 3) made it clear that few studies investigated the adoption of EHRs in the KSA, and none of these studies employed an IT theory perspective and there is no framework for EHR adoption factors by any of the identified studies. Most importantly, no previous study investigated the adoption of EHRs in primary healthcare practices in the KSA. Furthermore, reviewing the global literature (i.e. studies outside the KSA's context), few studies employed a theoretical model, most of which were established in developed countries and in large and tertiary healthcare organisations, and the findings of these studies are disparate (Chapter 4). Moreover, the deductive research methodology employed by these studies limits the identification of new factors that may be important for the achieving successful EHR systems' adoption.

This research addresses these research gaps using a mixed method approach performed in two main phases of research. The first phase utilised a qualitative research methodology in order to develop a framework of key factors that are important in affecting the adoption of EHR systems by primary healthcare physicians in the KSA. The second phase used a quantitative research methodology through structural equation modelling to understand the relationships between the factors identified in the first phase of the research.

There were four main research questions investigated by this research, which were outlined in Chapter 1. These research questions are discussed again below:

RQ1: What are the factors that are likely to influence primary healthcare physicians' adoption of EHR systems in the KSA?

This research question was answered using three stages of literature review (Chapter 5). First, a systematic review study (Chapter 3) was conducted in order to identify barriers to the adoption of EHR systems in the KSA and to build up the proposed framework on the existing evidence with regard to EHR adoption barriers in the KSA. Second, a review of the most widely used theories of user adoption of IT was conducted (Section 4.2) in order to identify determinants of user adoption of IT. This approach of identifying determinants of user adoption of IT was employed because the findings of prior research suggest that employing an integrated theoretical perspective provides a greater explanatory power in the healthcare context than does a single theory or an extended one (Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014). The third stage of literature review concerned a review of prior studies that employed a theoretical model to understand physician adoption of EHR (Section 4.4), which revealed other important factors in the specific context of EHR adoption by physicians. As a result of the framework development methodology, an integrated framework was proposed, which was composed of eight key factors, namely: perceived usefulness, perceived ease of use, computer self-efficacy, social influence, physician participation, perceived threat to physician autonomy, attitude toward using an EHR system, and confidentiality concerns.

RQ2: What is the appropriate framework for the adoption of EHR systems by primary healthcare physicians in the KSA?

The aim of this research question was to develop a framework of key influential factors that are important in affecting the adoption of EHR systems by primary healthcare physicians in the KSA.

Given that EHR is still an emerging phenomenon in KSA, and that existing theories and findings are still lacking in terms of offering a comprehensive set of factors that influence primary healthcare physicians' adoption of EHR, a qualitative study approach was selected in order to confirm the proposed framework and to explore other important factors, which may not have been considered in prior models. Qualitative approaches are responsive to the context, needs and experiences of stakeholders, and can provide a powerful mechanism to gain in-depth understanding of the phenomena under investigation (Chapter 6).

Moreover, a particular characteristic of the study context (i.e. the KSA) is that large and tertiary healthcare organizations are in advanced stages of EHR implementation (Altuwaijri, 2008, 2011; Aldosari, 2014), while the adoption of EHRs, and health IT in general, in primary healthcare practices is rare (Altuwaijri, 2011; Almaiman *et al.*, 2014). The views and expertise of leaders and experts of EHR implementation from those large healthcare organizations were deemed important in validating and enhancing the proposed framework. However, to improve the credibility and the validity of the framework, the views of primary healthcare physicians were also investigated. This was achieved through a concurrent data triangulation methodology (Chapter 6), which involved collecting data from two key groups of informants: (1) leaders and experts of EHR implementation in the KSA, and (2) decision makers and physicians in primary healthcare. The aim of data triangulation was to increase the validity of the findings and to gain a more complete picture. The data was collected through a semi-structured interview format. A total of twelve participants from each group were interviewed.

Data obtained from each group was analysed separately using a detailed and rigorous thematic analysis as explained in Chapter 6. The findings from the analysis of experts' and primary healthcare physicians' responses were presented in Chapter 7 and Chapter 8, respectively. A summary and discussion of the findings from the two groups was provided in Chapter 9, which presents the main outcome of the first stage of this research, which is the framework of key EHR adoption factors by primary healthcare physicians in the KSA (Figure 9-1). Attempts to minimize any bias in the qualitative analysis included: the systematic approach for data analysis as explained in Chapter 6 and the triangulation of the findings as discussed in Chapter 9. The full list of codes with examples of coded extracts within each code, and the associated and themes and sub-themes resulting from the analysis of experts' and primary healthcare physicians' interviews were provided in Appendices C and D, respectively.

The findings revealed that all the proposed factors were found to be important and influential for the adoption of EHR systems by primary healthcare physicians in the KSA, except confidentiality concerns, which appeared to be mitigated by trust. Also, an additional important factor which has not been considered in prior models of physician adoption of EHR was identified, namely: compatibility. Importantly, the findings from both groups were consistent with each other, providing evidence for the validity of the framework.

RQ3: What is the appropriate model for explaining and predicting the adoption decisions of EHR systems by primary healthcare physicians in the KSA?

The first phase of this research resulted in the identification of key factors that are important in influencing the adoption of EHR systems by primary healthcare physicians in the KSA (Chapter 9). The next investigation, which is the aim of the present research question, was to understand how the identified factors are inter-correlated in affecting EHR adoption decisions. This research question represents the second phase of this research, which utilises a quantitative research approach through structural equation modelling to build a model that explains EHR adoption decisions by primary healthcare physicians. The research methodology for the second stage of this research was explained in Chapter 10. The Following three sub-questions were established to answer this research question:

RQ3.1: What are the most salient direct or indirect effects of the key factors identified in response to RQ2 on EHR adoption decisions?

The aim of this research question was to understand the relationships between the factors of the validated framework and how they are linked to determine EHR adoption decisions. It represents the first step in developing an explanatory model of EHR adoption decisions. To answer the research question, the eight factors of the validated framework (Chapter 9) were linked to EHR adoption decision by a set of research hypotheses. The hypotheses were developed by building on the knowledge acquired through the qualitative study performed in the first stage of this research (Chapters 7-9) as well as the relevant academic literature. The development of research hypotheses as well as the proposed EHR adoption model were provided in Chapter 11.

RQ3.2: What is the appropriate instrument to measure the key factors identified in response to RQ2?

Because the EHR adoption factors are latent (unobserved) variables, it is important to measure them through observed variables that are both content valid and reliable. The aim of this research question was to develop a valid and reliable instrument to measure the EHR adoption factors. Three main steps were followed for the development of the instrument (Chapter 12). The first step involved the selection of measurement variables for the EHR adoption factors. The selection of measurement variables was informed by the findings of the qualitative study performed in the first phase of this research as well as prior research. Specifically, the selection of measurement items from the literature was guided by the findings of the qualitative study performed in the first stage of this research (Chapter 9), however new measurement items were added by the researcher based on the findings of the qualitative study. This was to enhance content validity of the measurement items, and to ensure that the scale items representatively cover the specified domain of interest. After measurement variables have been selected, the instrument was designed including two sections, the demographics information section and the instrument measuring EHR adoption factors.

Then pre-test interviews were conducted with experts to further validate the instrument for face and content validity. Following this, a pilot study was conducted with the targeted population in order to confirm the reliability of the scales. Responses were collected from a convenient sample of 32 physicians working in public primary healthcare centres in the KSA. The reliability of the scales was assessed using internal consistency reliability, which was calculated using Cronbach's alpha. The results of the reliability analysis showed that most scales exhibited good to very good internal consistency reliability scores. The reliability of scales was further improved by analysing the item-total correlation and Cronbach's alpha if item deleted for each scale. In addition, slight modifications to the final design of the instrument were made upon receiving the feedback from the participants. Finally, two experts further reviewed the final instrument after the modifications made based on the results of the pilot study. Based on these steps, the final instrument was developed consisting of 49 items to measure the EHR adoption factors as shown in Table 12-5, (Chapter 12). The complete instrument, including the welcome statement and demographic questions, is presented in Appendix E.

After the final instrument has been developed and evaluated as described in Chapter 12, it was used for the main data collection as explained in Chapter 13. The study conducted in Chapter 13 included a further validation of the measurement instrument using Confirmatory Factor Analysis (CFA), which was the first step in Structural equation Modelling (SEM). An overview of the SEM analysis conducted in this research is provided in the following research question (RQ3.3).

RQ3.3: Which relationships hypothesized in response to RQ3.1 will affect physicians' decisions to adopt EHR systems in Saudi public primary healthcare practices?

The aim of the present research question was to evaluate the hypothesized links between the EHR adoption factors, which were hypothesized in response to RQ3.1. The complete analysis of the main data collection, which answers this research question, is provided in Chapter 13. To analyse the hypothesized relationships, data was collected using a nationwide survey of physicians working in public primary healthcare practices in the KSA. The sampling procedure utilised a combination of random, snowball and convenience sampling approaches (Section 13.3). A total of 365 responses were received, among which 80 responses were removed due to rates of missing data over the acceptable threshold of 5% % (Acuna and Rodriguez, 2004). Moreover, as the target population for this research was primary healthcare physicians at public primary healthcare practices, responses received from physicians affiliated to non-public primary healthcare centres (e.g. the military healthcare sector and the private healthcare sector) were excluded, which were 39 responses (plus 2 responses with unknown affiliation). Further, one response was judged to be an unengaged response with an evidence of giving the exact same answer for every single item, thus was excluded. The final dataset used for the analysis was 243 valid responses, which exceeds the minimum sample size required for SEM analysis (Everitt, 1975; Schreiber et al., 2006; Velicer & Fava, 1998, Hair et al., 2014; Kline, 2015).

Before conducting SEM analysis, preliminary data analysis was performed, including handling missing data and internal consistency reliability assessment. For handling the missing values, as mentioned previously, cases with missing data values over 5% were excluded. For the cases having less than 5% of missing data, mean imputation was applied to substitute missing values. The reliability of scale measures was examined using the Cronbach's alpha, and the findings indicate that the scales' reliability scores ranged between 0.73 and 0.94, thus indicating a very good adequate internal consistency of the items measuring EHR adoption factors. The reliability of scales was further assessed by analysing the item-total correlation and Cronbach's alpha if item deleted for each scale, which resulted in the removal of only one item (PTPA1).

The first part of the instrument was the demographic information section, the purpose of which was to determine the characteristics of physicians participating in this research. The results of the descriptive and frequency analysis of the demographic information showed that the majority of physicians (65%) have over five years of work experience after the internship. Also, 39% of the respondents have prior experience in EHR systems, but only 9% of participants have an EHR system currently implemented at the primary healthcare practices where they work, while 10% had an EHR system piloted but discontinued, reflecting the current situation of EHR adoption in public primary healthcare practices in the KSA.

Structural equation modelling analysis was performed in two main steps: (1) measurement model analysis, and (2) structural model analysis. Measurement model analysis aims at confirming the relationships between measurement variables and their associated latent variables. This was to ensure the quality of the measurement variables before testing the hypothesized relationships between the EHR adoption factors. To achieve this, a Confirmatory Factor Analysis (CFA) was performed which included: assessment of composite reliability, construct validity and model fit. The results of composite reliability assessment showed that all constructs had reliability scores above 0.7, and most scores were above 0.80, indicating very good composite reliability. Validity of the constructs was confirmed in terms of both convergent and discriminant validity. The results of the fit statistics, which sought to establish whether the measurement model was fit to the collected data were as follows: (χ^2/df)=1.72, RMSEA=0.055, SRMR=0.061, CFI=0.927, TLI=0.918. These fit indices in fact show that the model fits the data well.

The second step in SEM analysis involved assessing the hypothesized relationships between the EHR adoption factors, which were hypothesized in response to RQ3.1. The results obtained from the analysis suggested that the research model exhibited a good overall fit to the collected data, as shown by the following fit indices: (χ^2/df)=1.756, RMSEA=0.056, SRMR=0.08, CFI=0.921, TLI=0.914. The proposed model was effective and was able to explain a large proportion of variance in primary healthcare physicians' decisions to adopt EHR systems (that is, 77 percent). Most of the hypothesised links specified by the model were strongly supported at either 0.001 or 0.01 significance levels. In summation, it can be concluded that the EHR adoption model developed by this research is valuable in explaining the adoption of EHRs by primary healthcare physicians in the KSA. In addition, it is supposed that the outcomes of this research can help decision makers, EHR developers and researchers in formulating reputable strategies that will encourage the adoption of EHR systems by primary healthcare physicians. The findings of this research can also enhance the above-mentioned parties' awareness and considerate of what derives EHR adoption decisions by primary healthcare physicians.

RQ4: Do the relationships between factors in the model vary between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR?

In this research, 39% (N=94) of participants have prior experience in EHR systems. The moderating effect of EHR experience was examined in order to evaluate whether the relationships in the model vary based on EHR experience. The moderating effect of EHR experience was assessed by: (1) estimating the model within two groups (i.e. physicians who have prior experience in EHR and physicians who do not have prior experience in EHR), and (2) performing multi-group analysis in order to determine if the differences in the model between the groups are statistically significant. The results of EHR moderating effect assessment were provided in Chapter 13 (Section 13.5.4.3). The findings indicate that EHR experience does not play a significant moderating effect on all relationships in the model, except on one relationship, which was COM→PU. Specifically, the effect of *compatibility* on *perceived usefulness* was stronger for physicians who have prior experience in EHR. This result means that physicians who have been exposed to and tried EHR systems have stronger beliefs about the importance of compatibility of the system with their work routines and requirements.

15.2 Fulfilling the Research Objectives

As mentioned in Chapter 1, the aim of this research was to support current policy initiatives in the KSA by carrying out an investigation of EHR adoption factors by primary healthcare physicians. The objectives of this research, which were outlined in Chapter 1, to address above aim were accomplished as follows:

- ❖ To identify factors that might influence primary healthcare physicians adoption of EHR systems in the KSA

This research objective was addressed in response to the first main research question (RQ1). To fulfil the aim of this research, an important first step was to review and summarise the current state of knowledge with regard to EHR adoption barriers in the KSA. This was to understand and identify the types of barriers to EHR adoption in the KSA based on prior empirical studies, and to build up on these findings when developing the proposed framework of EHR adoption factors by primary healthcare physicians. This step was performed using a systematic literature review of barriers to the adoption of EHR systems in the KSA (Chapter 3). Then, a critical review of theories of user adoption of IT and prior studies that employed a theoretical model to understand physician adoption of EHR was conducted (Chapter 4). The outcomes of these literature reviews were used to construct the initial framework of EHR adoption factors that are likely to affect primary healthcare physicians' adoption of EHR systems in the KSA, which was presented in Chapter 5.

- ❖ To develop a framework of key EHR adoption factors by primary healthcare physicians in the KSA.

This research objective was addressed in response to the second main research question (RQ2). The proposed framework developed in response to research question (RQ1) was empirically validated and enhanced using a qualitative data triangulation approach, which included in-depth interviews with two key groups of informants: experts and leaders of EHR implementation in the KSA, and primary healthcare physicians. The data obtained from each group was analysed using thematic analysis as explained in Chapter 6. The findings of data triangulation, presented in Chapter 9, show that the findings from the two groups were highly consistent with each other, providing evidence for the validity of the framework. The main and important outcome at this stage was the development of a framework of key factors that influence the acceptance and adoption levels of EHR systems by primary healthcare physicians in the KSA, which was presented in Chapter 9.

- ❖ To develop a model that explains and predicts EHR adoption decisions by primary healthcare physicians in the KSA.

Identifying key factors affecting the adoption of EHR systems by primary healthcare physicians was the first phase in this line of enquiry. It is important to understand how these factors are interrelated in affecting EHR adoption decisions by physicians. In particular, developing a model that explains how these factors are linked to EHR adoption decisions will help healthcare organisations in designing adequate implementation strategies in order to achieve successful EHR adoption. This research objective was accomplished in response to research question (RQ3). First, an explanatory model that links the EHR adoption factors to EHR adoption decision through a number of research hypotheses was proposed (Chapter 11). Following this, a measurement instrument to measure the identified EHR adoption factors was developed and validated (Chapter 12). The validated instrument was then used to collect data from a large sample of primary healthcare physicians in the KSA in order to test the proposed model (Chapter 13). The results of SEM analysis confirmed that both the measurement model (i.e. instrument used to measure the EHR adoption factors) and structural model (i.e. the proposed EHR adoption model presented in Chapter 11) were well-fitted with the collected data. The model was effective and was able to explain a large proportion of variance in physicians' intentions to use an EHR system (77%). Thus, the developed model is considered to be valuable in explaining the adoption decisions of EHR systems by primary healthcare physicians.

- To fill the gap in the existing literature and provide guidelines for healthcare organisations, EHR developers, IT managers, government and policy makers in order to increase the chances of EHR systems implementation success and to achieve the desired objectives of EHR implementation

This research has filled the gap in the existing literature throughout the various stages carried out in this research. The important and significant theoretical contributions provided by this research are outlined and discussed in the following section. The empirical evidence obtained from the full study will contribute to the literature on EHR adoption, and provide a 'Potential for success' rate for EHR systems' adoption projects. This can, in turn, aid the design of implementation strategies when intending to implement an EHR system. In addition, the Saudi healthcare organisations that have started the implementation of an EHR system could use the model to help increase the adoption rates of the system by individual users. Further, the results from this study will provide IT practitioners and EHR developers with corroborated experimental data that can inform the engagement, marketing and design of EHR projects. Moreover, as the results of this study contribute to the knowledge on the subject of EHR systems' adoption, it may be possible for this developed model to be used in other countries in the Middle East; after all, most of these countries are similar and share many characteristics, such as language, religion, and culture.

15.3 Research Contributions

The outcomes of this research will contribute to, and extend, the knowledge in the subject of EHR systems adoption. The theoretical contributions added throughout the different stages of the research conducted in this thesis are discussed in the following sub-sections.

