Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS)

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A thesis submitted in partial fulfilment of the requirements of Staffordshire University for the degree of Doctor of Philosophy

December 2017

Abstract

Cloud Computing is an evolving information technology paradigm that impacts many sectors in many countries. Cloud Computing offers IT services anytime, anywhere via any device and is applicable to healthcare organisations, offering a potential cost saving of 15% to 37%. This research investigates Cloud Computing as a facilitating technology to solve some of the challenges experienced by healthcare organisations such as the high cost of implementing IT solutions. The purpose of this research is to develop and apply an Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS) to provide a systematic approach to the adoption of Cloud Computing that considers different perspectives. Although, Cloud Computing is becoming widely used, there is limited evidence in the literature concerning its application in the Saudi healthcare sector. In the thesis, current cloud adoption decision-making frameworks are analysed and the need to develop a strategic framework for Cloud Computing decision-making processes which emphasises a multidisciplinary holistic approach is identified. Understanding the different strategic aspects of Cloud Computing is important and could encourage organisations to adopt this model of computing since the decision regarding whether to adopt Cloud Computing is potentially a complex process; there are many perspectives to be considered, and studying this process requires a multiple perspective framework. The framework developed in this thesis aims to support decision-makers in healthcare organisations by covering five perspectives of Cloud Computing adoption: Organisation, Technology, Environment, Human and Business. The framework integrates the TOE (Technology-Organisation-Environment) framework with the Information Systems Strategy Triangle (IS Triangle) and the HOT-fit (Human- Organisation-Technology) model to support an holistic evaluation of the determinants of Cloud Computing adoption in healthcare organisations. The factors that will affect Cloud Computing adoption in healthcare organisations in Saudi Arabia have been identified using quantitative and qualitative methods, and a case study approach was implemented to validate the framework. The results of the validation showed that the framework can support decision-makers in understanding an organisation's position regarding Cloud Computing and identifying any gaps that may hinder Cloud Computing adoption. The framework can also provide healthcare organisations with a strategic assessment tool to help in gaining the advantages of Cloud Computing.

Acknowledgements

First of all, great thanks to almighty God (Allah) – the most merciful – for enabling me to complete this work.

I offer my kindest regards and gratitude to all the people who have supported, encouraged and helped me during this journey. I would like to thank my principal supervisor, Professor Anthony Atkins, whose insights, support, encouragement, comments and guidance were invaluable and helped me a lot to complete this research. I would like also to thank my second supervisor, Dr Clare Stanier, for her constructive comments, ideas, support and encouragement. I was lucky in having such a great supervision team who showed me the power of teamwork. My thanks also extend to Dr Justin Champion, who was my second supervisor during the first year of my PhD.

I also would like to express my deepest appreciation to all the participants who took part in the studies and to the case study organisations for permission to conduct the interviews and workshops at their sites and to all the people who have helped and supported me during my research work. I also appreciate the support of the Saudi government represented by Shaqra University for its financial support.

I owe special thanks to my parents, sisters, brothers and my cousin, Mr. Faris Alharbi, for their prayers and support. Lastly, but more importantly, I would like to express my deep thanks to my beloved wife, my son and my daughter for their support, encouragement, patience and prayers while I completed this work.

Dedication

This thesis is dedicated to

To my grandmother

Who taught me how to be strong enough to achieve my goals

To my Father, Mother

To my Wife May

To my son Ghassan, my daughter Ghina

To my sisters and brothers

Publications

Journal Papers

Alharbi, F., Atkins, A. and Stanier, C., 2016. Understanding the determinants of Cloud Computing adoption in Saudi healthcare organisations. *Complex & Intelligent Systems*, *2*(3), pp.155-171.

Alharbi, F., Atkins, A. and Stanier, C., 2017. Cloud Computing Adoption in Healthcare Organisations: A Qualitative Study in Saudi Arabia. *Transactions on Large-Scale Data- and Knowledge-Centered Systems XXXV*. (pp. 96-131).

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Alharbi, F., Atkins, A. & Champion, J., 2014. Cloud Computing is Reshaping Health Services in Saudi Arabia: A Strategic View'. In *8th International Conference on Advanced Computing & Communication Technologies*. pp. 172–177.

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List of Abbreviations

API	Application Programming Interface
BSC	Balanced Scorecard
CapEx	Capital Expenses
CCOA	Cloud Computing Open Architecture
CDSS	Clinical Decision Support System
Cloud-RMM	Cloud Reference Migration Model
DOI	Diffusion of Innovation theory
EHR	Electronic Healthcare Record
EMR	Electronic Medical Record
ESOA	Enterprise Service-Oriented Architecture
GDP	Gross Domestic Product
HAF-CCS	Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector
HC2SP	Healthcare Cloud Computing Strategic Planning
HIPAA	Health Insurance Portability and Accountability Act
HIS	Hospital Information System
HIT	Health Information Technology
HITECH	Health Information Technology for Economic and Clinical Health
HOT-fit	Human- Organisation-Technology model
HTTPS	Hypertext Transfer Protocol Secure
IaaS	Infrastructure as a Service
IFCA	IBM Framework for Cloud Adoption
IS Triangle	Information System Strategy Triangle
LIS	Laboratory Information System
MCDA	Multiple Criteria Decision Analysis
NIST	National Institute of Standards and Technology
OpEx	Operating Expenses
PaaS	Platform as a Service
PIPEDA	Canadian Personal Information Protection and Electronic Documents Act
PIS	Pharmacy Information System
QoS	Quality of Service
REST	Representational State Transfer
RIS	Radiology Information System
SaaS	Software as a Service
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SMI	Service Measurement Index
TCO	Total Cost Ownership
TOE	Technology-Organisation-Environment framework
URI	Uniform Resource Identifier
XML	Extensible Markup Language

1 Introduction

1.1 Introduction

This chapter introduces the background and motivation of the research and states the aim and objectives. The chapter clarifies the significance and contribution of this research. It also explains the research process by discussing different aspects such as research philosophy, approaches, strategies and the overall research design. Validation and evaluation approaches are discussed along with the ethical considerations of the research. The chapter concludes by providing a figure detailing the overall outline and structure of the thesis.

1.2 Background and Motivation

Achieving high quality in healthcare services is one of the ultimate goals for many governments and organisations all around the world. Traditional healthcare systems are facing many challenges such as the increase of chronic diseases (Almalki et al., 2011), increases in life expectancy (World Health Organisation, 2016), the shortage of healthcare professionals (Alkraiji et al., 2014) and consequently the increase in the cost of delivering healthcare services. Thus, there is a need for innovative ways of providing healthcare services and many initiatives have been promoted such as privatisation of healthcare services delivery (Almalki et al., 2011), the movement towards preventive behaviour (Black et al., 2011) and the use of information technologies in the healthcare domain.

The use of IT in the healthcare sector in general is referred to as e-health (World Health Organisation, 2011); e-health can provide or facilitate many benefits such as enhanced information sharing, improved healthcare quality and improved healthcare safety. However, current e-health solutions and projects face some challenges such as the high cost of implementing IT systems in healthcare services (Alkraiji et al., 2014), the shortage of health informatics specialists and IT professionals (Khalifa, 2013), the presence of heterogeneous devices (AbuKhousa et al., 2012) and the large amount of data in healthcare applications (Kruse et al., 2016). This creates a foundation for the use of innovative technologies and models that may move healthcare IT systems forward, such as the adoption of Cloud Computing.

In Saudi Arabia, it is the practice to provide healthcare services free of charge to all Saudi nationals (Almalki et al., 2011). The country's population of 30 million people (MoH, 2016) is spread unevenly across 2 million km² of the earth's surface (Saudi National e-Government Portal, 2017). Figure 1.1 provides an overview of Saudi Arabia.