15.3.1 First Contribution

The first contribution of this research was the systematic literature review of barriers to the adoption of EHR systems in the KSA presented in Chapter 3. Prior research suggests that most of the implemented systems in Saudi healthcare organizations are administrative systems rather than patient-care focus (Altuwaijri, 2010, 2011). Only few hospitals have moved toward the EHR (Altuwaijri, 2008, 2011; Bah *et al.*, 2011; Aldosari, 2014), and most of the implemented EHR systems are disparate with little interoperability between them (Altuwaijri, 2008, 2010). In primary healthcare practices, the uptake of IT in general is rare (Altuwaijri, 2011; Almaiman *et al.*, 2014).

While previous studies have been conducted to understand barriers to the widespread adoption of EHRs in the KSA, there has been no systematic review of these studies.

The purpose of the systematic review was to summarize existing evidence with regard to EHR adoption barriers in the KSA, and to incorporate this evidence into the present research. Systematic reviews differ from ordinary reviews in being formally planned and methodically executed (Khan, Niazi and Ahmad, 2011). They are considered to be essential tools for summarizing evidence published in primary research, and may provide a greater level of validity in the findings than might be possible in any one of the included primary studies (Kitchenham and Charters, 2007; Khan, Niazi and Ahmad, 2011).

This systematic review adds original contributions to the literature. First, it summarized the existing state of knowledge with regard to EHR adoption barriers in the KSA. Second, it adds to the limited knowledge on EHR adoption in developing countries. Many systematic reviews have highlighted this knowledge gap, in which little is known about barriers to EHR adoption in developing countries (Boonstra and Broekhuis, 2010; McGinn *et al.*, 2011; Gagnon *et al.*, 2012; Li *et al.*, 2013). It is considered that the findings of this systematic review will offer a valued information source to researchers, policy makers, and EHR vendors in the KSA in particular, and in developing countries in general.

15.3.2 Second Contribution

The second contribution of this research was the framework. This research developed a novel framework for the adoption of EHRs by primary healthcare physicians in the KSA. The systematic review of prior studies conducted in the KSA revealed that no previous research developed a framework of EHR adoption factors by healthcare professionals in the KSA, and no previous study was conducted in this area in primary healthcare (Chapter 3). To support current policy initiatives by the Saudi Ministry of Health (Ministry of Health, 2011), and given that user resistance has been reported by previous studies conducted in the KSA as a major barrier to the successful implementation of EHR systems (Nour El Din, 2007; Altuwaijri, 2008; Bah *et al.*, 2011; Shaker and Farooq, 2013; Alharthi *et al.*, 2014; Hasanain and Cooper, 2014; El Mahalli, 2015a, 2015b), it is important to understand what affects users' adoption of these systems. The focus of this research was physicians as the main frontline user-group of EHRs. It has long been suggested that physicians play a key role when it comes to the success of EHR systems (Chau and P. J.-H. Hu, 2002; Doolin, 2004; Boonstra and Broekhuis, 2010). Thus, understanding what affects physicians' decisions to adopt and use EHR systems is important.

While technology acceptance theories have provided high explanatory power in business and educational settings (e.g. (Venkatesh *et al.*, 2003)), the application of those theories in healthcare settings have provided limited explanatory power (e.g. (Yarbrough and Smith, 2007; Holden and Karsh, 2010; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014)). Thus, an integrated theoretical approach was recommended by many studies in order to improve its explanatory power (Yarbrough and Smith, 2007; Seeman and Gibson, 2009; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014). The framework proposed in this research provides a novel integrative theoretical perspective that is based on: (1) empirical research conducted in the KSA, (2) the most widely used theories of user acceptance and use of IT, particularly: TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), TAM (Davis, 1986), and UTAUT (Venkatesh *et al.*, 2003), and (3) prior studies employing a theoretical model to understand physician adoption of EHR. Prior studies employing theoretical models are limited in terms of providing an integrative theoretical perceptive of the adoption factors.

The proposed framework was empirically validated and enhanced using a qualitative triangulation approach. It was decided to use a qualitative approach in order to get in-depth investigation of the identified factors and to explore other important factors, thus applying both deductive and inductive research approaches. The examples of failed ICT projects in the healthcare sector have highlighted the need for an in-depth investigation of the processes used to implement such innovations (Dowling Jr, 1980; Lawler *et al.*, 1996; Weingart *et al.*, 2003; Doolin, 2004; Lapointe and Rivard, 2006; Patterson *et al.*, 2006; Koppel *et al.*, 2008; Cucciniello *et al.*, 2015). A major significance of the qualitative study used to validate the framework is that the respondents are professionals with extensive collective experience of EHR implementation and adoption strategies, and key decision makers and physicians in primary healthcare. The semi-structured interviews allowed respondents to describe their own thoughts and experiences, and the triangulation approach provided a useful mechanism for increasing the validity of the findings.

The qualitative investigation contributes to the literature by empirically validating the proposed integrated framework, and by the identifying a new factor that has not been considered in prior models of physician adoption of EHR, namely: *compatibility.* The qualitative investigation also contributes to the literature by providing *in-depth explanation and discussion* of the identified factors. To the best of the researcher's knowledge, there has been no previous qualitative study employing IT adoption theories to investigate healthcare professionals' adoption of EHR. As reported by Holden and Karsh (2010), conducting qualitative studies with IT adoption theories is important and will lead to better refined, contextualized theories of healthcare IT/IS acceptance and use. It is believed that the qualitative study performed in the first stage of this research (Chapters 7-9) will provide a valued information source to researchers and practitioners in the field of EHR adoption and implementation. In addition, the framework developed by this investigation provides policy makers with the key influential factors to consider when promoting and implementing EHR systems.

15.3.3 Third Contribution

The third contribution of this research is the production of a specific instrument. The instrument was developed to measure the EHR adoption factors in the EHR adoption framework. Holden and Karsh (2010) reviewed studies that applied IT adoption theories to the healthcare context and concluded that measures used in prior research are mostly generic measures adapted from the general IT adoption literature. This resulted in an inconsistency in the predictive power of these factors in the e-health context. Theories of IT adoption were developed outside the healthcare context, and therefore some of their core measures may not be meaningful or sufficient in the e-health context. Consequently, Holden and Karsh (2010) strongly advocated for studies developing contextualised measures that are more relevant to the e-health technology under investigation.

This research contributed to knowledge in in this area. First, the qualitative study performed in the first stage of this research (Chapter 9) has defined the dimensions of core factors in IT adoption theories for the EHR adoption context. Second, the measurement instrument was developed based on the findings of the qualitative study performed in the first stage of this research (Chapter 9) and the literature. Specifically, the selection of measurement items from the literature was guided by the findings of the qualitative study performed in the first stage of this research, however new measurement items were added by the researcher based on the findings of the qualitative study (see Chapter 12). The instrument was then validated for both face and content validity using pre-test interviews with experts. The reliability of the instrument was then validated using a pilot study with primary healthcare physicians. The steps carried out for the development and validation of the instrument were provided in Chapter 12. Finally, the instrument was further validated using Confirmatory Factor Analysis (CFA) with a large sample (N=243), which was the first step of structural equation modelling (SEM) (as presented in Chapter 13). The results of the CFA confirm constructs' reliability, convergent and discriminant validity and show that the measurement model fits the data well.

The process involved in developing the instrument in the present research resulted in a well-designed instrument that can be used in future studies related to this field. It is believed that the measurement model developed and validated by the present research will be a valued information resource to researchers and practitioners in the field of EHR adoption and implementation.

15.3.4 Fourth Contribution

The fourth contribution of this research was the development of a model capable of establishing the relationships between the EHR adoption factors. A proposed model that links the EHR adoption factors to EHR adoption decision was developed by building upon the knowledge acquired through the qualitative study performed at the first stage of this research as well as the relevant academic literature (Chapter 11). The proposed model was empirically examined using responses from 243 physicians in public primary healthcare practices in the Kingdom of Saudi Arabia (Chapter 13). The results obtained from the structural equation modelling analysis showed that the model is well-fitted to the collected data. In addition, the model exhibited a high predictive power with R^2_{BIU} =0.77, and most of the hypothesised links specified by the model were supported. Prior models of physician adoption of EHR systems provided lower levels of predictive power (Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015). In addition, the validity of the model (i.e. model fit) was not examined in most previous models of physician adoption of EHR (Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014, 2016). Therefore, it can be concluded that the resulting model of the present research is valid and capable of making a valuable contribution in explaining the adoption of EHR systems by physicians.

15.3.5 Fifth Contribution

This work also filled the gap in the literature by assessing the impact of prior EHR experience on the relationships between the factors in the model. To the best of the researcher's knowledge, the moderating effect of EHR experience was examined in only one previous study (Venkatesh, Sykes and Zhang, 2011), which lacks many of the factors and relationships examined in the present research. Hence, this research has enriched the existing literature and increased our understanding of the differences between physicians who have prior experience in EHR and physicians who do not have prior experience in EHR systems in terms of what affects their EHR adoption decisions.

15.3.6 Sixth Contribution

Lastly, this thesis also contributes to the limited knowledge of EHR implementation and adoption in developing countries. It has long been suggested that the implementation of EHR systems is an uncertain and challenging task even in developed countries, calling for a sensitive matching of local needs to available technologies and resources (Currie and Finnegan, 2011). Experience with implementing EHR systems in the developing countries is much more scarce; and requirements, priorities and local constraints are still not well understood (Fraser *et al.*, 2005). Hence, it cannot be suggested that a single EHR implementation and architecture will fit all environments and needs (Fraser *et al.*, 2005). The findings of this research will help researchers, implementers and policy makers in developing countries not only in the area of EHR adoption, but also in healthcare IT/IS adoption in general.

15.4 Research Implications

This research has made a determination to make a significant contribution to the subject of EHR adoption by physicians. The obtained research data and outcomes are particularly relevant and timely in the context of the National EHR project currently promoted by the by the Saudi Ministry of Health (Ministry of Health, 2011), and will serve as a valuable information source for IT managers, senior managers, policy makers, EHR vendors and researchers. The following sub-sections discuss the practical implications of the findings of this research.

15.4.1 Implications for IT Managers

The findings of this research can guide IT managers whose objectives are to foster the adoption and use of the system among physicians in their organisations. First, the findings of this research indicate that, in order to increase the adoption of the system by physicians, it is crucial to cultivate and solidify positive attitudes toward the new system. In this light, positive perceptions of systems' usefulness are crucial. Positive perceptions of systems' ease of use are also important, but perhaps to a less extent than perceived usefulness. Consequently, IT managers should place a high emphasis on demonstrating the usefulness of the system to the target physicians. Using effective means to communicate the usefulness of the system is crucial. In this connection, the observed significance of social influence in having a direct effect on physicians' intention to use the system, as well as an indirect effect on perceived usefulness through computer self-efficacy, suggest that providing information sessions and training by well-respected medical champions and super-users will serve as an important and effective mean to communicate the usefulness of the system to the target physicians. This will also increase physician's perceptions of computer self-efficacy and systems' usability. The main objective of the initial orientation and training sessions should be to encourage and cultivate positive attitudes among physicians; hence these sessions should focus mainly on the utility of the system to the medical practice rather than the operational procedures or sequences.

Additionally, for perceived usefulness and perceived ease of use, many dimensions that define what makes an EHR system perceived as useful and and easy to use have been defined by the qualitative study performed in the first stage of this research (Chapter 9). These dimensions were found to be significant indicators of these two factors in the Confirmatory Factor Analysis (CFA) performed in the second phase of this research as evidenced by the standardised factor loadings (see Table 13-7). These dimensions can provide IT managers and participating physicians with useful insights to consider when evaluating and selecting an EHR system. Moreover, the participants in the first stage of this research reported that the system is likely to increase physicians' workload at the beginning of implementation. Consequently, reducing the number of appointments and providing extensive support to physicians are two crucial interventions at this stage of system implementation. In this connection, because there is currently no appointment system in the primary healthcare system in the KSA, it is extremely crucial to implement an appointment system before introducing an EHR system.

The observed effect of compatibility on three critical beliefs in the model: perceived usefulness, attitudes, and computer self-efficacy, suggests that compatibility is the key driving force in fostering system acceptance and use by physicians. Compatibility also had a significant negative effect on perceived threat to physician autonomy. The evaluation of the moderating effect of EHR experience on the model revealed that the effect of compatibility on perceived usefulness, although significant for all participating physicians, was stronger for physicians who have prior experience in EHR, which further signifies the importance of compatibility in achieving EHR adoption success. Moreover, the findings showed that physician participation has a statistically significant and large effect on compatibility perceptions by physicians. Consequently, IT managers should involve physicians heavily in system selection and implementation. This includes, as reported by participants in the first stage of this research (Chapters 7-9): requirements analysis, selection and customisation of the system, workflow re-design, usability testing and continuous feedback evaluation. Experts interviewed in the first stage of this research (Chapter 7) emphasized the importance that a physician committee, as a sub-committee of the project management committee, should be the real owners and the real implementers of the system. Physician participation will also increase perceived ownership of the system by the target physicians and their commitment to the new system as well as reduce their resistance to change.

The findings also indicate that computer-self-efficacy has a strong direct effect on perceived ease of use and direct medium effect on perceived usefulness. Concretely, training and IT support are crucial for successful EHR acceptance and use. As mentioned previously, the significant effect of social influence on both computer self-efficacy and perceived ease of use suggest that a crucial step in the implementation phase is to identify "super users" capable of providing training and support in early stages of implementation. Additionally, IT managers should take into consideration the selection of EHR providers who provide sufficient training and support before, during and after the implementation of the system.

15.4.2 Implications for Senior Managers and Policy Makers

The model developed by this research will help senior managers and policy makers to break down the concept of EHR adoption by physicians into smaller, theoretically distinct and adaptable factors to support the project of EHR implementation in primary healthcare. In addition, the findings presented by the model developed by this research will help planning appropriate intervention policies that will increase EHR success.

Foremost, support from top management in healthcare organizations is needed to increase the adoption of EHR systems in the KSA. The observed total effect of social influence on physicians' intentions to use an EHR system indicates that physicians are more likely to accept and adopt the system when important referents support the use of the system. One of the major sources of social influence as identified by the qualitative study (Chapter 9) of this investigation and confirmed by the quantitative analysis, i.e. SEM analysis (see standardised factor loadings for SI1 and SI2, Table 13-7, Chapter 13), is *top management support*. Hence, senior management's support, involvement and commitment as perceived by its affiliated physicians can significantly increase the adoption of the EHR system and reduce resistance to change. The implementation of an EHR system involves changes in the culture, structure, and work routines of users. Hence, the presence of strong and supportive management that have the capacity to implement the changes that come with implementation of the EHR system is essential. Management support includes encouraging users to use the system, communicating openly and honestly with users, and leading by example (Alohali, O'Connor and Carton, 2018). This is important because, as illustrated in the case study by Lapointe and Rivard (2006), physicians tend to resist changes in their work environment and reject the views from other professions such as IT practitioners. Therefore, a strong and supportive management is vital for system success.

In addition, the observed significant effect of computer-self efficacy in the model suggests that senior managers should dedicate resources to raise computer self-efficacy in the use of an EHR system. For this, training and timely support are crucial for system success. Physicians who were interviewed in this research (Chapter 8) and who tried the pilot EHR system suffered from the lack of training and IT support, which contributed to the discontinuation of the system by users. Providing adequate training and timely support will increase physicians' computer self-efficacy in the use of the EHR and result in more positive perceptions of systems' utility and usability as shown by the model.

Furthermore, experts interviewed in this research (Chapter 7) reported that some regulators use the technology as a way of changing existing work routines, thus resulting in introducing two changes at the same time (i.e. process and technology), which increases users' frustration and may lead to failure. The observed total effect of compatibility in the model suggests that senior managers and policy makers should be aware that, in order to foster EHR system acceptance, the system should be compatible with existing processes as well as practice needs. To minimize user resistance, senior managers and policy makers should first evaluate the fit of the EHR system with the current work processes in primary healthcare practices before committing resources to EHR acquisition and implementation. In situations where large changes need to be implemented, areas of improvement should be identified and strategies should be developed to implement a gradual and smoothing transition toward the necessary changes. Only when physicians have higher perceptions of system compatibility with their existing values, prior experiences and practice needs there is a higher possibility to achieve successful EHR acceptance.

15.4.3 Implications for EHR Vendors

Current policy initiatives by the Saudi Ministry of Health suggest that the Saudi healthcare sector is an important market for EHR vendors. Therefore, this research has important implications for EHR vendors and will help them to understand the key drivers that affect physicians' acceptance and use of these systems. Also, this research identified key dimensions that define what makes an EHR system useful and easy to use to physicians (i.e. dimensions of perceived usefulness and perceived ease of use identified from the qualitative investigation, Figure 9-1, and confirmed as significant indicators of these factors in the measurement model analysis in Table 13-7). Hence designing systems that meet these dimensions is likely to increase physicians' perceptions of system's utility and usability and result in more successful EHR adoption. Furthermore, the large and statistically significant effect of compatibility suggests that EHR vendors should put a strong emphasis on user requirements analysis, which in turn should inform the design and development of an EHR system to be introduced to primary healthcare practices. By doing so, the chances of EHR system success will be significantly higher than otherwise.

15.4.4 Implications for Researchers

For the researchers, prior research on IT acceptance in general and EHR acceptance in particular has been focused on the general components of TAM and utilised a quantitative (i.e. deductive) approach for validation. The current research approached the phenomena from a broader perspective by considering multiple theoretical perspectives, the findings of prior theoretical models of physician adoption of EHR and findings of relevant empirical studies conducted in the study context (i.e the KSA), and utilised a mixed method approach for model improvement and validation. This is important because the investigated technology is still an emerging concept in the study context and the current findings in the literature are still lacking a comprehensive framework of EHR adoption factors. The empirical findings of this research have been confirmed to have higher predictive power compared to previous studies. This will provide a new way of thinking for developing prediction models of user acceptance of IT/IS, particularly in situations where the investigated technology is still an emerging phenomenon in the study context or when the literature is still lacking a comprehensive framework of the adoption factors relevant to the technology under investigation.

In addition, the second version of TAM (Davis, 1989) excludes *attitude* from the model and suggests that it only partially mediates the effect of perceived usefulness on behavioural intention. However, the findings of the present research suggest otherwise. Attitude fully mediated the effect of perceived usefulness on behavioural intention and had a strong and significant effect on behavioural intention. Hence, the findings of this research, consistent with the theoretical foundation of both TRA (Fishbein and Azjen, 1975) and TPB (Ajzen, 1991) and the findings of many previous studies of technology acceptance (Kim, Chun and Song, 2009; Ibrahim *et al.*, 2017; Rahman *et al.*, 2019), suggest that attitude should be used in subsequent research.

Furthermore, the findings of this research showed that *compatibility* had the second strongest total effect on behavioural intention to use EHR, which comes directly after attitude in terms of total effect in the model. This result is consistent with the findings of many previous studies (Horan *et al.*, 2004; Bhattacherjee and Hikmet, 2007; Wu, Wang and Lin, 2007), which found that compatibility has the largest total effect on physicians' intentions to use healthcare IT. Consequently, it is suggested that compatibility should be considered in subsequent research of EHR and health IT/IS adoption in general.

Overall, the investigation and findings of this research deliver a common framework, which will help researchers in healthcare IT/IS adoption to theorise and simplify their research. In addition, the outcomes of this research offer a valued information source for upcoming researchers in the area of new technologies adoption in general.

15.5 Future Research Directions

The main aim of this research was to develop a model of EHR adoption by primary healthcare physicians, which could serve as a guideline for Saudi healthcare organisation's decision makers as they consider adopting an EHR system. To accomplish the aim and the objectives of this research (Section 15.2), this research employed a mixed method research strategy to develop and empirically validate a theoretical framework (Chapter 9), a measurement instrument (Chapter 12), and a model (Chapter 13) of EHR adoption decisions by primary healthcare physicians in the KSA. This research also evaluated the moderating effect of prior EHR experience on the model (Chapter

13). New theoretical contributions and practical implications were added by this research as discussed in the present chapter (Section 15.3 and Section 15.4, respectively). However, despite the fact that this research has achieved its aim and objectives, it still has some limitations, which provide insights into future research directions.

First, the fact that this research involved only participants from the Saudi healthcare system suggests that the developed model and the findings may not be reflective of the EHR adoption decisions in other healthcare systems. Future studies validating the model in other healthcare systems are needed in order to increase its generalizability.

Second, due to the limited time available for this research and the cost, the methods used to achieve its objectives were limited to certain qualitative (i.e., semi structured interviews) and quantitative (i.e., survey) methods. Although the data was analysed using powerful techniques (i.e. thematic analysis for the interviews' data, and multivariate analysis, SEM, for the surveys' data), follow-up studies utilising longitudinal data collection methods, such as case studies, are recommended in order to observe the usefulness of the findings of this research in practice. Case studies allow a researcher to employ the findings of this research in real world settings, so that they can be revalidated and improved in different contexts. The case studies should use multiple sources of evidence (e.g. documentation, observations, interviews) where data needs to converge in a triangulating fashion (Recker, 2013).

Furthermore, it may be effective to extend the model developed by this research into a wider context by providing detailed guidelines on the different steps and measures, which organisations should follow; this could provide a basis for the development of an adoption roadmap.

Finally, investigating if the model further explains physicians' acceptance among different types of healthcare IT/IS, such as telemedicine, would also strengthen the findings of this research and increase the generalizability of the model.

15.6 Final Remarks

Understanding the acceptance and adoption of EHR systems by physicians in a country where there is a lack of related studies was a challenge. Additionally, the fact that the well established IT adoption theories such as TAM (Davis, 1986) and UTAUT (Venkatesh *et al.*, 2003) have been reported to provide a limited explanatory when applied to physician acceptance of IT/IS (P J Hu *et al.*, 1999; Chau and Hu, 2001; Chau and P. J.-H. Hu, 2002; Yarbrough and Smith, 2007; Venkatesh, Sykes and Zhang, 2011; Gagnon *et al.*, 2014) made it more challenging. Therefore, this research designed a three-tier approach to develop a framework of potential key decision factors that are important for the adoption of EHR by primary healthcare physicians in the KSA (Chapter 5). The developed framework employed the findings of relevant empirical studies conducted in the KSA, the determinants of user adoption of IT based on four common theories: TRA (Fishbein and Azjen, 1975), TPB (Ajzen, 1991), TAM (Davis, 1986), and UTAUT (Venkatesh *et al.*, 2003), and the determinants of physician adoption of EHR based on prior empirical studies (Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015). A qualitative study was then conducted in order to validate the proposed framework and to explore other important factors (Chapter 9). The findings of the qualitative study strengthened the confidence in the importance of the identified factors and revealed a new factor, *compatibility*. These factors were then structured into an explanatory model based on the findings of the qualitative study and the literature (Chapter 11). The qualitative study also helped addressing gaps in the literature with regard to refining the measurement variables of the identified factors (see Section 15.3.3. of the present chapter). The results of SEM analysis (Chapter 13) showed that the model developed by this research is well-fitted to the collected data and has an explanatory power of 77%, which demonstrates a better predictive power than models in prior published research (Morton and Wiedenbeck, 2009; Seeman and Gibson, 2009; Archer and Cocosila, 2011; Venkatesh, Sykes and Zhang, 2011; Esmaeilzadeh and Sambasivan, 2012; Gagnon *et al.*, 2014, 2016; Abdekhoda *et al.*, 2015; Steininger and Stiglbauer, 2015).

The model developed by this research makes relevant suggestions on how to achieve a favourable implementation environment for the adoption of EHR systems. It is strongly recommended that this model be used by Saudi healthcare organisations, which are planning to adopt an EHR system or to achieve an EHR system success. The full study carried out in this research is one of the first in-depth attempts to establish how healthcare organisations can make physicians' adoption of EHR systems successful. It is also believed that this research provides a valuable information resource for future researchers in the EHR adoption area, as well as in the area of new technologies' adoption in general.

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Appendix A Participants invitation letter for the qualitative study

Dear [*Participant name*]

Assalamu Alaikom,

I am Asma Alqahtani, a lecturer of computer information systems at the College of Computer Science, King Khalid University, and a PhD student at the University of Southampton, the UK.

I am investigating the factors that influence the acceptance and use of Electronic Health Records (EHRs) by primary healthcare physicians in the Kingdom of Saudi Arabia.

I have proposed a number of factors based on extensive literature reviews. However, I need to get your opinion regarding the importance of these factors. Your expertise as [*an expert of EHR implementation/a (senior) primary healthcare physician*] will provide me with significant insights.

Can I make an interview with you, either face-to-face, online, or via phone, in this regard, please?

The interview may take 30 minutes. If you agree please let me know the appropriate time for you.

Your participation is important for this research. The information and data you provide will remain confidential, and will be used only for this research.

Looking for your valuable response,

Thank you very much,

Asma

Participant Information Sheet Sent to Participants

Study Title: Factors influencing the adoption of Electronic Health Record (EHR) by primary healthcare physicians in the Kingdom of Saudi Arabia

Researcher: Asma Alqahtani **Ethics number**: 24595

Please read this information carefully before deciding to take part in this research. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

This research aims to identify the factors that are likely to have an influence on the acceptance and use of is Electronic Health Records (EHRs) by primary healthcare physicians in Saudi Arabia. Identifying these factors will help to increase the success rate of implementing EHRs in Saudi primary healthcare centres. This research is under the direction of the School of Electronics and Computer Science, University of Southampton in the UK.

Why have I been chosen?

You are invited to participate in this study due to your expertise and experience with regard to the aim of the study. Your opinion and feedback will help in improving the proposed framework to increase adoption rates of EHRs by primary healthcare physicians in Saudi Arabia.

What will happen to me if I take part?

I will ask you to sign a consent form, and then the interview will begin. The interview consists of a number of open-ended questions. The interview will be recorded and it will be used only for the purpose of this study.

Are there any benefits in my taking part?

This research is not designed to help you personally. Your feedback will help me to develop and enhance the proposed framework for the successful implementation and increased adoption rates of EHRs in primary healthcare centres in Saudi Arabia

Are there any risks involved?

No

Will my participation be confidential?

Yes. All information gathered from you will be stored and used on secure systems and will be used for the purpose of this study only, all your responses will be anonymized. All responses will be compiled and analysed together.

What happens if I change my mind?

You have the right to terminate your participation in the research, at any stage, you do not need to give any reason, and without your legal rights being affected. Your data will be deleted directly if you decide to withdraw at any time.

What happens if something goes wrong?

In the unlikely case of concern or complaint, please contact Research Governance Manager (02380 595058, rgoinfo@ soton.ac.uk)

Where can I get more information?

For further details, please contact me or my study supervisors, Dr Gary Wills or Dr. Richard Crowder.

Investigator: Asma Alqahtani (aaja1g15@soton.ac.uk)

Dr. Gary Wills (gbw@ecs.soton.ac.uk)

Dr. Richard Crowder (rmc@ecs.soton.ac.uk)

Consent Form

Study title: Factors influencing the adoption of Electronic Health Record (EHR) by primary healthcare physicians in the Kingdom of Saudi Arabia

Researcher name: Asma Alqahtani
Ethics reference: ERGO/FPSE/24595

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet (Date 23/11/2016/version no. 1) and have had the opportunity to ask questions about the study.

I agree to take part in this research project and agree for my data to be used for the purpose of this study

I understand my participation is voluntary and I may withdraw at any time without my legal rights being affected.

I am happy to be contacted regarding other unspecified research projects. I therefore consent to the University retaining my personal details on a database, kept separately from the research data detailed above. The 'validity' of my consent is conditional upon the University complying with the Data Protection Act and I understand that I can request my details be removed from this database at any time.

Data Protection
I understand that information collected about me during my participation in this study will be stored on a password protected computer and that this information will only be used for the purpose of this study. All files containing any personal data will be made anonymous.

Name of participant (print name)…………………………………………………

Signature of participant……………………………………………………………..

Date…………………………………………………………………………………

Appendix B Socio-demographic questions used in the interviews

A. Socio-demographic questions applying to leaders and experts of EHR implementation

1. Area of expertise	☐ Chief Information Officer (or equivalent) ☐ Director of Health Information System (HIS) ☐ Medical informatics specialist ☐ Others: *please specify* ____
2. Healthcare experience	○ Physician ○ Healthcare professional other than a physician ○ Others: *please specify* ____
3. Healthcare authority	○ Ministry of Health (MOH): *please specify* ____ ○ Military hospitals: *please specify* ____ ○ University hospitals: *please specify* ____ ○ Others: *please specify* ____
4. Years of experience in EHR implementation	_______ Years.
5. Age	_______ Years.
6. Gender	○ Male ○ Female

B. Socio-demographic questions applying to primary healthcare physicians

1. Position	○ Senior primary healthcare physician: *please specify* ____ ○ Others: *please specify* ____
2. Specialization	○ Family physician ○ Others: *please specify* ____
3. Years in medical practice	○ 5 – 10 years ○ 10 – 15 years ○ 15 – 20 years ○ 20 years or more
4. Years of EHR experience	○ No experience in EHR ○ 1 – 5 years ○ 5 – 10 years ○ 10 – 15 years ○ 15 – 20 years ○ 20 years or more
5. Healthcare authority	○ Ministry of Health (MOH): *please specify* ____ ○ Military hospitals: *please specify* ____ ○ University hospitals: *please specify* ____ ○ Others: *please specify* ____
6. EHR status in the primary healthcare center /department	○ EHR system implemented ○ EHR system piloted but discontinued ○ No previous implementation or piloting of an EHR system
7. Location of the primary healthcare center /department	___________________
8. Age	_______ Years.
9. Gender	○ Male ○ Female

Appendix C Thematic analysis of experts' interviews

The full list of codes, themes (factors) and sub-themes (dimensions of factors), as well as examples of coded extracts within each code, resulting from the analysis of experts' interviews are provided on the following pages.

Themes (Factors)	Sub-themes (Dimensions)	Codes	Number of coded extracts	Examples of coded extracts	Total number of coded extracts
Perceived usefulness		Perceived usefulness is important	20	“*It is very important that the provider knows how will the system benefit him. If the physician beliefs that the system will assist him in an effective way he will fight for it*” (Expert4). “*This is the factor that makes the practitioner run for the system*” (Expert 5). “*The physicians need to realize the benefits first, if they do not realize the benefits of the solution, they will not accept it*” (Expert 10). “*It is not about automation, but about addressing problems. The system should be able to solve problems and to provide an added value, otherwise the physician will not go for it*” (Expert 2). “*Very important factor. The main problem is that people understand that the solution came from the IT. It is not an IT-driven, it should be providers-driven. The business owner is the one who should own the system*” (Expert 9).	20
	Improved job performance	Benefits on personal performance are important	7	“*I stress more on the issue that there should be a complete clarification on what’s in it for you as a physician*” (Expert 10). “*Benefits for him personally will matter a lot*” (Expert 7).	23
		Providing better workflow support and supporting physicians’ decisions	8	“*If he knows the benefits that will return to him personally, yes it will be important, highly important. How can the system ease his job, how he can get his data, this is very important and will encourage him*” (Expert 7). “*If there is a usefulness for the professional practice, I mean if it makes his job easier, helps him to get drug-drug interactions, or helps him in deciding the follow-up with the patient, or helps him in making prescription, or in selecting or ordering the right lab tests or other investigations*” (Expert 11). “*The most important thing is that the benefits of the system are clarified to them. How the EHR system will simplify their workflow, how it will facilitate their communication with the other departments, how it will make it easy to access patient’s information without having to go back to paper records*” (Expert 1)	

		Saving physicians' time	6	"*Many seniors [physicians] became motivated because he found that the system saves his time, of course I am not saying this from the beginning, this was after one, two, and three months of implementation… one of the senior physicians, he was the head of one of the departments, he says that I can finish my work one hour and a half earlier than the regular time, I can see 30, 35, and 40 patients in the clinic*" (Expert 3). "*The positive side is that the system saves his time in finding information about the patient's condition, such as risk factors, instead of searching in papers*" (Expert 9).	
		Providing a clear documentation of physicians' work	2	"*Everything you write will be documented, if it is written on paper sometimes it is not clear, but if is typed on the computer every single word is clear. This will help a physician improve himself, improve his practice, people will be convinced from this perspective*" (Expert 8). "*It helps the physician to prove that I am doing a good job besides following the medicine best practices*" (Expert 7).	
	Quick and easy access to information	Quick and easy access to data is important	15	"*When we ask the groups of physicians about the benefits of EMR, it is the easy access to the patient chart, you access it from your computer, you can make an order through the CPOE, you can view the lab results, view the x-rays, you do not need to call the lab*" (Expert 5). "*The real benefits that they care about is the ease of use, accessing the data more efficiently than before, more important than all of this is that they feel that they have access to their patients' records anytime anywhere. That is fast, easy, accessible. These three are the major areas that are very important to them"* (Expert 10). *"If he finds all patient's images, lab reports, previous notes, all of these in one screen in front of him, this builds the their trust in the system*" (Expert 5). "*The positive side is that the system saves his time in finding information about the patient's condition, such as risk factors, instead of searching in papers*" " (Expert 9).	21

		Problems with paper-based health records	3	*"The current situation in the primacy healthcare centre, the chronic diseases physician keeps patients' records separately, and so as the general practitioner, the obstetrician, and the dentist. There is no holistic view of the patient's information in front of the physician under his fingertips, this is extremely important from the perspective of physicians"* (Expert 9). "*He will realize the benefits, it is the trigger that says yes it is what I need, I was missing these system it was nice when I work with them, all I have to do is a click and I have all the data I don't have to wait for two hours until they bring me the file or the file is in another station and still using it and I have to wait and so on*" (Expert 8).	
		Visualizing data	1	"*When they realise the benefits and feel the power of the data and reports and graphs I think definitely it will make them accept the system and adopt the change easily*" (Expert 10).	
		Structured data	2	"*The usefulness of having structured data and data all saved in a computer system is definitely going to be much better and going to help those people who have to search in volumes of patients' data… they will know the usefulness when they search for the needed data on the computer and get that data in front of them, definitely this is much better and extremely important*" (Expert 8).	
	Enhanced patient safety	Clinical decision support	14	"*The system must help in improving patient's safety, and there are systems that do not, if it is just a data entry system without clinical decision support, the adoption will decrease, the physician will find no value in using the system*" (Expert 1). *"We had one the of the physicians completely resisting the system and trying to convince others not to use it. Later, after a few years of implementation I met him, he became one of the most supportive people for EHR systems. He said I did not realize the benefits until after 3 or 4 years, I started to feel that the system is providing me with things that are very powerful, in knowing my patients, sometimes when I am at home I receive an alert about a critical result, this could save patients' lives"* (Expert 10). "*We demonstrate for them that using EMR and DSS will help you avoid doing mistakes such as adverse occurrence or side effects of medications and allergies, the system here will alert you, it will also remind you through electronic clinical pathways that you for example forgot to order this device or this tissue for the operation. In this way, the practitioner starts to perceive the usefulness of the system*" (Expert 5).	14