Population: 30 M

Population Growth: 2.3%

Life Expectancy: 74.5 years

Area (in sq. km): 2,150,000

GDP Growth: 5.13

Figure 1.1 Overview of Saudi Arabia (United Nations Development Programme, 2017)

The Ministry of Health (MOH) is the main government provider and has overall responsibility for all healthcare services in Saudi Arabia (Altuwaijri, 2008). The MOH is also responsible for monitoring healthcare services carried out by the private sector (Almalki et al., 2011). In addition to the MOH, there are other government agencies such as the Ministry of Defence and Aviation (MODA), Saudi Arabian National Guard (SANG), Ministry of Interior (MOI) and King Faisal Specialist Hospital & Research Centre (KFSH &RC) which also contribute to the delivery of healthcare services for Saudi citizens (Altuwaijri, 2008). The private sector also provides healthcare services, especially in cities and large towns. There are 462 hospitals in Saudi Arabia, and Figure 1.2 shows the relative size of the three different sectors (i.e. Ministry of Health, other government agencies, private sector). The financial proportion of the government budget allocated for the Ministry of Health (MoH) was approximately SAR 62 billion in 2015 (MoH, 2016), up to 7.25% of the total governmental budget. To meet the challenges of the Saudi healthcare system, the Council of Health Services and MoH in Saudi Arabia have set out a national strategy for healthcare services (Almalki et al., 2011). This strategic healthcare plan recognises the need for reform and transformation of healthcare services by implementing many strategic initiatives such as the National E-health Strategy.

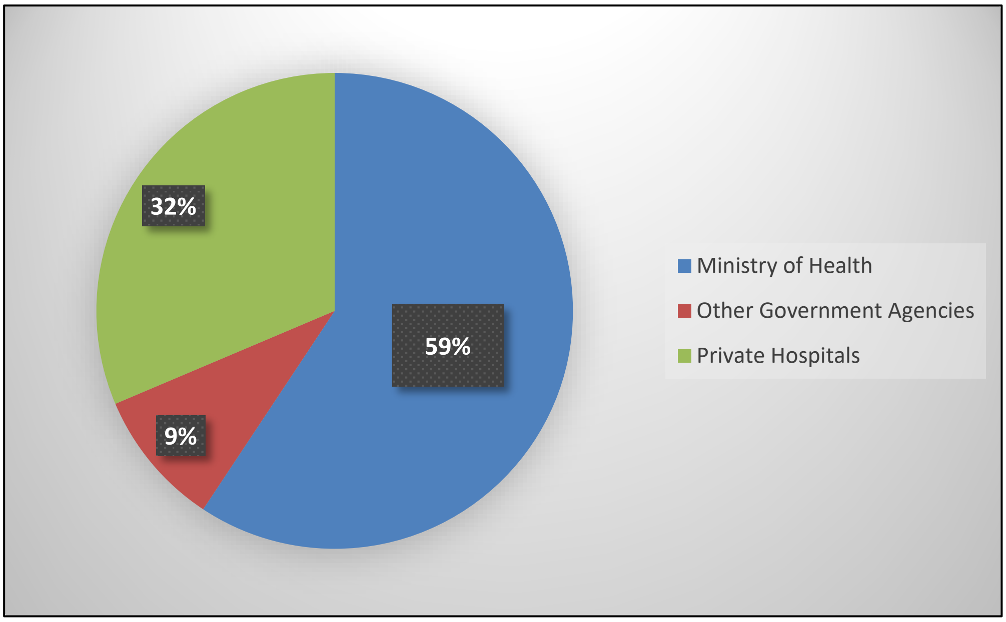


Figure 1.2 Hospitals in Saudi Arabia based on different sectors

Although many countries have similar issues in terms of healthcare services, Saudi Arabia was chosen as the case study of the thesis for a number of reasons. The delivery of healthcare services in Saudi Arabia is a significant challenge for the Saudi government because of the large geographical area of the country, its many rural areas (Alaboudi et al., 2016) and the fragmentation of its healthcare systems (Alkraiji et al., 2014), which all lead to extra costs in delivering high-quality healthcare services. The implementation of electronic services in the healthcare domain is behind that of other sectors such as the banking and industrial sectors (Alsulame et al., 2015; Alkraiji et al., 2013). For example, a survey reported that only three out of 19 hospitals in the eastern region of Saudi Arabia had implemented the Electronic Healthcare Record (EHR) successfully (Bah et al., 2011). In 2016, as a part of the National Transformation Program 2020 (NTP),the MoH in Saudi Arabia set out 15 strategic objectives to improve healthcare services around the country and to transform the healthcare system (National Transformation Program 2020, 2016), as shown in Figure 1.3. One of these strategic objectives was to improve the efficiency and effectiveness of the healthcare sector through the use of information technology and digital transformation.

- Increase private sector share of spending through alternative financing methods and service provision.
- Increase the efficient utilization of available resources.
- Improve the efficiency and effectiveness of the healthcare sector through the use of information technology and digital transformation.
- Increase training and development both locally and internationally.
- Increase the attractiveness of nursing and medical support staff as a preferred career path.
- Improve healthcare provision before hospitalization and in the main hospitals (ER & ICU).
- Improve integration and continuity in service provision by developing the primary care.
- Improve the infrastructure, facility management, and safety standards in healthcare Facilities.
- Attain acceptable waiting times across all stages of service delivery.
- Improve governance in the health system in order to enhance accountability with regards to quality issues and patient safety.
- Adopt a national plan for emergency response to public health threats per international standards.
- Identify additional sources of revenues.
- Improve public health services with focus on obesity and smoking.
- Improve the quality of life and healthcare service provided to patients outside hospitals.
- Improve quality and safety principles as well as skills of service providers.

Figure 1.3 The National Transformation Program objectives of the MoH in Saudi Arabia

Cloud Computing is a developing phenomenon in the ICT field that has gained increasing attention from healthcare organisations aiming to overcome some of the e-health barriers (Kuo, 2011; AbuKhousa et al., 2012). Cloud Computing can provide or facilitate many benefits for healthcare organisations such as cost saving (Yao et al., 2014), improving patient care by providing access to appropriate information anytime and anywhere (AbuKhousa et al., 2012), and providing better support for research and development by allowing access to powerful computing resources to carry out advanced research activities (Priyanga & Muthukumar, 2015). However, there are still some concerns about Cloud Computing implementation in healthcare organisations, such as security and privacy concerns and legal compliance issues (AbuKhousa et al., 2012). Successful Cloud Computing adoption in the health sector requires strategic planning to take full advantage of this emerging model (Kuo, 2011). Understanding the different strategic aspects of Cloud Computing is important and could encourage organisations to adopt this model of computing (El-Gazzar et al., 2016).

This research will provide a comprehensive understanding of, and investigation into, Cloud Computing phenomena in healthcare organisations to develop a strategic framework which can be implemented to support decision-making for Cloud Computing adoption based on an holistic view. An holistic approach considers the importance of the whole organisation rather than performing a separate analysis of isolated units (Van Gemert-Pijnen et al., 2011); this allows the developed framework to deal with factors other than technological ones, such as: human, business, organisational and environmental factors. The framework can assist a healthcare organisation planning to adopt Cloud Computing solutions by measuring how prepared the organisation is for the move to Cloud Computing implementation and identifying organisational strengths that can be used to support Cloud Computing initiatives.

1.3 Aim of the Investigation

The main aim of this research is to develop an Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS) to support Cloud Computing adoption in healthcare organisations by identifying factors that affect this adoption from multiple perspectives.

1.4 Research Objectives

The aim of this research will be achieved by the following objectives:

- To conduct a comprehensive literature review on current Cloud Computing technologies, trends and decision-making strategies and frameworks for Cloud Computing in different sectors.
- To critically review the existing Cloud Computing applications and the use of Cloud Computing in the healthcare sector.
- To identify factors that affect the adoption of Cloud Computing in the healthcare domain from multiple perspectives.
- To understand the determinants of Cloud Computing adoption in Saudi healthcare organisations using quantitative methods.
- To investigate Cloud Computing adoption decision-making in Saudi healthcare organisations using qualitative methods.
- To develop a strategic framework for Cloud Computing decision-making particularly in health sector applications in Saudi Arabia.
- To validate the developed framework using healthcare case studies from Saudi Arabia.

- To evaluate the developed framework from the user's perspective using a panel of experts.
- To evaluate the research and the research process as a whole.