	Improved quality of care for patients	Improved quality of care for patients is a motivational factor	3	“*If you say that this will help patients and reduce your work, he will accept it greatly*” (Expert 3).	12
		Comprehensive view of patient’s records and therefore better decisions	6	“*The EHR improves quality of care, the physician will be able to view information held by various clinics about the patient, this helps in continuity of care, there will be no fragmented information*” (Expert 1). “*If he has a holistic view of patient’s medical information in one screen, he knows if this patient is a diabetic patient, or has allergies, or is a high risk patient, the system should handle it and give him these information directly instead of looking into and searching in many papers where he may not get these information*” (Expert 9). “*When the physician has a complete history of the patient he will be able to make a more proper decision for the patient’s care*” (Expert 12).	
		Improved monitoring and follow-up	3	“*Having an EHR helps the physician to monitor his patient*” (Expert 7). “*If he has a chronic disease patient, he can do a correlation between the medication he takes and the blood pressure or sugar level for example, is it under control? Or do I need to increase or decrease the dose, so these functionalities enable him to improve the quality of care for the patient*” (Expert 9)	
	Improved communication between	Communication with other departments and physicians	3	“*We changed the previous system because it was not much useful for physicians. The documentation was almost on paper, and no referral tools for other physicians*” (Expert 3). “*It is very important to clarify how the system will ease their communication with the other departments*” (Expert 1).	9

	healthcare providers	Connection with hospitals	6	“*There is no [electronic] connection between the primacy healthcare centre and the hospital. When the primary healthcare physician makes a referral to the hospital [in paper], the patient takes this referral and goes to the hospital, the hospital will do more advanced investigations and identify the condition of the patient and provide the treatment, then the patient will follow up with the primary healthcare physician. However, the primary healthcare physician does not receive the feedback from the hospital, and he has no ability to view the patient’s record at the hospital’s system*” (Expert 6) ”*This problem has disappeared in NGHA, the primary healthcare physician has the ability to view patient’s information at the hospital. This led to patient’s trust in the primary healthcare physician, because he knows his condition and will not give him a wrong medication or make a wrong diagnoses. This connectivity made the system very useful from the perspective of the primary healthcare physicians*” (Expert 6).	
	Empowering patients	Improved communication with patients	1	“*The presence of EHR will help communicate with the patient. I will give you an example, if I have vaccinations, when the MOH used SMS as a reminder for vaccinations, the load on primary care centres increased substantially. Therefore when you are able to communicate with patients more, and when you are able to know the condition of the patient with all details, the medications he takes, his allergies, practically you will be able to make prevention of major problems before they happen*” (Expert 4)	2
		Involving patients in decision making	1	“*I want the patient to participate in decision making by allowing him to access his or her record, for example if we made a diabetes screening test, the patient can view the result on his or her personal record*” (Expert 2).	
		Others	9	“*the system itself, the system should be built from the physician perspective. I focus here on the physician, because the physician is the core in EMR. He is mainly the core; the others are supporting the core for the quality of healthcare. So, the system has to be built, a physician-centric, somehow. It should be built around the physician’s needs, and from the perspective of the physician*” (Expert 3). *“The strategic mistake is that, the physician is a logical person, I mean when you come and tell him that I will implement the system, he views it as a pure IT system, just another version of paper charts… Who is the right person to convince them about the benefits? he should be a physician or a person who talks to them in their own terminology. Because of this many, many physicians resist technology more than others because people in charge of the implementation fail to consider that the person who talks to them should be a physician”* (Expert 10)	9
				Total comments on perceived usefulness	**110**

Perceived ease of use		Perceived ease of use is important	20	"*I've worked with systems that were in fact difficult, annoying, it is true that they are very effective and very functional but for someone who do not have computer knowledge he will find large difficulty in using them*" (Expert 8). "*If I brought him a system, although he knows the benefits of it, but if it is not easy to use he will not accept it, it will be difficult to adopt*" (Expert 1). "*Ease of use is one of the most important factors that affect the adoption of the system by physicians*" (Expert 12).	20
	Time required for data entry	Minimizing data entry tasks	22	"*If I have a system that is text-based or designed with more keyboard entries, the acceptance will be more difficult for us, and this is something I am sure of. Because of this I sometimes return to the developers and request changes… If we make all the data entries in the form of radio buttons or check boxes, always the acceptance will be better*" (Expert 4). "*We had a system that was developed locally. People resisted it because they had to type in text, not clicks… But if the data entry is in the form of a list of questions and I have to answer them with yes/no for example, this will allow him to complete data entry in a very short time*" (Expert 6). "*The more the details requested by the system, the more the complexity of the system*" (Expert 9).	27
		Tools for simplifying data entry	5	*"Time to enter data is very important, the majority of companies are now trying to introduce logics or rules, business rules, to make the system thinks and do things on behalf of the physician, they are reducing the number of clicks, they are reducing the number of entries the physician has to do, just to help increasing physicians' acceptance or adoption of the system. They introduced tools such as voice recognition when we talk about dictation. There have been touch screens and using pens on the screens, using the tablet, so all of these they are extremely important"* (Expert 10). "*The implemented system became simple to use, the entry methods became flexible. If he cannot use the keyboard he can use the voice recognition. The technology must be smart enough so that it is not hectic for use, because when it is hectic for use and the load increases then he will try it once or two or three times and then abandon it*" (Expert 3)	

	Physician-patient communication	System complexity affects physician-patient communication negatively	17	"*Doctor-patient relationship worsens if the physician has to enter the data during the time he is required to see the patient, If the system is complex and difficult and its use requires more time, this affects negatively the ability of the physician to communicate with the patient*" (Expert 4) "*It is one of the challenges even worldwide. Here is the point, ease of use and simple layout, these are the challenges from the IT part or people working in software programming, how can they minimize the number of clicks, the number of instructions that you need from the user in order to dedicate most of the time to the patient. It is very annoying for the patient to have a doctor just setting in front of a computer typing or dictating and he is not giving attention to the patient*" (Expert 7). "*The physician will spend time in navigation, typing, making orders, doing referrals if required, and making documentation. All of these, the more the system is easy to use, the more it allows the physician more time to communicate with the patient and to serve him faster*" (Expert 6).	18
		Selection of EHR solution should consider this issue	1	"*Now they [EHR vendors] have reduced the level of complexity and provided tools to make the system less complex and more useful. They have introduced channels of communication between the physician and patient, such as patient portals, instant messaging that comes between physicians and their patients. These systems are empowering patients. I am talking about the solutions that are classified as good solutions, I am not talking about EHRs that are ranked low in the market, these do not help in that aspect. In general, if we talk about proper EHRs that are in the market, they play a major role in communication with the patient*" (Expert 10)	
	Initial workload increase	Increased workload in early stages	10	*"In the beginning initially people were resisting because normally on the paper it took them two minutes to write all of their investigations, now they have to go to the computer. Initially it took them 10 times or even 20 times more than the time they spend on the paper, and people were not happy. Either they write it on a paper and then they request the nurse to type it on the computer, which is completely wrong, or they do the work twice [on paper and then on the computer]"* (Expert 8) "*The workload at the beginning will increase, because at the beginning all the patients the physician receives are new patients completely, so most of the time will be spent on data entry and updating their information. After a time period, it could be six months or one year, the patients the physician receives start to be the same patients who have been seen before. He will find all their information on the system, and the workload starts to decrease. This issue should be justified and be made clear from the beginning during the training*" (Expert 11)	18

		Reducing the number of appointments in early stages	8	*"Always in any EHR implementation, at the beginning of implementation, it is very important to reduce the appointments by certain percentages to help in the adoption. Because physicians need time to adopt, they need to see fewer patients so that they can realise the benefits gradually. Always there are recommendations to cut down the appointments between 30-40% depending on the volume; this will tremendously help physicians to adopt the system easily. And then the appointments can be increased gradually after two or three months. You reduce and then you start to increase"* (Expert 10) "*During implementation and before the implementation and during the go-live, we reduced the number of appointments to the half in order to increase the adoption of the system by physicians and to facilitate their use of it, because it will be a new system for them from paper and legacy systems to completely computerized work, and this has helped them*" (Expert 12)	
	Ease of navigation	Ease of navigation is important	15	"*The more the functions a physician needs are easily accessible from one screen, during one login, without the need for more than one login, the more the system acceptance will be easier. And I have many systems in the hospital, and I see the difference between them. One of the systems requires you to open four screens in order to enter a type of data or to read this same type of data, this system I really face a difficulty in convincing people to use it, even the people who know how to use it, they do not want it*" (Expert 4) "*We previously had a system that requires you to go from one screen to the other, one screen to the other, and this is one of the things that people were very annoyed from. Navigation is one of the most important things, if you do not put everything in front of him, the physician, you will lose him, if you make him move from one page to another and from one page to another he feels lost and you will lose him definitely. For example, for investigations, put all the investigations that he needs in front of him, I want to do blood work I need to do urine analysis I want to do radiology investigation, it is all in front of me, and if I need one of them click and it goes… and with one button I can go back to the main investigation screen and go to another investigation, so navigation is extremely important, please make everything clear, they will love it*" (Expert 8) "*One of the points that people hate with the previous system is that in order to update a case you have to go through several screens, very annoying*" (Expert 3)	15

	Time to master the system	Time to master the system is important	5	“*For an EHR system to be efficient and easy to use, it should be easy to learn directly by individual users and it should be understandable using common sense*” (Expert 6) “*The system should be easy to use and does not require the physician to spend a long time whether on training or use*” (Expert 1) “*Physicians are very busy, he [the physician] says I cannot leave the work for two days for training*” (Expert 12)	9
		Time to master the system depends on computer self-efficacy	4	“*Some people may learn it in 8 hours and some may need a longer time. There are varying computer capabilities and computer knowledge… One of my colleagues is working in another hospital, and the system there is friendly and people say that it is easy and they learned it quickly, but some people were complaining*” (Expert 8)	
		Others	8	“*there should be a balance between the complexity and the volume of data in the system. The system may not record even the vital signs, only records registration, diagnosis and prescription, doesn't meet the main goal*” (Expert 9)	8
				Total comments on perceived ease of use	**115**
Computer Self-Efficacy		Computer self-efficacy is important	20	“*Some physicians who were resisting, he says that he came to see the patient not to work on the computer. This is because he does not have knowledge on how to use it and the ability to use it effectively*” (Expert 9) “*The third challenge, is the fear from technology, for them EMRs or EHRs or IT in general is a black box… when they do not see the expected data right away they jump to the conclusion that the system is not working*” ” (Expert 7) *“It is very important that the physician advocate or the implementation team makes a proper assessment of physicians’ computer skills before the implementation. And if there are specific areas that need to be improved, and they helped in this, I think it is worth”* (Expert 10)	20

	Training	Training is important	16	*"We underestimate the capabilities. There are no training programs for them, the HIS [Health Information System] comes and people are requested to start working with it and they might fail, they may not know how the tasks are performed with the system, it takes much more time for them to accomplish their work"* (Expert 8) "*There must be a training plan at the implementation and before the go live, during the go live and after the go live. Training is a critical success factor in the beginning, because at the beginning people will not accept the change, especially the physicians, the physicians are very difficult to convince, if he finds the colour of a field changed he will say no I won't use it*" (Expert 4) "*Many times projects fail because of lack of training. Once they do not get training they cannot use the system and cannot get the work done…or the worse, he would share his user name with the nurse to finish his work… training is extremely important, and continuous training it is not a one-time training, it should be continuous and follow-up*" (Expert 7) "*training training training very very very critical for the adoption. It is one of the critical success factors for any system especially the EMR*" (Expert 3)	44
		Lack of training could affect patients' safety	1	"*The problem is that the physician if he wasn't trained on the system properly he will always be reluctant to use the system. We always say that the system helps in patient safety and quality but it sometimes can kill a patient if the physician or other users were not trained on it properly*" (Expert 1)	
		Training should be designed according to the needs of different specialties	1	"*Sometimes some vendors or companies provide a training program for the physicians for example half a day, while when we look at it in detail we find that some specialties need two hours and some specialties need full day and some need more*" (Expert 10)	
		Providing multiple methods of training	3	*"The methods of training need to be done in an innovative way to deliver these materials. Do not only depend on the typical and old approach. Use multiple methods of training and be innovative. Make use of nowadays-social media to deliver the message. Do not depend on the manual method of training, or training z and x, no, deliver it in methods that could be nice like these innovations to attract physicians. In each method of training, you will attract a specific group of people. Different methods in delivering training will make the adoption greatly faster"* (Expert 3)	

		Providing one-to-one training for those resisting the system	2	"*Some users will start to seek for any reason in order not to use the system. The solution for these cases is simple, he can talk to the CEO or his head, and he will assign someone to help him in the form of one-to-one training, not group training, usually this lasts for only few days*" (Expert 5)	
		Making contents of training available	2	"*You have to invest that the content of training is always available, and accessible from anywhere, the content should be written in a way that is really smooth and can be easily understood by healthcare professionals, this is very important. The contents should not only be in the form of text or slides, there have to be videos as well*" (Expert 3).	
		Continuous training	4	"*In primary healthcare enters in the KSA, we have a large percentage of turnover especially in rural areas. This is because most of the physicians are expatriates and therefore their turnover is quick... Therefore, it is important to provide an online-training course or that training programs are arranged for the newly employed physicians. So continuous training is especially important for large healthcare authorities such as the MOH because the turnover there is high, you do not want the system to stop when you changed the physicians*" (Expert 6)	
		Training by champions and super users	15	"*Subject matter experts are people who are experienced in the business work of physicians if we are just talking about physicians, but he could be subject matter expert in pharmacy or lab, so these are the people who have interest in IT but they come from a different domain. These subject matter experts are experts in the field, you take them and train them on the system until they become aware of the system, the ins-and-outs of the system, they do not take basic training they take advanced training… they're the ones who could do the training to end users because they know what the majority of their colleagues need and how to speak to them*" (Expert 7) "*We give training to physicians only by physicians or nurses in order to answer their clinical questions*" (Expert 2)	
	IT support	IT support is important	14	*"If the level of support is not up to the standard, the physician will eventually abandon the system. He will say I cannot keep the patient waiting 10 minutes or 20 minutes until the IT replies to me to tell me what to do"* (Expert 7) *"The presence of IT support staff is important whether inside the primary healthcare centre or supporting three primary healthcare centres for example, so that if the physician encounters a problem such as the patient's record was not found, the patient will not be delayed"* (Expert 6)	23

		IT support at the beginning of implementation by super users	9	“*We had super users in the areas, which are the departments and clinics. Super users where nurses who have received an advanced training on the physician’s role. These were assigned completely to help physicians, if any physician has a problem, for example, he does not know how to order a specific medication or how to enter his notes, the super user is available and will come directly and help him… this helped physicians a lot*” (Expert 12) “*You will need what is called subject-matter experts from the physicians to go and train the physicians, and assist the physicians, solving their problems, understanding their issues. And that’s what the word CMIO [Chief Medical Information Officer] means, he is the layer between the IT and the medical group, you need physicians to talk to physicians, IT cannot talk to physicians, unless he has a degree in health informatics and these are very rare. And you have to put someone respected in the physician community to speak to them, someone who is proactive in the medical group*” (Expert 7) “*The functional support should always be there, not technical, the functional. Part of it is performed by the super users, not the IT, the business people that you trained them to support the business. The functional means, for example, I ordered medicine x and it was submitted mistakenly, or when I enter the order in this form I get a wrong calculation, here you need someone who knows the system’s ins and outs to resolve the problem from a functional perspective quickly, he has a technical background but he is more into functions than technical, means he is not the developer no, one who is an analyst from the business, he knows how to translate this into something that can be done technically*” (Expert 3)	
		Others	4	“*Sometimes they claim about lack of computer literacy either because they fear from technology or they do not want to use the system”* (Expert 9)	4
				Total comments on computer self-efficacy	**91**
Social influence		Social influence is important	7	“*The whole social environment around him, if it is positive he will change with them, he will step with them, and vice versa if the people around him are complaining about the system, he will start building barriers and barriers over that. It is a very careful approach, because if someone’s attitude becomes extremely negative, it is very difficult to win his attention again*” (Expert 8) “*Let me tell you the social side in our country is the one that makes projects succeed or fail”* (Expert 4)	7

	Top management support	Top management support is important	37	*"Now because of the importance of management, the major international companies or the main health IT suppliers, before they start any project they do something called strategic assessment, the most important thing in strategic assessment is not to assess the building or the readiness of the infrastructure, no, it is mainly to assess the management or the decision support process in the organisation and they give a clear recommendation that in order for you to achieve your goal, you need to have a proper decision making and you need to have a quick response. For example, if there is a specific change, there must be enforcement from the MOH or the CEO of the organisation or even the manager of the organisation etc. If there is no support and no enforcement, you will definitely fail in the adoption. Because physicians are very difficult people to deal with unless there is a strong management that is clear and having solid goals and objectives"* (Expert 10). "*Higher management support or influence is the key success factor for system acceptance. If the manager said no more orders can go to the pharmacy except through the system, it is done, people will have no other choice. But if he allows paper and electronic orders, people will refuse the system… The management support is make it or break it, literally. If the manager is not strong and weak, physicians are the most difficult people in these systems. If you ask me about one main reason for our success, I will say it is the senior management support*" (Expert 2) "*Some physicians were not committed to using the system, and continued working on papers. He says I don't want to use the system, I don't know how to use it, it wastes my time, and it is easier for me to write on papers. At that time, the lab and the pharmacy when they receive the orders in paper, they refuse them, and the order returns to the physician and he has to type it on computer, this caused problems at the beginning. Later on, when the top management made a decision to prevent the use of any paper whether in ordering or in documentation, the physicians became committed to using the system*" (Expert 12)	37
	Peers influence	Super users	7	"*Physicians can talk easily to other physicians. They will accept it from their colleagues more than from someone who they consider a programmer. If he said the system is difficult, and another physician came and said you see only 5 patients in the clinic, I see 20 patients and I am using the system and it is good and these are the added values, he will accept it more. So, peer pressure is important, therefore we let physicians be trained only by other physicians, or nurses, so that they can answer their clinical questions*" (Expert 2)	24

		Champions	8	"*There must be a champion from the organisation itself. Because he will influence the other physicians, he will convince them with the benefits of EHR, he will market the system and can understand issues and concerns from others regarding the implementation of the system"* (Expert 1) *"Champions in every specialty are essential… these are the ones who are going to convince, they will be the example for others. They will be your eye about concerns and problems and they will correct the errors by themselves you can depend on them*" (Expert 8) *"We had 5 or 6 physicians who were the leading physicians team, they were responsible for the awareness before the implementation. They visited every department and made a presentation about the system and its benefits. When the physician gets the information from another physician, this helped in paving the way for the go-live. So it is very important to have champions from the physicians themselves because the physician accepts the information from a physician, but not from an IT specialist*" (Expert 12) *"The strategic mistake is that, the physician is a logical person, I mean when you come and tell him that I will implement the system, he views it as a pure IT system, just another version of paper charts… Who is the right person to convince them about the benefits? he should be a physician or a person who talks to them in their own terminology. Because of this many, many physicians resist technology more than others because people in charge of the implementation fail to consider that the person who talks to them should be a physician"* (Expert 10)	
		Other peers	8	"*This is a very important point. At the go-live, it is very important that your team be very close to end-user. Because if one of the physicians does not want to use the system, and this physician is talkative, knows lobbying people, he will influence the others*" (Expert 5) "*I was training the physicians in 2002, and a team of senior physicians were training with me. If the residents and fellow physicians see the senior is training, it's done, they will adopt the system easily*" (Expert 2)	

		Social networks with peers	1	*"We created a social network for physicians, any physician who has an idea, a specific method he discovered in working with the system that could simplify the life for others, I mean in how to work with the system, he can share it through WhatsApp as a video clip and we announce it under his name. So when we created a social life among those, everybody wants to show that he is capable to use the system, he shares the video, how you can do this from line A to Z. This social network also created another training material, it is not structured, but nice and the people like to use it especially the middle aged and junior physicians"* (Expert 3).	
	Perceptions of patients attitudes	Perceptions of patients attitudes are important	7	*"We have in the KSA the issue of attention or cultural aspect, some people you need to give them a specific attention to feel that you are treating him and that you are with him and that you are passionate with the patient, and these things are influential because the physician if he used the computer and turned to the screen to write while the patient is in front of him some people get offended. Many of the physicians lose this balance at some point, so I think it is very important"* (Expert 10) "*We had in some hospitals some patients were complaining that the physician does not look at him, means he types on the computer and asks him and types without an eye contact*" (Expert 11)	10
		Patients' attitudes could be encouraging	3	"*A manager of a primary care center created a Whatsapp group for the patients, this was amazingly accepted and valued by the people, people appreciated the new idea and that he tries to communicate with them. This idea although very simple, succeeded more than, for example, if I try to apply it here in the hospital*" (Expert 4) "*The patient experience is important, when the patient feels that his information is already in the system and that it is being managed correctly, this builds up trust on the physician who uses the system*" (Expert 11)	

	Other medical staff's influence	Support from the other members of the healthcare team	8	"*Motivation has two types: a group motivation, at the level of the primary healthcare centre, and individual motivation, at the level of individual users. Individual motivation is good but what is better is the group motivation, because in a group motivation all individual stakeholders support each other*" (Expert 6) "*If someone of the other medical team was complaining to others about the system, and he may not have attended the training session and thus has a bad experience with the system, for example, I put information for patient A and I found it in patient B, a kind of complaints we always hear. This causes a kind of frustration to the rest*" (Expert 5) "*It is not necessarily that super users are only physicians, we had super users who are nurses. They received an advanced training on the system as a physician user. These were assigned completely to help physicians at the beginning of the implementation, if any physician has a problem, for example, he does not know how to order a specific medication or how to enter his notes, the super user is available and will come directly and help him… this helped the physicians greatly*" (Expert 12)	8
				Total comments on social influence	**86**
Perceived threat to physician autonomy (PTPA)		PTPA is important	16	"*The physician likes to be a black-box, no one knows what he is doing. Let's admit that they are the leaders in the hospital. Some physicians think that this system was put to monitor them or to spy on them or to measure their performance, how many patients he sees, how many hours he works. We need to assure them that the system was not put for this, it will enhance the patient journey, it is not here to monitor the practitioner or to measure his performance*" (Expert 5)	32
		Strong support and commitment by the senior management to reduce resistance due to PTPA	3	"*Sure, this may cause resistance if there is no strong commitment by the management, because sure this will affect the autonomy of the physician, mainly the physician. Because you now have put someone to monitor me, previously when I record a medication or make changes, no one monitors me, revising paper records is difficult. Now the system monitors all my actions and I lost the autonomy I had before. Here, if there is a lack of business commitment - senior management commitment - this could be a barrier to adoption*" (Expert 3) "*Yes, it is really important, because there will be KPIs on the productivity of physician, the number of patients he has seen, number of surgeries he has made. It is very critical; especially when it is a private organization sometimes the pay is based on the productivity. So, definitely physicians do worry, and this is one of the reasons for their resistance, because it will measure their productivity. I have seen this in the hospital, some physicians were resisting because of this. But this is not a very important factor if there is a strong leadership*" (Expert 1)	

		PTPA may increase or decrease based on PU and PEOU	5	“*The more the system is perceived as easy to use and useful, the more the physician will be inclined to it and will overcome the limitations… PTPA may increase or decrease based on the solution we select, we are supporting this feeling if we selected a system that is bad, not helping the physician, and at the same time counts his mistakes*” (Expert 6)	
		Others	8	“*[Monitoring and measuring performance] this is the right approach to measure facts. You need to make sure that the quality of care you’re providing is based on medicine best practice. You do not leave it to each physician to work as he wants, there are some guidelines that should be followed, and these guidelines once automated will help, rather than restrict, the physician to make sure that he is doing the right job*” (Expert 7)	
				Total comments perceived threat to physician autonomy	**32**
Confidentiality concerns		Usually a concern of the healthcare organization or the patient rather than the physician or other end users	7	“*In my opinion confidentiality concerns do not affect the physician’s decision, rather they affect the organization’s decision… confidentiality is more about rules and regulations… the physician will say I will apply your rules and regulations, if you have regulations I will apply them, if you do not have regulations, it is your problem not mine. So mostly there will be no effect on the physician*” (Expert 4) “*I have never seen in any implementation I experienced [24 years experience] that there were concerns related to confidentiality from the side of physicians*” (Expert 1) “Data confidentiality may be a concern of the patient not the physician or other end-users” (Expert 5)	12
		Trust	3	“*I don’t think so. Long time ago we were looking to the computer system that it is possible to be accessed by anyone and data can be seen by anyone. But now everyone knows that the confidentiality is reserved and protected on the computer and that every user has a username and password*” (Expert 11) “*I don’t remember that any of the physicians was rejecting the system because of confidentiality concerns...people underestimate things rather than overestimating*” (Expert 8)	
		The EHR increases confidentiality of data	1	“*No, this is not a barrier. The paper file is more vulnerable to confidentiality breaches. The person who brings the file to the physician can view it from the beginning to the end while he/she is in the elevator and no one knows about this. Whereas in the EHR, there are logs and privileges, who are you to access this file and what is your relationship with the patient, and you cannot change anything in the system’s log*” (Expert 2)	

		Others	1	“*The organization has to build a strong data governance structure… it could become a big issue if there is no proper access control and proper data governance in general*” (Expert 3)	
				Total comments on confidentiality concerns	**12**
Physician participation		Physician participation is important	9	“*Any EHR implementation in order to help in the adoption, physicians in general must be involved from the beginning*” (Expert 10) “*Extremely important, because this will affect the first factor which is perceived usefulness, and perceived ease of use, very important, definitely, the physicians or business owner participation in this issue is very important, and the work cannot be done without it*” (Expert 9)	47
		Psychological ownership	19	“*I emphasise this hundred times, implementing an EMR or an EHR is not an IT project. As soon as they consider it an IT project, it becomes a failure. It is an organisational project, a strategic project touching the organisation. So everybody involved, everybody has ownership in the implementation of this project. IT [department] is an enabling tool, an empowering tool, IT [department] provides the technology and everything but to get the business value out of it, it is the responsibility of both the IT [department] and stakeholders*” (Expert 7) “*In implementation as governance, the medical or clinical services - the area that manages physicians - they have to be the real owner of the system*” (Expert 3) “*when we come as an IT or informatics department and select the solution for them, the reaction from the practitioner and end-users will be kind of we did not select the system, no one consulted us, no body involved us*” (Expert 5) “*You as an IT [department], you have to be a back-end supporter and facilitator. The physician has to own the solution… Physician participation starts from the selection and continues until the implementation of the solution*” (Expert 3)	
		Workflow redesign	6	“*Subject matter experts are the people who are experienced in the business work of physicians if we are just talking about physicians…they are the people who will give information about their workflow, they are the ones that you set with them and design the current workflow and design the future workflow, the optimized workflow because they know the business very well, they know it much better than IT [personnel]*” (Expert 7)	

		Selection and customisation of the system	5	"*Even before selecting the system, the physicians must see the different alternatives and vendors. Physicians are the most difficult in accepting the system, and the most difficult in adopting the system, and the most difficult in the requirements. Every specialty needs different requirements than the others. So at the beginning of the project in our case, there were over 15 vendors in the market. The physicians and the other healthcare professionals were invited, and they filled out a survey on each system. Based on the survey results, we selected three vendors from which this current system was selected. So physician participation is very very important*" (Expert 12) "*Starting from the pre-selection, you need to have a team from the physicians. This team should work with the IT or informatics team even before purchasing the system… the champions in this team will greatly influence the other physicians… the more the physicians are involved in decision making, the more they will accept the system and perceive it as their own system*" (Expert 4)	
		Usability testing	1	"*And also in testing, to make sure that what I have done until this point is meeting the expectations of practitioners. It is very important that the end users are involved in the testing phase and to make sure that the system is meeting their expectations*" (Expert 5)	
		Continuous feedback	2	"*Feedback and timely response when we come to the go-live, or let us say, after roll-out. If we do not listen to physicians after roll-out, means we made the system live and the physicians have started to use the system and the decision has come from the management to use the system, we have to be around the physicians at this time. This phase is very dangerous because it is phase of gaining trust. Of course 100% any new system will have many issues, either technical or sometimes the design is not what they want. So we as an informatics team must be around them, taking the issues that we overlooked and enhance the system immediately. Because if the end user started to use the system and found that it is not as expected, this causes a kind of abandonment later. So we should be around after the go-live*" (Expert 3)	

		Others	5	“*Colleagues from the UK’s NHS, when they visited us in KSA, they said that one of the major reasons for failure is that vendors worked without involving stakeholders. So if you want to digitalize systems you should ask every single one about his opinion, what he thinks, doing surveys, otherwise you’ll have negative environment and you will lose the people definitely*” (Expert 8) *“This factor in my opinion is the most important factor. And it is almost completely absent in most healthcare organisations. Most organisations do not ask physicians about their opinions effectively, and most decisions are limited to managerial decisions, which are far different from reality. And this makes the system fail on the long term”* (Expert 4)	
				Total comments on physician participation	**47**
Attitude		Attitude is reflexive of the other factors	4	“*Attitude is reflexive of some of the factors we mentioned, it could also be reflexive of a failure story in another hospital*” (Expert 2) “*The people complaining about the system, when we investigated their complains we found that the complains have no reason. He is internally against the system and doesn’t want to learn. Many factors contributing there is no clear concept to describe this*” (Expert 8)	16
		Awareness programs to influences attitudes	8	“*Most physicians in the public sector lack the knowledge on EHR, and the nature of human beings anything they do not know it, they resist it. So this is very important because there is no awareness on the EHR system and its benefits and to make sure what’s in it for them as physicians*” (Expert 10) “*We created an awareness campaign several months before the implementation. Our team, the champions who were physicians, went to the departments and explained to people about the system and its benefits. They also distributed brochures and posters. We also made a paper-off day to release the project, and we made a presentation to explain about the project and its importance*” (Expert 12) “*For awareness you have to use multiple methods, intranet, mobile apps, SMS, social media, all methods available. And choose based on demographics, the junior physicians and nurses are more into social media, so use multiple methods for awareness, this is very effective and very important*” (Expert 3)	

		Managing expectations	4	"*Of course I will return to an important point when I look to any system implementation, the most important point is the communication. You should communicate with people in the right way, do not set the expectations high, and do not set the expectations low*" (Expert 3) "*Sometimes the expectations become very high, and if the expectations become very high, the acceptance of the system will decrease upon the delivery… Therefore you need to manage this part, you need to manage the expectations of people and keep them always involved in decision making*" (Expert 4) "*Sometimes the expectations are very high, this is due to the lack of understanding of what an EHR is all about, and how it will reflect on their day to day work. Sometimes most of the physicians, especially the senior generation, they think that once they have the system, the system will do everything, that it will give them the information they need without understanding that they need to enter the data and to continuously enter the information into the system in order to get knowledge from the system, such as registry, reports, population health management, etc. In order to get all the advanced health analytics to manage the healthcare of patients, you need to make sure in each step of the workflow that data is entered and is entered correctly by different stakeholders. This is one factor, very high expectation of the system and lack of understanding on what is needed from their side*" (Expert 7)	
				Total comments on attitude	**16**
Compatibility		Changes in the work process	11	"*With the system there might be a change in the process, a change in the form of documentation, and changes in the way of providing primary care. So it is important not to do two changes at the same time. The regulators sometimes use the technology as a way of changing work procedures, and this is an extreme risk… You need to change the process and the form of documentation, then introduce the technology*" (Expert 9) "*Now we start the issue of change with the change, when you implement a new system you are changing the technology, sometimes when you change the technology you have to change with it another change which is process, this is scary. You have to minimise the change in process, do not do multiple changes at the same time. If you do both changes people will be confused, this sometimes increases frustration. Once people are used to the technology you can refine the processes in a second frame, multiple changes normally lead to failure*" (Expert 3)	24

		Compatibility with the needs of different specialties and individual physicians	8	"*Before, they [EHR vendors] were trying to come up with a unified use, the same as what is happening with papers, with papers there is only one form of progress notes and is used by different people. Vendors or suppliers started to realise that I need to focus on what is written on the paper not the paper itself. So, before, they were developing it as one complex screen where you can capture massive data, and these systems were very difficult for physicians to adopt. But now vendors started to reduce the complexity by tailoring the solution or views to the specialty level and at the same time they provided the physician the ability to tailor it more to his/her own use. So this factor was very influential on the issue of adoption*" (Expert 10)	
		Compatibility with the needs and priorities of primary healthcare	5	"*Most systems implemented in primary healthcare enters in the KSA are not specialised in primary care, they are either an extension of the hospital's system or a polyclinic system, so the business values required for primary care are not supported by these systems… So the physician, if they brought him a system that is not compatible with his work process, the system does not encourage him because it does not help him in his work and does not support his decisions, for example, guides him to the steps, alerts him when there are errors, all of these make the physician excited and feel that the system is useful*" (Expert 6)	
				Total comments on compatibility	**24**
				Total comments on all factors	**533**

Appendix D Thematic analysis of primary healthcare physicians' interviews

The full list of codes, themes (factors) and sub-themes (dimensions of factors), as well as examples of coded extracts within each code, resulting from the analysis of primary healthcare physicians' interviews are provided on the following pages.

Themes (Factors)	Sub-themes (Dimensions)	Codes	Number of coded extracts	Examples of coded extracts	Total number of coded extracts
Perceived usefulness		Perceived usefulness is important	17	*"An automated or a semi-automated system is better than the situation now. In terms of documentation, ease of work, extracting indicators, and many other things. The primary healthcare centre that has a partial EHR system is better than the one that works completely with paper records"* (Physician 1) *"We have a system I can't say it is a full EHR but it is for monitoring the quality of chronic disease management programs in one of the health sectors in the province with around 30 primary healthcare centres. This system is completely successful despite the so many barriers and despite that the system is self-funded, it is not funded by any program or by the ministry, it is funded by the people working in chronic disease management. This provides evidence that if the user is convinced with the system, he will be motivated for it and he will adopt it even if he pays for it from his own pocket"* (Physician 6)	17
	Improved job performance	Providing better workflow support and supporting physicians' decisions	13	"*Useful means integrated, it has a decision support system, easy workflow, I have all the resources automated*" (Physician 1) "*With the paper system, I need someone to work with files, and I need the nurse to bring me the file and to go to the nursing station to take the vital signs and then to come back to me. With the electronic system, I do not need this anymore, the receptionist makes the registration and processes the request to the nurse station, the nurse station takes the vital signs, and all of this comes to me on the system directly, I take the physical exam and the history and then make the order electronically, to the lab or to the pharmacy*" (Physician 7) *"It will support me in clinical decision making, for example, I can see the status over a year of a diabetic patient, is he improving or not, it is very important that it helps me monitor the patient's health condition*" (Physician 10)	31
		Saving physicians' time	7	"*it saves your time, and easy for the patient, and in referral and feedback and so many things*" (Physician 8) "*it allows me to get the results of patients' investigations quickly*" (Physician 10) "*they became motivated to use the system [a system for chronic disease management implemented by a groups of physicians] because they realized that it saves their time and effort*" (Physician 6)	

		Improving documentation of encounters	11	"*Mainly the documentation, he [the physician] will see his own documentation every time he wants to see the patient. What happens now is that the patient comes sometimes without a file because the file is lost in another clinic. With an EHR, the documentation will be systematic, you will see your own records in the system whenever you encounter the patient*" (Physician 9) "*The previous system didn't succeed because it was not serving the goal, it was not supporting patient-centred care, this was very disappointing... there was no place to enter clinical notes in the system*" (Physician 8)	
	Quick and easy access to information	More data availability	9	"*The computer system provides quick access to data, it saves the physician's time in accessing the data without the need for another person [the nurse] to get these data*" (Physician 3) "*There has been a big difference with the system. The staff, whether the nurse or the physician, has become able to retrieve the files and results easily*" (Physician 5) "*Previously, with a paper-based record, I had to spend time searching for a specific data… and the file is sometimes large and not organised. But now, with the EHR, I can access lab reports with just one click, even the old reports are retrieved, this is a very excellent feature, I can browse them in one minute*" (Physician 7)	26
		Problems with paper based health records	8	"*Imagine when I receive a case with specific symptoms and I don't know what did this case have before, for one reason, the file is lost. This problem happens to me frequently once a day or once a week with the paper medical records*" (Physician 6) "*Sometimes you don't find the papers because people who made the classification of papers put them in the wrong place [within the record]*" (Physician 5)	
		Data visualization and analysis	8	"*Especially the system in another medical practice, you can visualise data such as trends… so you can make a follow-up easily, it was great*" (Physician 7) "*With the electronic system, I can compare the data easily without returning back to papers*" (Physician 5) "*One of the priorities in primary healthcare is chronic disease management. The system can provide me with graphs for the last year, how is the condition of the patient*" (Physician 10)	
		Others	1	"*In our system it is sometimes silly to order a medical report it will take a huge number of clicks to issue one medical report and this is not because the user, it is the system's problem*" (Physician 11)	