1.5 The Research Contribution

The major contribution of this research is the development of a strategic framework to support Cloud Computing decision-making processes. Many researchers have recognised the need for a multidisciplinary holistic framework when studying the use of IT in healthcare organisations (Lluch, 2011; Paré & Trudel, 2007). The framework developed in this thesis can act as an assessment tool for healthcare organisations planning to adopt Cloud Computing. The framework will help health organisations in the decision-making process by evaluating various factors affecting the Cloud Computing adoption. The framework will fill the gap between theory and practice since many researchers refer to the factors without discussing how to implement these factors for readiness assessment based on multiple perspectives. Migrating towards the cloud needs a multiple prospective strategy that supports Cloud Computing capabilities (Haddad et al., 2014).

The initial literature review showed that there is limited empirical research about the factors that have an impact on the adoption of Cloud Computing in Saudi Arabia (Yamin, 2013; Alkhater et al., 2014; Alsanea & Barth, 2014) and, in particular, none within the Saudi healthcare context. Thus, the first contribution of this research is to present the factors that will affect Cloud Computing adoption in Saudi healthcare organisations. While most existing studies focus on developed countries, very limited academic research has addressed Cloud Computing phenomenon in developing countries. The adoption of emerging IT models such as Cloud Computing in developing countries differs from that in developed countries due to differences in financial aspects, legal aspects and physical infrastructures and to the strong influence of cultural factors (Aldraehim & Edwards, 2013). To the best of the researcher's knowledge, this research is among the first to address the Cloud Computing phenomenon in the Saudi healthcare context and this represents a minor contribution of the thesis.

The research also contributes to the body of knowledge by providing a critical review of many aspects of Cloud Computing which can be used by decision-makers and academics to maintain updated knowledge about this model. The thesis contains in-depth investigation of the enabling technologies of Cloud Computing, comparison between various Cloud Computing deployment and service models, and discussion of the potential benefits and challenges of adopting Cloud

Computing. The thesis also provides a critical review of the e-health situation in Saudi Arabia and the way in which Cloud Computing can contribute to improving healthcare services in the country.

1.6 Research Process

Research can be represented as a process that requires a series of steps to be completed. The first step is to formulate and identify the topic under investigation. Studying the adoption of new technology such as Cloud Computing is part of the Information Systems (IS) field (Choudrie and Dwivedi, 2005). IS is considered a socio-technical field (Gonzalez and Dahanayake, 2007) that has diversity in its disciplines and research methods (Vessey et al., 2002). Consequently, conducting IS research will require research approaches and research methods that cover multiple-context subjects. This section will discuss the research methodology which is followed in this research by providing a detailed explanation of the research philosophy, research approach, research strategy and research methods. Figure 1.4 presents the research process that is followed in the thesis, and the research methodology is discussed as follows:

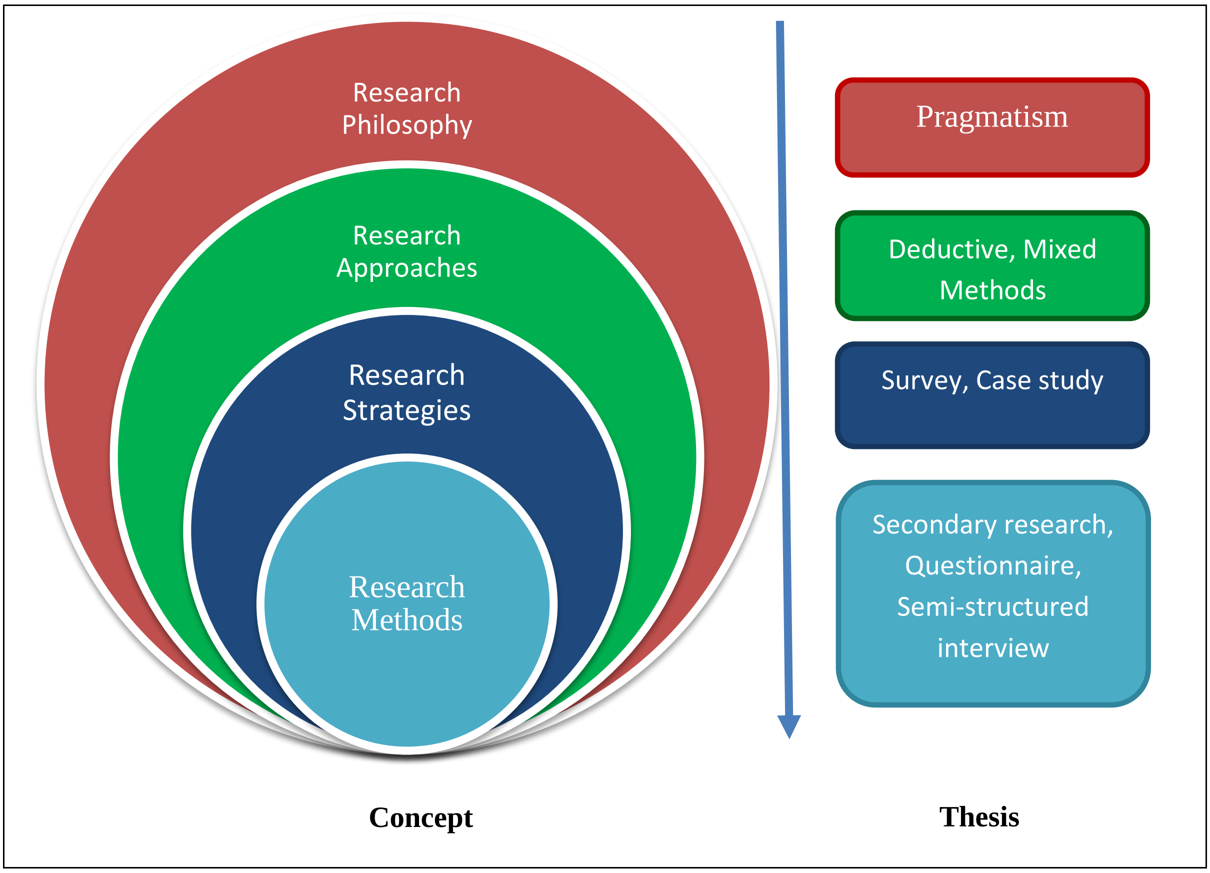


Figure 1.4 Research Process adapted by author -Saunders et al. (2009)

1.6.1 Research Philosophy

Research philosophy can be seen as the development of research knowledge and guidance for conducting research (Saunders et al., 2009). Several philosophical stances and schools of thought exist and they are classified into four main schools: positivism, realism, interpretivism and pragmatism (Saunders et al., 2009).

The positivist research philosophy considers the researcher to be independent of the phenomenon being investigated (Creswell, 2013). In this paradigm, the researcher interprets and observes an objective reality which is external and independent of social actors (Saunders et al., 2009). The positivist research philosophy applies statistical or mathematical procedures to explain the causalities, causes and effects of the problem being studied (Sidorova et al., 2013). It usually tests existing problems based on prior knowledge to draw conclusions that can be generalised (Creswell, 2013). Positivism is usually implemented in natural and physical research where repeatability and reductionism are important (Creswell, 2013). However, some researchers argue that – in some cases – positivist positions are not suitable for complex problems, especially in social science phenomena (Leidner et al., 2009).

Similar to the positivist paradigm, the realist theory applies the logic and approaches of natural science to study a phenomenon (Mingers, 2006). The realist researcher believes that reality exists independently of human thoughts (Saunders et al., 2009). A realist researcher considers reality as it exists on multiple levels so the interrelationship between different social structures such as individuals, groups and organisations influences the problem under study (Saunders et al., 2009).

The interpretivist research philosophy implies that the phenomenon under investigation has subjective meanings which are socially constructed (Creswell, 2013). This paradigm allows the researcher to study subjects based on the meanings that people assign to them and in their natural environment (Sidorova et al., 2013). The researcher can be part of what is being researched since the meaning can be understood through social constructions such as language (Saunders et al., 2009). Interpretivist researchers usually employ qualitative methods in gathering the required information (Creswell, 2013). The main limitation of the interpretivism paradigm is the difficulty of generalising the findings since the collected data is impacted by participants' and researcher's viewpoint and values (Mackay et al., 2001), which can make the research findings valid only in the settings where the problem is investigated (Sidorova et al., 2013).