	Enhanced patient safety	Reduction of medical errors	10	“*The system should be clinically intelligent, means, when I enter the temperature or order a medication, the system should be intelligent enough to tell me if there is a contradiction with another medication the patient takes or with another health condition with the patient or with a laboratory investigation of the patient*” (Physician 6) *“For the safety of patients we need to make sure that there is no known allergy to medication or to food before the medication order is sent to the pharmacy. This was not available in the system we had, you may not be able to check for these types of allergies [manually] because of overload. This was one of the negative points”* (Physician 7) “*The usefulness of EHR is that it reduces medical errors*” (Physician 8)	10
	Improved quality of care for patients	Improved monitoring and follow-up	5	“*I can retrieve the KPIs and know how many patients are controlled in diabetes and how many are uncontrolled*” (Physician 10) “*It will improve the quality of care and follow-up for the patient*” (Physician 3) “*For me, it greatly helped me, greatly, in the follow-up with the patients… even the patient himself, when he sees that in a second I can get data on what medication he had before and what investigations he made, these things are very difficult to find in a paper record*” (Physician 7)	13
		Saving patient’s time	3	“*The system will improve quality of care for the patient. For example, I can know the time the patient arrived to the centre. This is one of the most important factors. I can know when did he come and how long he waited until he was seen by the physician. This is not happening with paper records. The patient comes and registers and may wait for one hour or for ten minutes, he doesn’t know when will the physician see him, it depends. The EHR system will enable me to improve my KPIs, that is, how long my patient waits, in order to improve the quality. I can know the waiting time in clinic A and compare it to clinic B*” (Physician 10)	
		Others	5	“*It reduces the time for you, and easy for the patient in the referral and feedback*” (Physician 8) “*The benefit in my opinion is that it helps providing comprehensive care and in high quality…This is the most important point in my opinion*” (Physician 10) “*The quality of care in the electronic system is much greater than in the paper system*” (Physician 2)	

	Improved communication between healthcare providers	Connection with departments in the same primary care centre	3	*“The system was not supporting patient centred-care, no, it was not fulfilling this goal… there were no links between the departments, means I cannot see the laboratory reports… We only still use the referral system, when the patient needs a referral this is still done through the system, but we do not use the system for the other parts of work”* (Physician 8)	12
		Connection with the regional lab, supervisory centres, and other primary care centres	2	“*We have the problem of fragmented services. Not all services are under one floor especially here in the KSA. For example, the investigations are performed in the regional lab. The regional lab is usually far. The heads of departments are in the sector management whereas the employees are in the primary care centres. The primary care centres are not connected with each other and it is difficult to reach each other unless there is an EHR system between healthcare providers*” (Physician 9)	
		Connection with the hospital	7	“*The system was not integrated with the hospital system, this is the first and biggest problem we suffer from… When I want to send the patient to the hospital, I make a paper referral, and I cannot know what happened to the patient in the hospital, I do not receive a feedback, as if I did nothing. The system in the primary healthcare centre should be integrated with the hospital in its region, there must be a link between the system I have and the system in the hospital*” (Physician 10)	
	Empowering patients	Functions to support patient’s education	6	“*One of the priorities is that the system should support patient’s education… In the primary healthcare centre, it is important to provide patient’s education, such as sending educational materials to the patient based on his/her case and allowing him/her to access his/her personal health record and to view these educational materials*” (Physician 10) “*In the system we had, there were things we need but were not supported by the system. For example, we need something for health education of the patients, this was not available in the system*” (Physician 7)	7
		Patient portal	1	“*The system does not have a portal for the patient so that the patient receives messages with his/her appointments, prescriptions, and reminders for continuous follow-up*” (Physician 10)	
		Others	3	“*If they see its usefulness, they will adopt it. However, its usefulness should be viewed from their perspective, not from the perspective of the manager or the IT engineer*” (Physician 6) “*The situation in Saudi Arabia is different than the USA. In the USA, the physician is the one who should pay for the system and is the one who should bring the IT and because of this they give them incentives. In Saudi Arabia, the government pays for the system, so this is a bonus for us, we do not have this problem [financial barriers]”* (Physician 12)	3

				"*May be because of this [lack of perceived usefulness], the providers do not want the system. They say that this system was not useful in any other organization so they brought it to us. It was not useful and friendly to use. That was a major barrier*" (Physician 8)	
				Total comments on perceived usefulness	**119**
Perceived ease of use		Perceived ease of use is important	13	"*From my experience, there was a set a factors that helped physicians to accept the EHR and a set of barriers to acceptance… one of the most important acceptance factors in my opinion is the ease of using the system against the difficulties*" (Physician 11) "*In my opinion, the first and the most important factor for a physician is the ease of use. This is the most influential factor on the usage of the system. The system must be user friendly*" (Physician 10) "*May be this is the reason that users no longer want to use the system, it was not user friendly, this was a major barrier*" (Physician 8)	13
	Time required for data entry	Minimizing data entry tasks	20	"*We discovered that it [the piloted system] was so much difficult, it was not applicable at all. Primary healthcare is a very busy service and the patients are drop-in, means there are no appointments, we do not know who will come next. This system was requiring 10-15 minutes in order to fill the forms out for each patient. If the physician has only 10-15 minutes to encounter the patient as a whole, he cannot spend this much time typing on the system, so it was so difficult…You have to click on so many things and you have to enter each and every piece of information… You have to be descriptive so much while you are writing for your patient, that was very difficult*" (Physician 9) "*In brief, the most important factor that affect the use is the time the physician needs in using the system. Physicians in primary healthcare are in race against time… even if the system is very useful and the physician is convinced in it and wants to use it, if he does not have the time to enter data, the system will fail*" (Physician 6)	28
		Tools for simplifying data entry	8	"*Time factor is very important, because in our culture, typing was not provided in our training. In the UK, Canada, and USA, people are trained on typing on computers from the first day in school so they are good in typing. This is weak in our culture. So this was a problem, but we solved it in fact by using Dictaphones, and this solved a large problem we faced. I know a group of physicians in another healthcare facility who suffer greatly from this problem*" (Physician 12)	

				"*I like the system, it is amazing but my use of it depends, if these tools were applied such as dictation instead of having to stay in the clinic typing*" (Physician 5) "*Instead of me sitting on the computer and just typing like a secretary while the patient is talking to me, no, when I went to the USA and trained there, I found that they use Dictaphones, I mean after the patient leaves the clinic and before another patient comes I use the Dictaphone to complete the history and the physical examination and the care management for the patient who left*" (Physician 8)	
	Physician-patient communication	System complexity affects physician-patient communication negatively	16	"*Yesterday I was sitting with my colleagues and one of them was complaining greatly about the EHR and that it is wasting his time and that he cannot spend the time very well with the patient, rather, he is spending most of the time facing the computer*" (Physician 4) "*Correct, and this is a disadvantage that sometimes you are busy with the system more than the patient. But again, if the system is user friendly this will not be an issue*" (Physician 12)	20
		Physician-patient communication should be enhanced with training	4	"*It is important to train physicians on how to deal with the EHR during patient's consultation. Otherwise they are computer-illiterate and it might be difficult for them to deal with the situation*" (Physician 3) "*I don't think that physician-patient communication will be affected if time the system takes was put into consideration and the physician was provided adequate training on the system, training and not orientation or introduction. And this training should include how to use the EHR during the consultation with the patient*" (Physician 6)	
	Initial workload increase	Providing extensive support and reducing number of patients in early stages of implementation	3	*"From our experience, when we started, people were working one hour or two hours overtime to finish their jobs…and there were lots of complaints. But we were supporting them all the time until all issues were resolved. Lately, after around 6 to 9 months, they leave before their duty time one hour earlier" (Physician 11)* *"The first time we introduced an EHR system we reduced the number of patients received for two weeks"* (Physician 12)	6
		Others	3	"*The time I was spending with each patient with the paper system was around 10 minutes. With the electronic system it became around 15 minutes*" (Physician 7) *"The negative thing is that physicians may feel, due to the crowdedness of patients in primary healthcare centres, that the EHR is time-wasting"* (Physician 3)	

	Ease of navigation	Ease of navigation is important	8	*"Some systems are complex and require one log-in in one place, then another log-in in another place, then a another log-in in a third place, taking around ten minutes to complete while the patient is in the clinic"* (Physician 12) *"I am completely convinced in using the electronic system, but if you bring me a system that has too many windows I will be disappointed and will abandon it"* (Physician 7)	11
		Difficult navigation was a barrier to adoption	3	*"The windows do not come together… it was not integrated efficiently"* (Physician 9) *"It was very difficult to navigate… there was no integration between the departments"* (Physician 8)	
	Time to master the system	Time to master the system is important	8	*"The second factor that is very important from my experience is the time required to learn the system, if the system requires much time to learn it, it will exhaust me, but if it takes a short time it will benefit me"* (Physician 6) *"At least you need six months to learn the system from A to Z"* (Physician 5) *"Time to master the system is very important especially for physicians… They do not have time to learn and explore the system… the more the system is easy to learn, the more the adoption"* (Physician 4)	10
		Time to master the system depends on the support provided	2	*"with the new system, it is a barrier to adoption that you need time to master the system… But we provided a half-day one-to-one training and then they started working on the system. We supported them with super users in the department, especially in the first two weeks, you can start working and if you need any assistance you can call the super user and he/she will come and assist you, we had nurses and physicians super users"* (Physician 12)	
				Total comments on perceived ease of use	**88**
Computer Self-Efficacy		Computer self-efficacy is important	18	*"The second critical adoption factor of EHR from my experience is user's literacy of information technology in general… I noticed from my experience in training physicians that it is difficult for people with low computer literacy… This is a major factor"* (Physician 11) *"I agree, we used to get support from our colleagues who have computer experience, I totally agree. People with experience in informatics and computer skills adopt the system faster and use it faster than the rest, means the tasks that we used to accomplish within half an hour, they accomplish them in 15 minutes. So yes computer experience has a large role in the adoption"* (Physician 7) *"Of course computer experience has a large role in the adoption"* (Physician 10)	18

	Training	Training is important	18	"*Definitely, training earlier before using the system will decrease their resistance because they have trained on it before the go-live, training will make it easy to make them accept the system*" (Physician 11) "*We did not get any training. It is true that we were worried from making mistakes, and indeed we had some mistakes in using the system as a result of our lack of knowledge. Therefore, I reassure that training should be provided. You cannot ask a physician to be perfect if you did not provide training to him/her*" (Physician 7)	25
		Training methods	2	"*I compared training methods and the one of the best methods was online training, it is comfortable for the physician. And once the physician completes the online training he gets one-to-one training*" (Physician 4) "*We provided a half-day one-to-one training*" (Physician 12)	
		Training was inefficient or no training was provided	5	"*The vendor came and their employee responsible for system maintenance conducted the training, it did not work for us… the training was a barrier, it was weak*" (Physician 8) "*We did not get any type of training, I trained myself on the system… at the beginning there should be an orientation session, users should know their role in the system very clearly… and people who make the orientation session should have a proper experience, otherwise they will give a negative impression about the system*" (Physician 10) "*The vendor should allocate experienced people to make the training. In our case, the vendor was not so efficient in training. The training took place within one week and then the whole team left us. So we trained ourselves… the system has many useful things, but no one trained us on them*" (Physician 5)	
	IT support	IT support is important	19	"*IT support is important to ensure the continuous use of the system*" (Physician 3) "*IT support is very important. It should be clear, announced and easy. IT support implemented within the system is also important*" (Physician 4) "*No doubt, the IT support is important especially at the beginning. We had full-time IT personnel working with us during the first two weeks, full-time*" (Physician 12)	27
		IT support by super users	5	"We *provided a half-day one-to-one training and then they started working on the system. We supported them with super users in the department, especially in the first two weeks, you can start working and if you need any assistance you can call the super user and he/she will come and assist you, we had nurses and physicians super users*" (Physician 12)	

				"The thing that can help us is the availability of someone with expertise, because my experience is different that someone who is still a beginner with the system, when we have an expert user he can help us more with the system" (Physician 5)	
		IT support was inefficient or no IT support was provided	3	*"We did not have any technical support… there must be a timely technical support so that if I have a problem or I do not know how to do something I can return to the technical support instead of facing the problem myself and asking colleagues and friends how do you do this and how to do that, this was what consumes time"* (Physician 10) *"The problem that we faced during the previous attempt [the pilot EHR project] is that there was no IT support for any problem facing the physician"* (Physician 9)	
				Total comments on computer self-efficacy	**70**
Social influence	Top management support	Top management support is important	34	*"The top management support is a crucial point. This is the most important thing. When the management is cooperating with us, I expect that three fourth of the problems will be resolved if not all problems. But if the top management is working away from the needs of the medical staff, then we cannot reach the result that we want*" (Physician 5) *"This might be the most important factor. If the system is not fully supported by the senior management, this will be the quick route to failure. If there is only a technical support, meaning, if the IT department will lead and do it, the system will just become like any infrastructure, or networking, or a new computer or a new printer. There should be high support from the top management. Because otherwise, there will be gaps and a big area for resistance"* (Physician 4) *"I went to the Internal Medicine Department, and it took us six months trying to convince them to use the CPOE before the EHR and they refused. It was a bad experience that we spent six months and we were unable to convince them. And during one month when the order came from the CEO, all physicians attended the training"* (Physician 11)	34
	Peers influence	Super users	4	*"The thing that can help us is the availability of someone with expertise, because my experience is different from someone who is still a beginner with the system, when we have an expert user he can help us more with the system"* (Physician 5) *"We provided a half-day one-to-one training and then they started working on the system. We supported them with super users in the department, especially in the first two weeks, you can start working and if you need any assistance you can call the super user and he/she will come and assist you, we had nurses and physicians super users"* (Physician 12)	18

		Champions	5	*"The first and the most important thing is the availability of a champion in the organisation, who will lead the EHR and will promote for it. This is very, very, important… If there are no champions, this will reduce physicians' motivation to use the system"* (Physician 11) "*The availability of a good leadership will help promote the use of the system*" (Physician 10)	
		Other peers	8	*"Peers influence is very important. When we have a physician refusing the system, he can influence others' attitudes toward the system. Therefore, once a physician is resisting the system, they should resolve the problem before it becomes larger and he starts affecting the rest. This is very important, peers' influence, very important"* (Physician 7) "*Many physicians resist the change, many physicians. They say that we are comfortable with the paper system and we do not want to work on the computer, and they start affecting the people around them*" (Physician 10)	
		Social networks with peers	1	"*Currently the social media plays a major role in that…Peers influence for two physicians in the same specialty, each one in a different country; means peers influence is influenced by the social media. If someone knows the functions in the system and how to do them in a better way so we will learn from him indirectly. Currently the social media plays a major role*" (Physician 4)	
	Perceptions of patients attitudes	Negative attitudes of patients and less satisfaction	5	*"The second thing is personal, we have principles in medicine, when you make a consultation with the patient, you have to an make eye-to-eye contact. However, when I work on the EHR, most of my time is spent facing the screen and working with the keyboard and mouse, more than the time I make an eye-to-eye contact with the patient and take verbal and non-verbal information. Sometimes patients were not happy with this relatively long time, he says the previous [paper-based] system is more comfortable and easier and faster"* (Physician 7) *"The patient requires an eye to eye contact. It is one disadvantage that the EHR prevents good communication with the patient. So I think some patients may be uncomfortable with the use of EHR "* (Physician 10)	12
		Positive overall attitudes of patients and more satisfaction	7	*"I think that patients will welcome the use of the system…the technology will help the patient, saves his time, reduces his waiting time… when the patient feels the benefits whether in his health or in his time, he will definitely welcome the use of the system"* (Physician 6) *"There has been a big difference with the system… and even the patient became more satisfied when he/she comes and finds that we have everything in the system"* (Physician 5)	

				"Patients were involved in our implementation, we gave them access to their health records. He/she can access the system and view his/her lab results and clinical notes, and view the things that he/she should perform for health maintenance or preventive care. We empowered patients and they were very happy in fact, they were welcoming the use of the system because we empowered them" (Physician 12)	
	Other medical staff's influence	Support from the other members of the healthcare team	6	*"One of the things that will facilitate the adoption is the support from the nurse, if the nurse working with the physician in the clinic is trained this will facilitate the adoption"* (Physician 4) *"I as a physician, when I work on the system, the other healthcare professionals should be motivated to work on the system. For example, when I access the profile of the patient, I need to find the registration completed and the nurse should have entered the vital signs and made the assessment, the appointment should be working properly so that my work becomes organized… the pharmacist should have entered the stock and updated it, all medications should be available on the system without delay. So it is important for me that the other workers are motivated to work on the system"* (Physician 10)	6
				Total comments on social influence	**70**
Perceived threat to physician autonomy (PTPA)		PTPA is important	8	"*I think that this is an important factor, but it should be studied and a plan should be put in place to assure people that this is not affecting your autonomy*" (Physician 1) *"They feel that this will breach their autonomy. The audit will be easier, and the access to information by the superiors will be easier. Sometimes in the current audit, they see us coming to their clinics and taking their records and reviewing the files, while on the other hand when it becomes electronic the physician cannot know that you are auditing his/her own file. So what I think is that it might affect their behaviour"* (Physician 9)	21
		Increasing positive attitudes to reduce PTPA	7	"*People who put the system should understand that the system was put to assist us and to help us improving our performance not to monitor us for any mistakes, otherwise physicians will abandon it. Physicians should know that the review of their performance is being done for educational purposes, not for monitoring purposes*" (Physician 5) "*Practitioners who use the information system should be aware that this is a positive thing not a negative thing, and they should take it positively not negatively. Form the positive side it will notify me if I entered the wrong medication. And we as supervisors, if we use the system in the wrong way, we will make the physician feels that it was put to disclose the autonomy*" (Physician 6)	

		Others	6	“*This factor actually is there but this is a co-founder factor. It depends on the organization’s quality level before and after, if they use good quality measures, this will make no difference. But if they apply the quality in the new system definitely it will threaten them and prevent them from using the system, and increase the resistance… so it depends on the organization’s policies and procedures*” (Physician 11) “*Possibly, this is a fact of course that the availability of data could simplify evaluating the performance*” (Physician 3) “*I don’t think it is an important factor, the system will improve the service it was not put to monitor performance*” (Physician 2)	
				Total comments on perceived threat to physician autonomy	**21**
Confidentiality concerns		Trust	8	“*I don’t think so. Before 10 years ago this factor may be important but now fears about confidentiality loss have decreased a lot with the penetration of mobile devices and most importantly with the use of Absher system [e-Government]. If the system is protected by secure access and everything, people now trust the technology*” (Physician 1) “*No, I don’t agree with this. Even the paper file, it is placed in a cabinet and can get into any hand, so it is like the electronic file. I mean this is not a big issue. And also when I started using the EHR I signed an obligation that I do not share my username and password with anyone. And no one can view the patients’ file or the data I typed*” (Physician 7) “*I don’t think so, they understand that these things will have limited access by the IT*” (Physician 9) “*This will never be a concern. In our experience this was not a concern at all, because the opposite is true. In fact the EHR helps more… the confidentiality of data is now better than before because previously it was possible that someone opens the file and reads it and there is no record for that. Now I have a record that you accessed that file, why did you access it*” (Physician 12) “*No I don’t think so, it’s not a factor, because even the paper file someone can take it also. No this is not one of the barriers*” (Physician 5) “*No, no it’s not true, it’s not a factor*” (Physician 6)	12
		A concern of the healthcare organization rather than the physician or other end users	2	“*This is an organization’s authoritative concern not a physician’s concern. Because when they were using paper charts before no body was concerned about the confidentiality and privacy because they know there are systems through the medical record department to ensure these issues. Physicians are concerned about the clinical things not the administrative things.*	

				My opinion will there be concerns over confidentiality? yes but it does not create resistance to using the system, and this is the difference" (Physician 11)	
		Others	2	"*I agree, and this is the thing that makes companies compete on making secure systems. Every country and every institution works toward making a secure system*" (Physician 8) "*I agree, possibly, but they can put high protection on the system… data breaches happen in all systems worldwide, medical or non-medical*" (Physician 2)	
				Total comments on confidentiality concerns	**12**
Physician participation		Physician participation is important	16	"*Physician participation is very important and this is one reason for our success. The team, composed of physicians and nurses, was involved from day 1. Even the rest who were not in the committee, they were being briefed about the system. Then when we implemented the system we received new feedback from some physicians and we resolved the issues and tried to help them with these issues. So physician participation is very important*" (Physician 12) "*Physician participation is important because they are the users of the system… I, as a primary healthcare physician, in order for me to work on the system, it should meet my requirements*" (Physician 10) "*Yes, very important factor, because the physician is the one who will use the system. I might be a professional ophthalmologist, so I will select features important for me but not for the other specializations. The primary healthcare physician should be involved from the beginning because he is the one who knows the requirements in primary healthcare. By involving primary healthcare physicians from the beginning you will make the change easy for us instead of making it difficult*" (Physician 5)	36
		IT-led projects	6	*"Because I am the leader of the clinic, I am able to organise the processes in my clinic and make them for the best of the patient and the care management of the patient, by doing this the issues will be resolved. It is not workable that someone comes from the outside and arranges the processes for me, it's me who should tell them that I need this and this in the system"* (Physician 5) "*I think that the most frequent problem here in Saudi Arabia regarding the success of these projects is the involvement of the end users, especially the physicians. If they were involved during the implementation, this will have a large role in adoption.*	

				Especially that IT-led projects become as something enforced by the IT department, and this will make resistance" (Physician 4) *"IT engineers and most managers, and most physicians as well, think that the EHR is just a computerisation of papers, means the information instead of being on papers, it becomes on a screen, and this belief is very very very wrong, it is very risky and very dangerous… the physician should participate in everything requires him/her to use the system starting from seeing the patient to the follow-up procedures and to the monitoring of cases* (Physician 6)	
		Selection and customization of the system	5	"*The EHR requires a big change management. You should engage everybody. If the physician participated in the selection and implementation from the beginning, you will buy him easily in this issue*" (Physician 1) "*It should start from the beginning, involving physicians in selecting the system, what kind of systems do they want, what kind of features, and enable them building the system or at least customizing the system according to their needs. If they are involved early, they will later on accept the system because they are part of it*" (Physician 11)	
		Usability testing	2	"*One of the reasons of our success is that, at the beginning, we piloted the system on four or five physicians. We considered variation between physicians in our selection. We included an old physician and a young physician, and a physician with a good computer literacy and a physician who is computer illiterate. We resolved the obstacles they mentioned, and we noticed that each one of them has specific issues. So the pilot test that we made helped us in identifying possible problems, and we provided a solution for each one. Then when we implemented the system at the department, we did not face large problems or issues, all problems have been resolved with the pilot test*" (Physician 12)	
		Continuous feedback	7	*"Periodic feedback form the user is important. If there are issues in the system, and the system was not improved, and the physician must work on it, this will be frustrating"* (Physician 8) "*An important point I want to add is that there should be a regular update of the system… the system will not be 100% applicable from the beginning… they should get the feedback form us regularly and update the system based on our feedback*" (Physician 10)	
				Total comments on physician participation	**36**
Attitude		Attitude is important	11	"*At the beginning, the physicians were resisting the system… But now, it has been a year since we started the system, the physicians their attitudes toward the system have become very positive because they realized how helpful it is*" (Physician 11)	19

				"It is important to target the motivation at the beginning... There are some people who do not like the change, they are resistant to change... from their perspective, the system is wasting my time and I will not learn anything from it and they do not have motivation for training" (Physician 10)	
		Awareness programs to influences attitudes	8	"*At the beginning, there should be orientation sessions for all people about the system… People must understand the importance of the system. They must know their role in the system very clear. They should target the motivation at the beginning*" (Physician 10) *"During the training phase the primary focus should be on understanding the importance of the system"* (Physician 2)	
				Total comments on attitude	**19**
Compatibility		Compatibility with the work process	4	*"The more the system is compatible with the existing workflow of the physician, the more the system will be easy to adopt. You write the paper record in this way, and this is your workflow, so we will make the system compatible with your experience. But there are some processes that should be improved. The implementation of the EHR will correct problems in the process that were hidden or not apparent, so it is a chance for improvement. But generally, if the electronic system feels almost the same, it will be more comfortable for the physician"* (Physician 4)	27
		Compatibility with individual physician's work routines	3	*"The system should allow me to put my own options. For example, frequently used lab, I need to put this option on the main screen instead of having to access the lab and choose… I need to be able to make some customization to accommodate what I want from the system. Also, frequently used medication, for example if I have a list of medications I am authorised to order and I frequently use it"* (Physician 10)	
		Compatibility with the needs of primary healthcare	20	*"It is important whether the system was designed for primary healthcare or for a hospital. Many implemented systems, in most situations, were systems designed for a hospital not for primary healthcare centres…the system we had does not provide personal health records. It does not provide clinical decision support features that are designed for primary healthcare, for example reminders that this patient needs screening, or this patient based on her age needs mammogram. The family profile should be supported by the system, but it was not… The system does not support continuity of care"* (Physician 10) *"Because we [primary healthcare physicians] are a part of preventive care, we should have a plan for treatment, prevention, and referral, in general. For prevention, we have a program called periodic check, so if we have something electronic to*	

				support this program so that it provides us with hits and alerts, such as this patient is due for a specific investigation. We need this type of electronic systems… the system that was implemented was not serving our needs" (Physician 8) "*In the system we had, there were things we need but were not supported by the system. For example, we need something for health education of the patients, this was not available in the system*" (Physician 7)	
				Total comments on compatibility	**27**
				Total comments on all factors	**462**

Appendix E Survey instrument

عزيزي طبيب الرعاية الصحية الأولية
السلام عليكم ورحمة الله وبركاته

تهدف هذه الدراسة إلى تقييم العوامل المؤثرة على اعتماد السجل الصحي الإلكتروني من قبل أطباء الرعاية الصحية الأولية في المملكة العربية السعودية. تشمل الدراسة جميع الأطباء العاملين في مراكز وأقسام الرعاية الصحية الأولية مثل: طبيب الأسرة والمجتمع، الطبيب العام، طبيب الأطفال العام، طبيب الباطنية العام، طبيب أمراض النساء والولادة العام، وغيرهم من الأطباء.

سواءاً سبق لك تجربة السجل الصحي الإلكتروني أم لم يسبق لك تجربته، فإن مشاركتك في هذه الدراسة سوف يكون لها دور كبير في تحديد متطلبات تنفيذ هذه الأنظمة في مراكز وأقسام الرعاية الصحية الأولية من وجهة نظر طبيب الرعاية الصحية الأولية.

نظام السجل الصحي الإلكتروني هو عبارة عن نظام يسمح بتخزين السجلات الصحية للمرضى على أجهزة الكمبيوتر بدلا من الورق، ويحتوي السجل الصحي الإلكتروني على البيانات الصحية للمريض مثل: التاريخ المرضي، الفحص السريري، القرارات المتخذة، الحساسية ضد الأدوية، الأدوية الموصوفة، التطعيمات واللقاحات، نتائج الفحوصات المخبرية، صور الأشعة الطبية للمريض، والإحالات الطبية.

يربط نظام السجل الصحي الإلكتروني مختلف الإدارات داخل مركز الرعاية الصحية الأولية أو المستشفى بما في ذلك: الأشعة والمختبرات والصيدلية والعيادات الطبية، وتسمح أنظمة السجل الصحي الإلكتروني بنقل ومشاركة معلومات المرضى بين مراكز الرعاية الصحية الأولية نفسها، المختبرات المركزية أو الإقليمية، والمستشفيات. كما يشمل نظام السجل الصحي الإلكتروني أنظمة فرعية لدعم قرارات الأطباء والتقليل من الأخطاء الطبية من أجل زيادة سلامة المرضى مثل: نظام دعم القرار السريري، نظام إدخال الوصفات الطبية الإلكترونية، والتنبيهات الطبية والتذكير. وتشمل أنظمة السجل الصحي الإلكتروني أيضا على بوابات الكترونية خاصة بالمرضى، والتي تسمح للمريض بالوصول إلى أجزاء معينة من سجله الصحي مثل عرض نتائج الفحوصات المخبرية والأشعة والحصول على المواد التعليمية التي تساعد في تحسين صحة الفرد.

نظام السجل الصحي الإلكتروني في مراكز الرعاية الصحية الأولية هو حاليا تحت الدراسة والتنفيذ من قبل وزارة الصحة ضمن إطار الاستراتيجية الوطنية للصحة الإلكترونية، يرجى الضغط على الرابط التالي للحصول على مزيد من المعلومات: http://www.moh.gov.sa/en/Ministry/nehs/Pages/The-New-PHC-Systems.aspx

وللحصول على مزيد من المعلومات حول أهمية السجل الصحي الإلكتروني للطبيب، يرجى الضغط على الرابط التالي: http://www.moh.gov.sa/en/Ministry/nehs/Pages/Benefits-to-Providers.aspx

مشاركتك في هذه الدراسة سوف تساهم في نجاح تنفيذ نظام الصحة الإلكترونية في المملكة العربية السعودية، كما ستساهم في تطوير ونشر الأبحاث المتعلقة بتنفيذ هذه الأنظمة.

مشاركتك في هذا المشروع البحثي هي اختيارية، نود التأكيد بأن جميع الإجابات ستكون سرية. هذا البحث تحت إشراف كلية الالكترونيات وعلوم الحاسب، جامعة ساوثهامبتون، المملكة المتحدة (تصريح لجنة الأخلاقيات رقم: ERGO/FPSE/30517).

لمزيد من التفاصيل، يرجى الاتصال إما بي أو بالمشرفين على رسالتي الدكتوراه الدكتور غاري ويلز والبروفيسور مايك والد والدكتور ريتشارد كراودر.

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☐ **قبل بدء الاستبيان، يرجى وضع علامة في هذا المربع للإشارة إلى أنك قرأت المعلومات أعلاه وأنك موافق على المشاركة في هذا الاستبيان**

Dear primary healthcare physician,
Assalamu alaikom,

This study aims to evaluate the factors influencing the adoption of Electronic Health Record (EHR) by primary healthcare physicians in the Kingdom of Saudi Arabia (KSA). This study includes all physicians working in primary healthcare centers such as family physicians, general physicians, general pediatricians, general internists, general gynaecologists/obstetricians and other physicians working in primary healthcare centres.

Whether you have used an EHR system or not, your participation will have a significant role in determining the implementation requirements of these systems in primary healthcare centers from the viewpoint of primary healthcare physicians.

An EHR system is a tool that allows storing health records of patients on computers instead of papers. The EHR contains the health information of the patient such as: medical history, clinical diagnosis, clinical decisions, allergies, prescribed drugs, immunizations, results from laboratory exams and medical imaging, and referrals.

The EHR connects the various departments within the primary healthcare center including: radiology, laboratory, pharmacy, and medical clinics. Also, EHR systems allow for the sharing of patients' information between primary healthcare centers themselves, central or regional labs, and hospitals. The EHR includes various subsystems to support physicians' decisions, reduce medication errors, and increase patients' safety such as: clinical decision support system and computerized physician order entry system. EHR systems also include patient portals that allow patients to access and view the results of their laboratory and radiology examinations and to get educational materials to improve their health.

The EHR system is currently promoted by the Ministry of Health under the National e-Health Strategy, please refer to the following link to get more information: http://www.moh.gov.sa/en/Ministry/nehs/Pages/The-New-PHC-Systems.aspx.

To get more information about the benefits of the EHR system to physicians, please refer to the following link at the Ministry of Health's portal: http://www.moh.gov.sa/en/Ministry/nehs/Pages/Benefits-to-Providers.aspx

Your participation will help direct the future directions of EHR implementation in the Kingdom of Saudi Arabia, and will inform research/publications that may be of assistance to other providers and researchers.

Your participation in this research project is voluntary. All responses remain confidential. This research is under the direction of the School of Electronics and Computer Science, University of Southampton, UK (Ethics number: ERGO/FPSE/30517)

For further details, please contact either myself or my study supervisors Dr Gary Wills, Prof Mike Wald and Dr Richard Crowder.
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Dr Richard Crowder: rmc@ecs.soton.ac.uk

☐ **Before you start the survey, please tick this box to indicate that you have read the above information and consent to taking part in this survey**

Part one: Socio-demographic information الجزء الأول: المعلومات الاجتماعية الديموغرافية

Please, complete the following socio-demographic information. We would like to remind you that this questionnaire is entirely confidential.

الرجاء إكمال المعلومات الاجتماعية - الديموغرافية أدناه. نود تذكيركم بأن هذا الاستبيان سري تماما

1. Please specify your area of medical specialty الرجاء تحديد مجال التخصص الطبي

- ○ Family Physician طبيب الأسرة
- ○ General Practitioner (or general physician) طبيب عام
- ○ General Paediatrician طبيب أطفال عام
- ○ General internist طبيب باطنية عام
- ○ General gynaecologist/obstetrician طبيب نساء وولادة عام
- ○ Others, please specify your medical specialty in the box below أخرى، الرجاء ذكر التخصص الطبي في المربع أدناه

2. How long have you been practicing medicine after internship? كم من عدد سنوات ممارستك للطب بعد سنة الامتياز؟

- ○ Less than 1 year أقل من عام واحد
- ○ 1-5 years من عام الى ٥ أعوام
- ○ 6-10 years من ٦ الى ١٠ أعوام
- ○ 11-15 years من ١١ الى ١٥ عام
- ○ 16-20 years من ١٦ الى ٢٠ عام
- ○ More than 20 years أكثر من ٢٠ عام

3. What is your average daily use of computer/Internet whether at work, home, or personal use?

ما هو معدل استخدامك اليومي للكمبيوتر أو الإنترنت، سواءا في العمل او المنزل أوالإستخدام الخاص؟

- ○ Less than 30 minutes أقل من ٣٠ دقيقة
- ○ 30-60 minutes من ٣٠ إلى ٦٠ دقيقة
- ○ 1-2 hours من ساعة إلى ساعتين
- ○ 2-5 hours من ساعتين إلى ٥ ساعات
- ○ Over 5 hours أكثر من ٥ ساعات

4. Have you ever used or currently using EHR, whether fully, partially, or as a trial?

هل استخدمت مسبقا أو تستخدم حاليا السجل الصحي الإلكتروني، سواءا استخداماً كلياً أو جزئياً أو تجريبياً؟

- ○ Yes نعم
- ○ No (Please go directly to question 7 below) لا (الرجاء الذهاب مباشرة إلى السؤال ٧ أدناه)

5. Which functions of the EHR have you used? أي من العمليات التالية في السجل الصحي الإلكتروني قد استخدمتها

- ☐ Viewing laboratory results/ radiology images عرض نتائج المختبر/ صور الأشعة
- ☐ Making orders (laboratory, radiology) إرسال الأوامر الى المختبر أو قسم الأشعة
- ☐ Electronic prescribing ارسال الوصفات الإلكترونية الى الصيدلية
- ☐ Medication alerts and reminders التنبيهات الطبية والتذكير
- ☐ Clinical notes الملاحظات السريرية
- ☐ Generating reports إنشاء التقارير

6. How many years of experience do you have with EHR? كم عدد سنوات الخبرة لديك في السجل الصحي الإلكتروني

- ○ Less than 1 year أقل من عام
- ○ 1-5 years من عام الى ٥ أعوام
- ○ 6-10 years من ٦ الى ١٠ أعوام
- ○ 11-15 years من ١١ الى ١٥ عام
- ○ 16-20 years من ١٦ الى ٢٠ عام
- ○ More than 20 years أكثر من ٢٠ عام