The pragmatist research philosophy allows the researcher to work with a variety of assumptions regarding the phenomenon under investigation (Saunders et al., 2009). This position allows the researcher to select the appropriate research approaches and methods based on issues that have arisen during the study, which helps in investigating the research problem from different views (Creswell, 2013). Thus, both qualitative and quantitative approaches are applicable in this paradigm. This research philosophy allows the researcher to infer the research results based on objective and subjective views, which can enrich the findings of the research (Saunders et al., 2009). Runeson and Höst (2009) argued that the IS community is moving towards more pragmatic and result-oriented views away from other research philosophies.

This research adopts a pragmatic view by mixing some positivist and interpretivist practices because it provides a better understanding of the research problem in many ways. According to Leidner et al. (2009) applying such a philosophy will allow the researcher to bring certain prior expectations to the data analysis that emphasise the positivism philosophy. This allows the researcher to build the developed framework based on well-documented frameworks which have been used in studying the adoption of various technologies. At the same time, the pragmatism philosophy offers some degree of openness for more explanation of the field data which is a characteristic of interpretive research. This feature allows the researcher to study Cloud Computing adoption decision-making processes in healthcare organisations in their natural environment. The adoption of the pragmatic position helps the researcher in answering "What" and "How" research questions (Creswell, 2013). This is an important aspect when studying Cloud Computing adoption in healthcare organisations because the decision on the adoption of new technology requires the identification of the factors that can affect the decision and how these factors are related to each other. Pragmatists usually focus on outcomes of practice based on multiple realities (Saunders et al., 2009). This is useful when studying the decision regarding Cloud Computing adoption in healthcare organisations since this decision requires different stakeholders' (i.e. IT staff, managers, health professionals) involvement, with their different views and opinions. The pragmatism research philosophy offers broader research insights since it supports mixed-methods approaches (Creswell, 2013). This feature can also support the research activities in this thesis because Cloud Computing adoption decision-making relies on various quantitative and qualitative factors such as cost, strategic values, management support, etc. This research philosophy provides holistic views of the problem under discussion (Morgan, 2007), which is suitable for the study of Cloud Computing adoption since making this decision involves evaluation of multiple perspectives and requires an holistic approach.

1.6.2 Research Approaches

Research can be classified based on its approach into deductive and inductive (Saunders et al., 2009). The deductive research approach follows a top-down style, by beginning with a theory that is undergoing a rigorous test (Saunders et al., 2009). In this approach, the conceptual framework is tested in quantitative and operational terms to produce facts that can be generalised (Robson, 2002). The inductive approach is the opposite of the deductive approach since it works as a bottom-up approach by conducting the observations first and then formulating the hypothesis to develop a theory (Saunders et al., 2009). Qualitative methods are usually associated with the inductive approach to establish different views of the problem under study (Creswell, 2013). The deductive approach is adopted in this thesis for a number of reasons. Firstly, the developed framework was built based on theoretical perspectives chosen to link the research to the existing body of knowledge in Cloud Computing and e-health; this allows the framework to reflect the current situation of both domains. The research focuses on studying the factors affecting Cloud Computing adoption based on current theoretical frameworks using a quantitative method, which allows the researcher to examine these factors statistically. Although the research aims to explore Cloud Computing adoption in healthcare organisations in a real context based on qualitative study to allow a richer and deeper understanding of Cloud Computing adoption in healthcare organisations, the results and analysis of data followed a structured deductive approach using an analytical framework (Saunders et al., 2009).

There are three common research approaches: quantitative, qualitative and mixed methods. Quantitative research applies a numerical approach to investigate the phenomena under study and to data analysis (Creswell, 2013). It is appropriate when there is a need to establish or confirm the relationships between different variables or objects (Leedy & Ormrod, 2005). Qualitative approaches are developed in social sciences to improve the understanding of social and cultural phenomena (Creswell, 2013). They are appropriate when there is a need to increase the richness of the data about a research problem (Bryman, 2004). Mixed research methods involves the mixing of quantitative and qualitative approaches to obtain the advantages and eliminate the weaknesses of each approach (Creswell, 2013). Mixed-methods research can be conducted either in parallel, where the methods are applied at the same time, or sequentially, where the methods are implemented one after the other; this depends on the research objectives and questions (Saunders et al., 2009). The mixed-methods approach is selected for this research since it provides a better understanding of and accurately reflects the problem under investigation by IS researchers as reported by Venkatesh and Brown (2013). This approach allows the researcher to obtain more evidence from various sources to study the research problem. This research adopts the mixed-methods approach by starting with a quantitative method to identify factors that affect the adoption of Cloud Computing in the health sector. Then the qualitative approach is applied to provide in-depth understanding of Cloud Computing adoption decision-making. This can allow the results of both methods to be integrated and hence the findings to be more accurate and represent different views.

1.6.3 Research Strategies

A research strategy is a general plan that assists the researcher in solving the research questions in a systematic way (Saunders et al., 2009). There are many research strategies: experiment, survey, case study, action research, grounded theory, etc. (Creswell, 2013). The choice of research strategy is influenced by the research questions, the research objectives and the philosophy that underpins the research (Saunders et al., 2009). Survey and case study strategies are the main research strategies in IS (Choudrie & Dwivedi, 2005; Venkatesh & Brown, 2013), so they are selected as the research strategies that are applied for the thesis. Further reasons for their selection are discussed in the following sub-sections.

The survey strategy describes the process used to collect quantitative data in a standardised form usually via a questionnaire (Kelley et al., 2003). The use of a survey as the research strategy provides many advantages for the researcher since it is usually implemented to gather large volumes of information from a large population and it is typically linked to the deductive research approach (Saunders et al., 2009). Conducting a survey in a research project can also provide other advantages such as its acceptance by a wide range of participants (Saunders et al., 2009), its capability to describe different characteristics of a large population (Kelley et al., 2003), it allows the researcher to exercise better control over the research (Saunders et al., 2009), and it is more efficient than other research strategies with regard to time and cost – this is especially the case with online surveys (Saunders et al., 2009; Kelley et al., 2003). However, the survey may lack depth of understanding of the research problem and it is not always easy to secure the required response rate (Kelley et al., 2003).

A questionnaire is a widely used data collection tool which allows many respondents to answer similar associated questions in a predetermined order and it is used in this thesis for many reasons (Saunders et al., 2009). It is a research tool for gathering large amounts of information from people in a way that is economical in terms of time and cost (Mathers et al., 2009). The bias of some research tools is reduced when using a questionnaire because the questions in the questionnaire are asked in the same way to all the respondents (Phellas et al., 2012). The results of the questionnaire can be analysed as quantitative data which emphasises the objective and scientific views and makes the results more understandable for the researcher since it can be visualised (Saunders et al., 2009). Questionnaire tools can also be more convenient for respondents since they can complete the questionnaire based on their availability (Selm & Jankowski, 2006). However, a questionnaire may lack interaction between the participants and the researcher, which means that the researcher is not able to explain and discuss the questions with the participants. Thus, it is important to ensure that the design of the questionnaire follows specific steps to ensure the clarity and validity of the questions. This study followed the questionnaire development process mentioned in Moore and Benbasat (1991), where the development of the questionnaire is divided into three stages: item construction, reviewing process and testing stage.

Examples of qualitative strategies are action research, case study research and ethnography studies (Saunders et al., 2009). A case study strategy can serve many purposes, which are exploratory, explanatory and descriptive based on the research problem and objectives (Runeson & Höst, 2009). An exploratory case study seeks to provide understanding and new insights into the research problem and to produce better clarification for the researcher (Runeson & Höst, 2009). An explanatory case study identifies causal relationships between variables and is used to explain a specific situation (Saunders et al., 2009). A descriptive case study is implemented to describe a phenomenon in its real-life context and is usually complemented with other types of case studies (Saunders et al., 2009). Some researchers argue that the case study approach is used primarily for exploratory purposes (Runeson & Höst, 2009). In this thesis, an exploratory case study was used. A case study approach was selected for studying the Cloud Computing adoption decision-making process in healthcare organisations for many reasons. The case study is a research strategy that allows the researcher to study a certain research problem in its real-life context (Robson, 2002) and in its natural context (Runeson & Höst, 2009). Another advantage of the case study is the ability to gather information from specific entities (Noor, 2001) so the researcher can focus on a particular feature, issue or unit of analysis (e.g. business unit). An additional advantage of the case study is the availability multiple research methods for data collection such as interviews, observation and document analysis (Runeson & Höst, 2009), which gives the researcher the ability to explore the problem from different perspectives (Noor, 2001). Conducting a case study requires good time management and preparation, and precludes generalisation from the study results (Runeson & Höst, 2009).

A semi-structured interview technique was used as the qualitative data collection in this research. Use of this technique ensures that the same topics are covered in each interview while the emphasis can be shifted as appropriate (Runeson & Höst, 2009). It also allows the researcher to interact directly with the participants, which enables more clarity between them (Alkraiji et al., 2013). Meeting the respondents in their social context is one of the advantages of the interview method since it supports understanding of the problem under study in its natural environment (Lin & Chen, 2012). However, interviews have some disadvantages such as the time-consuming processes involved to complete data collection and analysis of the interviews (Saunders et al., 2009), and the difficulties in planning the appropriate time to interview the participants, especially if they are decision-makers. The results of the interviews were analysed through the use of the Framework Analysis (FA) approach, which is a widely used qualitative analytic method (Braun & Clarke, 2006; Gale et al., 2013). In this approach, four steps are applied: data familiarisation, code generation, theme allocation and report production (Braun & Clarke, 2006). This tool was selected because it is independent of theory and epistemology so it is a flexible tool which helps the researcher to organise the data and categorise it based on specific patterns (Braun & Clarke, 2006; Gale et al., 2013).

This investigation uses a survey as the primary research strategy to identify different factors of the developed framework; this also will emphasise the holistic approach. A case study strategy was also applied to gain an in-depth understanding of Cloud Computing in the Saudi context as a second phase of the primary research, and it is also applied to validate and evaluate the framework. The use of different research strategies can also promote data credibility to the research and provide a broader picture (Runeson & Höst, 2009; Baxter et al., 2008).

1.6.4 Research Design

The research activities in this thesis are divided into two main types: secondary research and primary research. Figure 1.5 shows the research design of the thesis, and the research activities are described as follows:

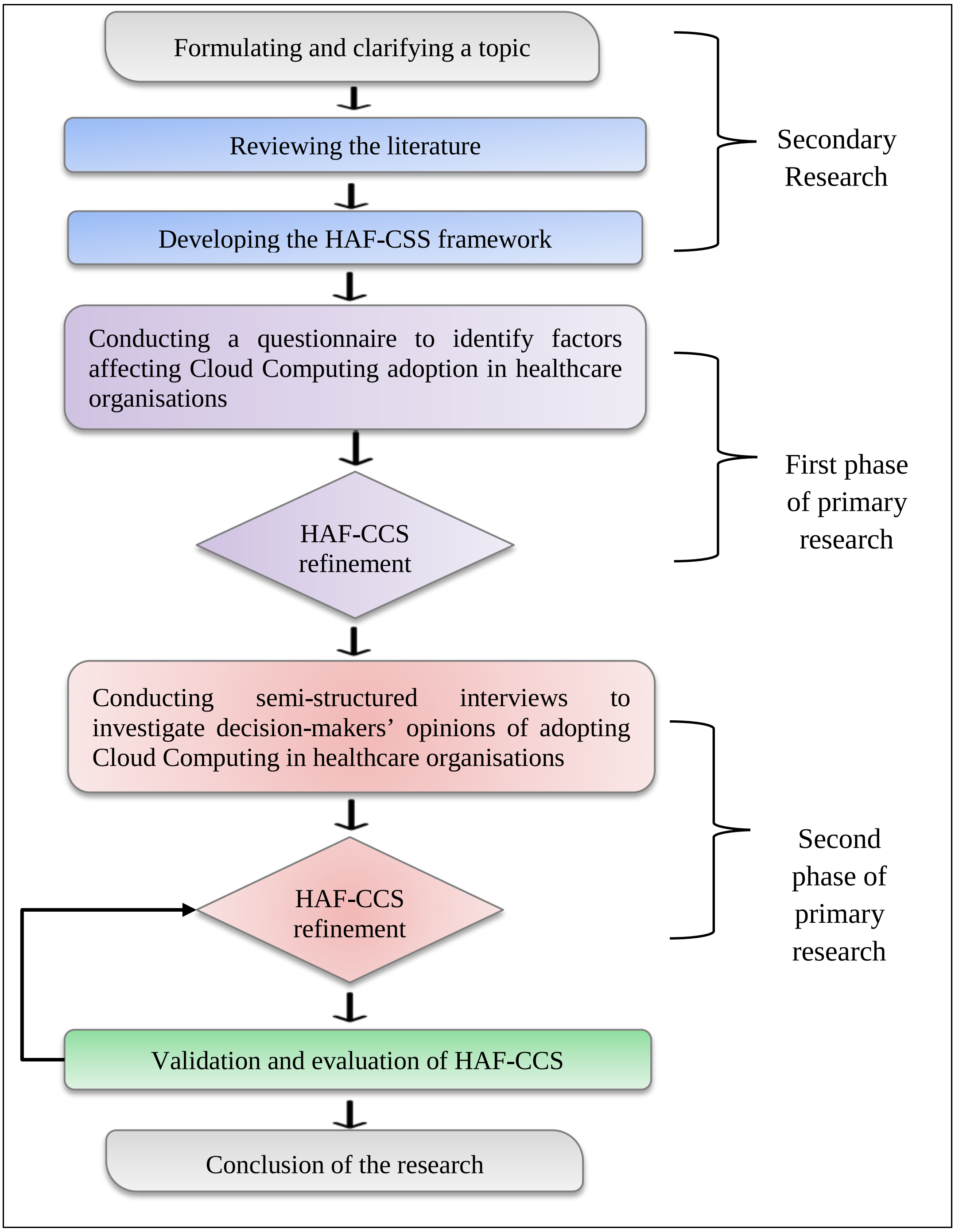


Figure 1.5 Research design

- **Secondary research**

This thesis adopts the three steps guidelines suggested by Brereton et al. (2007) for reviewing the literature: planning, conducting and documenting. During the planning step, the researcher identified the research problems and linked them with the research aim and objectives. Based on that, the secondary research was divided into different topics: Cloud Computing in general, Cloud Computing decision-making frameworks and models, Cloud Computing in the healthcare domain, e-health in general, e-health situation in Saudi Arabia and Cloud

Computing in Saudi Arabia. The conducting step involved collecting publications through various sources such as academic journals, conferences, books, industry reports and governmental reports. The main portals used during the literature search were Staffordshire University Library resources and the Saudi Digital Library. Various other databases were used during the literature review such as IEEExplore, Google Scholar, the ACM Digital Library, Springer Publications and ScienceDirect (Brereton et al., 2007). Industry reports were reviewed because they provide updated information about Cloud Computing in different sectors and locations and some of them are conducted every year, which allows a comparison of their results and shows the analysis of Cloud Computing adoption over time. The documentation step contains the results of the literature review and it is presented in different chapters of the thesis.

The research activities began with reviewing and analysing the literature with respect to the research aim and objectives. The research started by conducting extensive secondary research to identify current Cloud Computing adoption literature. E-health literature was also reviewed to identify the current situation with regard to e-health projects and to discuss how Cloud Computing can help in solving e-health challenges. The findings of the secondary research identified the need to develop a strategic framework that can support the Cloud Computing adoption decision-making process in healthcare organisations. Thus, the critical factors from multiple perspectives views that are influencing the decision concerning Cloud Computing adoption are recognised. Based on the critical review of the literature, a strategic framework (i.e. Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS)) was formulated to support Cloud Computing adoption in healthcare organisations.