7. Healthcare authority الرجاء اختيار المؤسسة الصحية التي تنتمي إليها

- ○ Ministry of Health وزارة الصحة
- ○ Military hospital (e.g. NGHA, Security Forces...etc.) مستشفى عسكري (مثلا: مستشفى الحرس الوطني، مستشفى القوات المسلحة، المستشفى العسكري، وغيرها)
- ○ University hospital (e.g. KKUH) مستشفى جامعي (مثلا: مستشفى الملك خالد الجامعي)
- ○ Private sector القطاع الخاص
- ○ Others أخرى

8. EHR status at the place where you work الوضع الحالي للسجل الصحي الإلكتروني في المركز الذي تعمل به

- The EHR system is currently implemented السجل الصحي الإلكتروني منفذ حاليا في مقر عملي
- The EHR system has been piloted but discontinued السجل الصحي الالكتروني تمت تجربته في مقر عملي ولكن تم ايقاف التنفيذ لاحقا
- No previous implementation or piloting of an EHR system لم يسبق تنفيذ او تجربة السجل الصحي الالكتروني في مقر عملي
- The EHR system is not currently implemented and I don't know whether it had been implemented or piloted in my medical practice or not السجل الصحي الإلكتروني غير منفذ حاليا في مقر عملي ولاأعلم إن كان تم تنفيذه أو تجربته مسبقا أو لا

9. In which settings do you usually work? أي من الفئات التالية يمثل المنطقة التي تعمل بها؟

- Urban مدينة
- Semi-Urban شبه مدينة
- Rural قرية

10. Please specify your gender الرجاء تحديد الجنس

- Male ذكر
- Female أنثى

11. Please specify your age group الرجاء اختيار الفئة العمرية من القائمة أدناه

- Less than 30 أقل من ٣٠
- 30-39 من ٣٠-٣٩
- 40-49 من ٤٠ الى ٤٩
- 50-59 من ٥٠ الى ٥٩
- 60 or more ٦٠ أو أكثر

Part two: Perceptions about EHR use in clinical decision making

الجزء الثاني: العوامل المؤثرة على استخدام السجل الصحي الإلكتروني في القرارات الإكلينيكية

Please, indicate to what extent do you agree or disagree with each of the following statements by checking the appropriate answer in the proposed scale:

الرجاء الإشارة إلى أي مدى توافق أو لا توافق على كل عبارة من العبارات التالية عن طريق اختيار الإجابة المناسبة في الجدول المقترح:

First: Perceived Usefulness أولاً: الفائدة المدركة

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. I think that using the EHR will improve my job performance (e.g. by supporting my clinical decisions, improving my documentation of patients' encounters) اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يطور من أدائي في العمل (مثلا: يدعمني في اتخاذ القرار، يطور من طريقة توثيقي لزيارة المريض).	○	○	○	○	○
2. I think that using the EHR will allow me to have an easy access to patients' data اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يساعدني في الوصول إلى بيانات المرضى بسهولة	○	○	○	○	○
3. I think that using the EHR will help me to retrieve the information that I need quickly اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يساعدني في البحث والعثور على البيانات التي أحتاجها بشكل سريع	○	○	○	○	○
4. I think that using the EHR will improve the quality of care اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يحسن من جودة الرعاية الصحية	○	○	○	○	○
5. I think that using the EHR will facilitate communication and data sharing between various healthcare providers (e.g. between primary care centres and hospitals) اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يسهل التواصل وتبادل البيانات بين مقدمي الرعاية الصحية (مثلا: بين مركز الرعاية الصحية والمستشفى).	○	○	○	○	○
6. I think that using the EHR will reduce the risk of errors اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يقلل من فرص حدوث الأخطاء الطبية	○	○	○	○	○
7. I think that using the EHR will help empower my patients to actively take part in their own health (e.g. by allowing them an access to their lab results online, or providing them educational resources) اعتقد بأن استخدام السجل الصحي الإلكتروني سوف يساعد في تمكين مرضاي من رعاية صحتهم (مثلا عن طريق السماح للمريض بالاطلاع على نتائج الفحوصات المخبرية عبر الإنترنت، او تزويد المرضى بمواد تثقيفية تخص صحتهم).	○	○	○	○	○
8. I think that EHR would help reducing my patient's waiting time for consultation أعتقد بأن السجل الصحي الإلكتروني سوف يساعد في تقليل وقت الانتظار لمرضاي من أجل الحصول على المشورة الطبية	○	○	○	○	○

Second: Perceived Ease of Use ثانياً: سهولة الاستخدام

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. I think that learning to use the EHR will be easy for me أعتقد بأن تعلم استخدام السجل الصحي الإلكتروني سيكون سهل بالنسبة لي					
2. I think that interaction with EHR will be clear and understandable for me أعتقد بأن التفاعل مع نظام السجل الصحي الإلكتروني سيكون واضح ومفهوم بالنسبة لي					
3. I believe navigation of EHRs would be easy for me أعتقد بأن تصفح نظام السجل الصحي الإلكتروني سيكون سهل بالنسبة لي					
4. I think that using the EHR during my consultations with patients will be simple and easy for me أعتقد بأن استخدام السجل الصحي الإلكتروني أثناء المشورة الطبية مع مرضاي داخل العيادة سيكون بسيط وسهل بالنسبة لي					
5. I think that learning to use the EHR will require much time أعتقد بأن تعلم استخدام السجل الصحي الإلكتروني سوف يتطلب مني الكثير من الوقت					
6. I think that using the EHR will require much time for data entry from me أعتقد بأن استخدام السجل الصحي الإلكتروني سوف يتطلب مني وقت طويل جدا في الكتابة					
7. I think using the EHR will add much extra workload أعتقد بأن استخدام السجل الصحي الإلكتروني سوف يزيد من أعباء العمل كثيرا					
8. Overall, EHR will be easy for me to use بشكل عام، أعتقد بأن نظام السجل الصحي الإلكتروني سيكون سهل الاستخدام بالنسبة لي					

Third: Self-efficacy in using the computer for the EHR ثالثاً: القدرة على استخدام الكمبيوتر في السجلات الصحية الإلكترونية

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. I feel confident I could use the EHR in my clinical activities if someone showed me how to use it first أثق أنني أستطيع أن أستخدم السجل الصحي الإلكتروني في مهامي الإكلينيكية إذا شرح أحدهم لي كيفية الاستخدام أولاً					
2. I feel confident I could use the EHR in my clinical activities if someone else had helped me get started أثق أنني أستطيع أن أستخدم السجل الصحي الإلكتروني في مهامي الإكلينيكية إذا قام أحدهم بمساعدتي في بدء الاستخدام					
3. I feel confident I could use the EHR in my clinical activities if I had seen someone else using it before trying it myself أثق أنني أستطيع أن أستخدم السجل الصحي الإلكتروني في مهامي الإكلينيكية اذا رأيت أحدهم يستخدمه قبل أن أجربه بنفسي					
4. I feel confident I could use the EHR in my clinical activities if I could call someone for help if I got stuck أثق أنني أستطيع أن أستخدم السجل الصحي الإلكتروني في مهامي الإكلينيكية إذا كان ممكناً أن أستدعي أحدهم للمساعدة عندما أحتاج ذلك					
5. I feel confident I could use the EHR in my clinical activities if there is no one around to tell me what to do as I go أثق أنني أستطيع أن أستخدم السجل الصحي الإلكتروني في مهامي الاكلينيكية اذا لم يكن هناك أحد حولي يساعدني في الاستخدام					
6. I feel confident I could use the EHR in my clinical activities if I have just the built-in help facility for assistance أثق أنني أستطيع أن أستخدم السجل الصحي الإلكتروني في مهامي الإكلينيكية إذا كان هناك فقط أيقونة مساعدة مبنية في النظام للدعم والمساندة					

Fourth: Social environment at work رابعاً: البيئة الاجتماعية في العمل

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. The senior management expects me to use the EHR when it becomes available in my practice الإدارة العليا تتوقع مني استخدام السجل الصحي الإلكتروني عندما يصبح متوفرا في مقر عملي	○	○	○	○	○
2. I expect that the senior management will be helpful in the use of EHR when it becomes available in my practice أتوقع بأن الإدارة العليا سوف تكون داعمة لاستخدام السجل الصحي الإلكتروني عندما يصبح متوفرا في مقر عملي	○	○	○	○	○
3. I think that the consultants in my medical area would recommend that I use EHR أعتقد بأن الاستشاريون في مجالي الطبي سوف ينصحون باستخدامي للسجل الصحي الإلكتروني	○	○	○	○	○
4. I think that my doctor colleagues would recommend that I use the EHR in my practice أعتقد بأن زملائي الأطباء سوف ينصحون باستخدامي للسجل الصحي الإلكتروني في عملي	○	○	○	○	○
5. I think that the other healthcare professionals (nurses, pharmacists) would support that I use the EHR أعتقد بأن ممارسي الرعاية الصحية الأخرين (مثل الممرضين والصيادلة) سوف يؤيدون استخدامي للسجل الصحي الإلكتروني	○	○	○	○	○
6. I think that my patients would become more satisfied when I use the EHR أعتقد بأن استخدامي للسجل الصحي الإلكتروني سوف يزيد من مستوى الرضا عند مرضاي	○	○	○	○	○

Fifth: Compatibility with the work needs and processes خامساً: توافق السجل الصحي الإلكتروني مع احتياجات وسير العمل

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. Compatibility of the EHR with the priorities of primary healthcare will increase my acceptance and use of the system توافق السجل الصحي الالكتروني مع أولويات الرعاية الصحية الأولية سوف يزيد من تقبلي واستخدامي للنظام	○	○	○	○	○
2. Compatibility of the EHR with the needs and requirements of my medical profession will increase my acceptance and use of the system توافق السجل الصحي الإلكتروني مع احتياجات ومتطلبات عملي الطبي سوف يزيد من تقبلي واستخدامي للنظام	○	○	○	○	○
3. Compatibility of the EHR with work process in my medical practice will increase my acceptance and use of the system توافق السجل الصحي الإلكتروني مع سير العمل في المركز الصحي أو القسم الذي أعمل به سوف يزيد من تقبلي واستخدامي للنظام	○	○	○	○	○
4. Compatibility of the EHR with the way I like to work will increase my acceptance and use of the system توافق السجل الصحي الإلكتروني مع الطريقة التي أفضل العمل بها سوف يزيد من تقبلي واستخدامي للنظام	○	○	○	○	○

Sixth: Physician participation in selecting and implementing the EHR سادساً: مشاركة الطبيب في اختيار وتنفيذ نظام السجل الصحي الإلكتروني

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. My (or a representative group of primary healthcare physicians) involvement in EHR selection and implementation will be effective مشاركتي (أو مجموعة ممثلة لأطباء الرعاية الصحية الأولية) في اختيار وتنفيذ نظام السجل الصحي الإلكتروني سوف يكون لها دور فعال في نجاح تنفيذ هذه الأنظمة	○	○	○	○	○
2. My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase is a must من الضرورة مشاركتي (أو مجموعة ممثلة لأطباء الرعاية الصحية الأولية) في اختيار وتنفيذ نظام السجل الصحي الإلكتروني	○	○	○	○	○
3. My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will make the system more useful for me مشاركتي (أو مجموعة ممثلة لأطباء الرعاية الصحية الأولية) في مرحلة تنفيذ السجل الصحي الإلكتروني سوف تجعل النظام أكثر فائدة بالنسبة لي	○	○	○	○	○
4. My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will make the system easier for me to use مشاركتي (أو مجموعة ممثلة لأطباء الرعاية الصحية الأولية) في مرحلة تنفيذ السجل الصحي الإلكتروني سوف تجعل النظام أكثر سهولة بالنسبة لي	○	○	○	○	○
5. My (or a representative group of primary healthcare physicians) involvement during EHR implementation phase will positively affect my attitude toward EHR مشاركتي (أو مجموعة ممثلة لأطباء الرعاية الصحية الأولية) في مرحلة تنفيذ السجل الصحي الإلكتروني سوف تؤثر في رأيي تجاه النظام بشكل ايجابي	○	○	○	○	○

Seventh: Physician autonomy سابعاً: استقلالية الطبيب

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. I think that using EHR may increase the ability of the higher authority to control and monitor my clinical practices and decision making أعتقد بأن استخدام السجل الصحي الإلكتروني قد يزيد من قدرة الإدارة العليا على السيطرة ومراقبة ممارساتي وقراراتي السريرية	○	○	○	○	○
2. I think that using EHR may result in legal or ethical problems for me أعتقد بأن استخدام السجل الصحي الإلكتروني قد ينتج عنه مشاكل قانونية أو أخلاقية بالنسبة لي	○	○	○	○	○
3. I think that using EHR may limit my autonomy in making clinical decisions or judgements أعتقد بأن استخدام السجل الصحي الإلكتروني قد يحد من استقلاليتي في اتخاذ القرارات والاحكام السريرية	○	○	○	○	○
4. I think that using EHR may threaten my personal and professional privacy أعتقد بأن استخدام السجل الصحي الإلكتروني قد يهدد خصوصيتي الشخصية والمهنية	○	○	○	○	○

5. Overall, I think that using EHR may negatively affect my professional autonomy بشكل عام، أعتقد بأن السجل الصحي الإلكتروني قد يؤثر على استقلاليتي المهنية بشكل سلبي					

Eighth: Attitude toward EHR ثامناً: الموقف الشخصي تجاه السجل الصحي الإلكتروني

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. The EHR is an appropriate tool for physicians to use السجل الصحي الإلكتروني هو أداه مناسبة للأطباء					
2. I like the idea of using EHR تعجبني فكرة استخدام السجل الصحي الإلكتروني					
3. I think using the EHR will be advantageous for managing the medical care for my patients أعتقد بأن استخدام السجل الصحي الإلكتروني سوف يكون مفيد لإدارة الرعاية الصحية لمرضاي					
4. Overall, my attitude about EHR usage is positive بشكل عام، رأيي في استخدام السجل الصحي الإلكتروني إيجابي					

Finally: Intention to use the EHR أخيراً: النية في استخدام السجل الصحي الإلكتروني

	Totally disagree لا أوافق مطلقا	Disagree لا أوافق	Neutral محايد	Agree أوافق	Totally agree أوافق تماما
1. When available in my medical practice, I intend to use the EHR for all my clinical activities أنوي استخدام السجل الصحي الإلكتروني في جميع ممارساتي الطبية عندما يصبح متاحا في المركز الصحي أو القسم الذي أعمل به					
2. The chances that I use the EHR in all my clinical activities when available in my medical practice are very high فرص استخدامي للسجل الصحي الإلكتروني في جميع ممارساتي الطبية عندما يصبح متاحا في المركز الصحي أو القسم الذي أعمل به كبيره جدا					
3. I predict to use the EHR in my clinical activities when it becomes available in my medical practice أتوقع أن استخدم السجل الصحي الإلكتروني في ممارساتي الطبية عندما يصبح متاحا في المركز الصحي أو القسم الذي أعمل به					

Your comments are welcome: نرحب بتعليقك وملاحظاتك

e.g. important factors from your viewpoint

شكراً على تعاونكم القيّم

Thank you for your valued collaboration!

Appendix F Descriptive statistics for the field survey data

	Mean	Std. Deviation	Skewness	Kurtosis
Specialty	1.83	1.253	2.416	5.567
Years in practice	3.23	1.319	0.582	-0.379
Average daily computer use	3.75	0.98	-0.736	0.425
EHR experience	1.61	0.488	-0.465	-1.799
EHR status	2.71	0.632	-1.975	2.416
Work settings	1.46	0.77	1.264	-0.116
Gender	1.43	0.497	0.271	-1.943
Age	2.26	0.808	0.696	0.655
PU1	4.59	0.607	-1.413	2.013
PU2	4.79	0.446	-1.999	3.249
PU3	4.75	0.511	-1.999	3.185
PU4	4.63	0.66	-1.788	2.784
PU5	4.77	0.471	-1.858	2.661
PU6	4.32	0.878	-1.273	1.254
PU7	4.39	0.841	-1.642	3.023
PU8	3.98	1.122	-0.98	0.202
PEOU1	4.39	0.717	-1.005	0.642
PEOU2	4.34	0.731	-0.816	0.008
PEOU3	4.37	0.742	-0.956	0.315
PEOU4	4.13	0.891	-0.802	0.021
PEOU5	3.56	1.239	-0.507	-0.83
PEOU6	3.19	1.26	-0.126	-1.03
PEOU7	3.43	1.252	-0.331	-0.897
PEOU8	4.2	0.814	-0.946	0.814
CSE1	4.57	0.567	-1.027	0.846
CSE2	4.51	0.578	-0.687	-0.509
CSE3	4.25	0.835	-0.968	0.347
CSE4	4.33	0.767	-1.022	0.683
CSE5	3.48	1.164	-0.328	-0.753
CSE6	3.6	1.101	-0.341	-0.527
SI1	4.27	0.747	-0.851	0.793
SI2	3.99	1.023	-1.001	0.685
SI3	4.18	0.843	-0.95	1.056
SI4	4.14	0.826	-0.584	-0.273
SI5	4	0.926	-0.629	-0.314

SI6	4.14	0.879	-0.683	-0.27
COM1	4.47	0.62	-0.739	-0.43
COM2	4.5	0.607	-0.809	-0.325
COM3	4.5	0.634	-0.879	-0.269
COM4	4.46	0.659	-0.924	0.126
PP1	4.5	0.709	-1.438	2.255
PP2	4.43	0.757	-1.319	1.696
PP3	4.49	0.714	-1.533	2.851
PP4	4.53	0.633	-1.225	1.299
PP5	4.42	0.698	-1.004	0.588
PTPA1	4.08	0.943	-0.874	0.317
PTPA2	2.38	1.191	0.572	-0.511
PTPA3	2.41	1.102	0.565	-0.254
PTPA4	2.25	1.119	0.651	-0.316
PTPA5	2.1	1.03	0.84	0.246
ATT1	4.5	0.593	-0.745	-0.412
ATT2	4.54	0.632	-1.159	0.706
ATT3	4.53	0.64	-1.205	1.188
ATT4	4.54	0.632	-1.159	0.706
BIU1	4.55	0.639	-1.485	3.294
BIU2	4.38	0.788	-1.301	1.663
BIU3	4.53	0.627	-1.072	0.576