- **Primary research (Questionnaire)**

The primary research was carried out by conducting a survey about Cloud Computing adoption in Saudi healthcare organisations. For the purpose of this research, the researcher developed the questionnaire based on the literature review. A snowball approach was utilised as the sampling technique for the study, which allowed the researcher to use social chain referral to identify more participants (Saunders et al., 2009). After collecting the data, the researcher applied statistical tests to examine the questionnaire and to find useful information about factors affecting Cloud Computing adoption in healthcare organisations, and the results of the first phase of the primary research were used to refine and update the HAF-CCS framework.

The development of the online questionnaire tool used in collecting the data and other aspects are explained in detail in Chapter 5.

- **Primary research (Semi-Structured Interview)**

The qualitative approach is applied in this research to provide in-depth understanding of Cloud Computing adoption decision-making in healthcare organisations in Saudi Arabia. The case study used in this research followed the case study research process steps described in Runeson and Höst (2009). They indicated that there are five major process steps for conducting case study research:

1. Design phase: In this phase, objectives of the case study should be defined and the case study planned. Planning for the case study should include many issues such as: deciding who to interview, in which departments, and on the data collection methods.
2. Preparation phase: In this phase, ethical considerations should be covered such as: informed consent, dealing with confidential information in an organisation, etc.
3. Collecting phase: Real data collecting process to be conducted in this phase.
4. Analysis phase: The main objective of conducting a case study is to derive useful conclusions from the data. Thus, analysis techniques and tools are implemented to draw those conclusions together.
5. Reporting phase: In this phase, findings of the study should be presented depending on the report's audiences.

The researcher conducted semi-structured interviews with different stakeholders (i.e. IT staff, health professionals and administrative staff) at two local hospitals. The researcher obtained agreement from two hospitals in Saudi Arabia to conduct a case study at their locations and planned the interviews with the participants based on their availability. A formal request to conduct this research was made by the researcher and was approved by the Regional Research Ethics Committee in Saudi Arabia. The researcher also investigated some documents regarding the IT adoption decision-making process such as the request for proposal (RFP) document and IT vendor analysis templates provided by the respective hospitals.

The second phase of the primary research allowed the researcher to become more familiar with the topic and to understand the Cloud Computing decision-making process inside healthcare organisations in more detail and enrich the information obtained from the questionnaire and from the literature, and to refine the HAF-CCS framework. The second phase of the primary research is described in detail in Chapter 6.

1.7 Validation and Evaluation of the Research

Validation is the process of ensuring that the framework actually meets the purpose for which it was intended (Beecham et al., 2005). Case studies in this research are implemented for dual purposes: (1) to provide in-depth understanding of Cloud Computing adoption decision-making in healthcare organisations in Saudi Arabia and (2) to validate the HAF-CCS framework. Two workshops were conducted to ensure that the framework can be applied in a real-world context to support Cloud Computing adoption decision-making. Although the validation phase may appear as a distinct stage in the research development process, it is a continuous procedure during the whole process. Table 1.1 presents the different validation procedures that the researcher has conducted during the research development process.

Table 1.1 Different validation procedures used in the research

Validated item	Definition	Conducted test or method
Content Validity	The degree to which questionnaire or interview content represents the topic being measured (Lian, 2017).	• Literature review • Expert opinion
Questionnaire Construct Reliability	The degree of internal consistency between the variables in each construct (Hung et al., 2010).	• Internal consistency assessment using Cronbach's alpha
Questionnaire Construct Validity	Reflects that each item within the questionnaire measures the theoretical construct it is intended to measure (Williams et al., 2012).	• Factor Analysis • Factor loading
Validity of the Framework	The process of ensuring that the framework actually meets the purpose for which it was intended (Beecham et al., 2005).	• Case study workshops

The Balanced Scorecard (BSC) approach was applied to measure the implementation of Cloud Computing for the healthcare organisation in one of the case studies. The Balanced Scorecard (BSC) is a concept developed by Kaplan and Norton (1992) as a means to evaluate organisation performance measurement. They argued that quantitative financial measures alone are not enough to provide a complete picture of business performance. The BSC combines traditional financial measures with other non-financial qualitative performance indicators. It also emphasises multiple perspectives since it includes the Financial Perspective, Customer

Perspective, Internal Perspective, and Learning and Growth Perspective (Kaplan & Norton, 1992). The BSC goes beyond typical performance measurement to be a popular strategic management tool that has been used widely, as it is used by 38% of managers worldwide (Rigby & Bilodeau, 2015). The BSC was chosen for this research because of its popularity among Saudi organisations (Althunaian, 2012) and for the flexibility it provides to make modifications to the perspectives.

Although validation and evaluation are used interchangeably by some researchers, other researchers have distinguished between the two terms (Kahan, 2008). In this thesis, evaluation presents the assessment of the framework regarding its acceptance by the end users and its performance in the field (Begueria, 2006). Expert feedback and judgement has been used in in the evaluation exercise in many studies (Beecham et al., 2005). In this study, selected experts in the area of health informatics and information technology have been chosen based on specific criteria to evaluate the framework.

1.8 Ethical Considerations

The thesis follows and adheres to Staffordshire University's code of ethics during all research phases. Several ethics principles were utilised to ensure that ethical considerations were covered; these principles are explained as follows:

- **Governance**

The researcher submitted the appropriate ethics form to the Research Degree Sub-Committee of Staffordshire University to gain approval before conducting the research activities. The researcher also made it clear to all the participants that Staffordshire University's code of ethics would be followed during all the phases of this research. A formal request by the researcher to conduct this research was approved by the Regional Research Ethics Committee in Saudi Arabia.

- **Informed consent**

The researcher provided written information for all the participants that explained the research aim and objectives. The developed consent form stated clearly that participation in this research study is completely voluntary and the participants have the right to withdraw from participation at any time without stating a reason for their withdrawal (Runeson & Höst, 2009).

- **Anonymity**

Anonymity is maintained during the research since no personal details are required and hence individuals will be non-identifiable (Saunders et al., 2009).

- **Confidentiality**

Data collection was collected in an anonymous and confidential manner and used for research purposes only. The results of the research will be published only in academic publications without providing the names of the individuals and organisations, and, to ensure confidentiality, no sensitive information to be published or leaked outside the organisations (Runeson & Höst, 2009).

1.9 Thesis Outline

The thesis structure follows the "Lead in, Core, Lead out" format suggested by Dunleavy (2003), as shown in Figure 1.6, and the thesis contains nine chapters as follows:

Chapter 1 **Introduction**: The purpose of this chapter is to introduce the context of the investigation by discussing the background and motivation of the research. It also provides information about healthcare in Saudi Arabia, which is selected as the research case study. The chapter presents the aim and objectives of the research and identifies the contributions to knowledge it provides. The chapter explains the research processes followed during the study, the validation and evaluation of the developed framework, and any ethical implications. It concludes by outlining the thesis structure.

Chapter 2 **Cloud Computing**: The aim of the chapter is to explore many aspects of Cloud Computing such as its characteristics, different Cloud Computing deployment models and services models. The chapter also includes a critical review of the benefits and challenges of implementing Cloud Computing solutions, and the current frameworks and models of Cloud Computing decision-making.

Chapter 3 **From E-health to E-health Cloud**: This chapter discusses the challenges of traditional healthcare systems and the benefits of e-health solutions. It also describes the challenges of current e-health practices and the movement towards Cloud Computing in healthcare organisations. The chapter then focuses mainly on Saudi Arabia by discussing e-health status in Saudi Arabia and how Cloud Computing can benefit Saudi healthcare organisations.

Chapter 4 **The Development of an Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS)**: This chapter describes the development process of the Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS). The chapter begins by introducing the theoretical basis of the framework since the framework is built based on three theoretical frameworks: TOE, IS strategy triangle and HOT-fit. Five perspectives (i.e. Business, Technology, Organisation, Environment, Human) and their sub-factors are reviewed based on the literature to explain their relation to the decision about Cloud Computing adoption.

Chapter 5 **Understanding the Determinants of Cloud Computing Adoption in Saudi Healthcare Organisations**: This chapter presents the study conducted to understand the factors affecting Cloud Computing adoption in healthcare organisations in Saudi Arabia by using a questionnaire. The chapter also contains the analysis of the collected data using various statistical tests such as Cronbach's alpha, Confirmatory Factor Analysis, KMO test and ANOVA. The results from the study are used to refine the framework.

Chapter 6 **Decision-Makers' Views of Factors Affecting Cloud Computing Adoption in Saudi Healthcare Organisations**: This chapter describes the investigation conducted among decision-makers in Saudi healthcare organisations in order to identify their views about Cloud Computing using semi-structured interviews. Framework analysis is implemented to analyse the results, which are tested against the developed framework.

Chapter 7 **Validating the Framework using Two Healthcare Case Studies**: This chapter describes the validation of the framework by means of workshops. It provides a description of real-world-based scenario case studies that are used to validate the framework. The application of the HAF-CCS in two healthcare organisations is explained to ensure that the framework can be applied in a real-world context and that its results supported the Cloud Computing decision-making.

Chapter 8 **Evaluation of the HAF-CCS Framework**: This chapter presents the evaluation of the developed framework using a panel of experts. The framework is tested against specific criteria to confirm its accessibility by the decision-makers in healthcare organisations.

Chapter 9 **Conclusion and Future Work**: This chapter draws the thesis to a conclusion by summarising the research findings and contributions. It also outlines the limitations of the research and potential areas for future work.

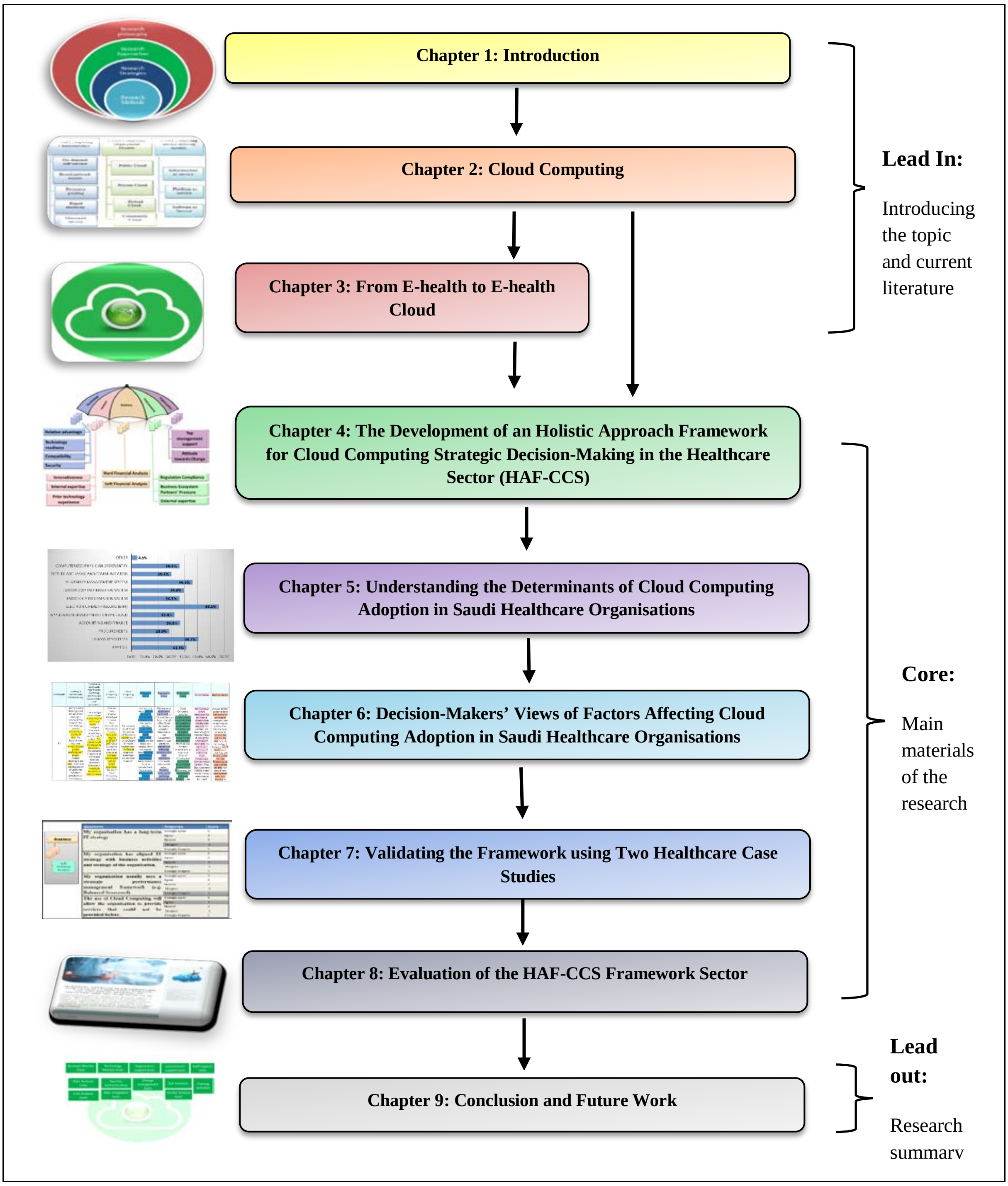


Figure 1.6 Thesis structure

1.10 Conclusion

This chapter has introduced the thesis by presenting the background of the research and the motivations for conducting this research. This was followed by stating the aim and objectives of the research and the contribution to the knowledge it offers. Then, the research philosophies, approaches, strategies, tools and process were explained and the choice of each concept was discussed and justified. The chapter also described the validation and evaluation approaches for the research and explained the ethical implication of the research. Finally, the chapter presented an outline of the thesis and a brief summary of each chapter. The following chapter will discuss the context of this research, which is Cloud Computing.

2 Cloud Computing

2.1 Introduction

This chapter provides a literature review of Cloud Computing to provide the technical basis for the study's investigation. This chapter starts by briefly exploring the evolution of Information and Communication Technologies that has led to Cloud Computing. A definition of Cloud Computing and its main characteristics is discussed along with the enabling technologies that help in understanding Cloud Computing phenomenon. A critical investigation of different Cloud Computing service models and deployment models is conducted and the benefits and concerns of each are discussed, followed by a comparison. Additionally, the advantages that drive Cloud Computing adoption and the concerns that may affect adoption are identified. Its relationship to existing information system topics such as Service-Oriented Architecture (SOA) and outsourcing is also described. Finally, current cloud adoption decision-making frameworks are analysed and the need to develop a strategic framework for Cloud Computing decision-making processes which emphases a multidisciplinary holistic approach is identified.

2.2 A Brief History

The continuous revolution and evolution of Information and Communication Technologies (ICT) have affected the way that organisations conduct their business. The ICT industry has moved through many stages, beginning with mainframe computing and moving to Cloud Computing. Although Cloud Computing is an emerging paradigm which is transforming the IT industry, the idea behind it goes back to the 1960s. In 1961 John McCarthy proposed the following:

> *If computers of the kind I have advocated become the computers of the future, then computing may someday be organized as a public utility just as the telephone system is a public utility… The computer utility could become the basis of a new and important industry.* (McCarthy, 1961, quoted in Erl et al., 2013, p.26)

Cloud Computing could be seen as a paradigm that has evolved from previous computing paradigms. Voas and Zhang (2009) suggested that there are six distinct phases for computing development, as shown in Figure 2.1. The first phase is mainframe computing, where multiple users share a CPU via a number of terminals. The second phase is stand-alone personal computers, where every user works alone. In phase 3, personal computers are connected to each other; this is called networking. The Internet or network of networks is the fourth phase of the computing movement. The fifth phase is grid computing, where many computing resources cooperate to achieve specific goals. Cloud Computing, which is an evolution of grid computing, is the sixth, current and emerging, phase of computing (Azeemi et al., 2013; Durao et al., 2014).

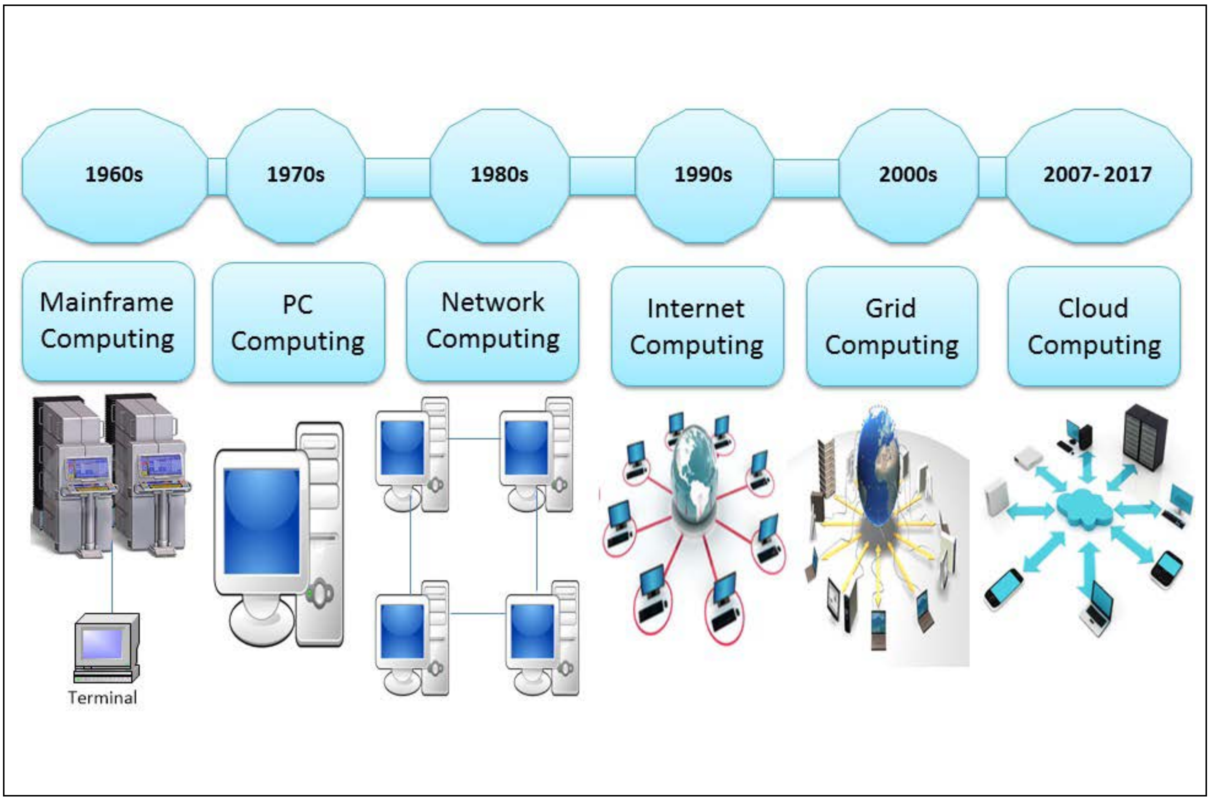


Figure 2.1 Computing paradigm shift

2.3 Cloud Computing Definitions

Although there is no generally accepted definition of Cloud Computing (Asatiani et al., 2014; Marston et al., 2011), there are some well-recognised definitions for it. The National Institute of Standards and Technology (NIST) at the US Department of Commerce has defined Cloud Computing as: *a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction* (Mell & Grance, 2011, p.2).

This definition was published as the 16th and final definition, The NIST Definition of Cloud Computing (NIST Special Publication 800-145) (NIST, 2011). However, the NIST definition considers only the technological perspective, overlooking an important aspect of Cloud

Computing, which is the business side. Vaquero et al. (2008, p.51) offered a definition for Cloud Computing that encompasses all cloud features, defining it as:

> *a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically re-configured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs.*

Although this definition covers business aspects, it ignores ubiquity, which must be part of any cloud infrastructure. Marston et al. (2011, p.177) outlined a more comprehensive definition for Cloud Computing, which is as follows:

> *an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality of service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks.*

By analysing the above three definitions of Cloud Computing (Mell & Grance, 2011; Marston et al., 2011; Vaquero et al., 2008), it can be seen that they emphasise similar aspects (Mell & Grance, 2011; Marston et al., 2011). Firstly, Cloud Computing is a model for delivering IT services and resources, not just new technology. Secondly, the provisioning of the computing resources is automatic and with a minimum of human interaction. Thirdly, access to the large pool of resources is over a network. Fourthly, IT services and resources are also available on demand with dynamic scalability and elasticity. Additionally, the provisioning of IT resources should be independent of device and location (i.e., should have the characteristic of ubiquity). Finally, the use of IT resources in Cloud Computing requires a clear business model and clear measurement that typically uses **Op**erating **Ex**penses (**OpEx**) payment methods (Marston et al., 2011). This analysis also shows the importance of applying a holistic approach when studying issues related to Cloud Computing since this model includes perspectives other than technology. Figure 2.2 shows a Cloud Computing definition schema based on the National Institute of Standards and Technology's (NIST) definition (Mell & Grance, 2011).

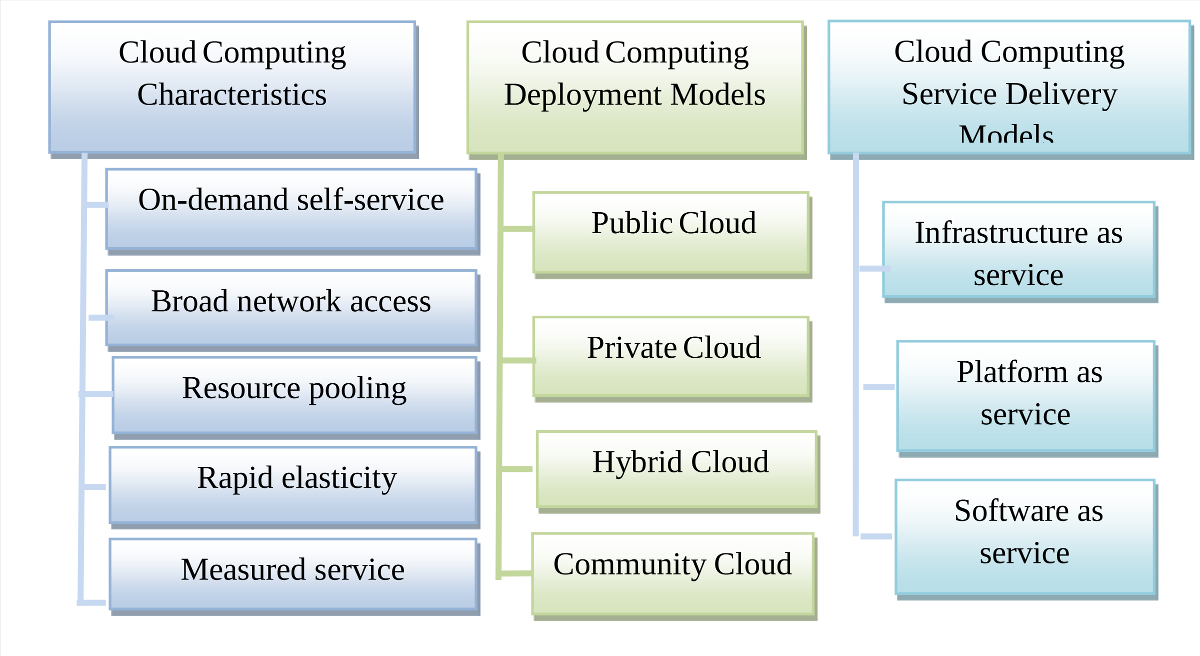


Figure 2.2 Cloud Computing definition schema

2.4 The Characteristics of Cloud Computing

Based on the previous analysis and the NIST definition outline, the defining characteristics of Cloud Computing are identified as follows:

- **On-demand self-service:** The user can obtain computing services (both hardware and software) when they are required, automatically and with a minimum of human interaction (Mell & Grance, 2011; Marston et al., 2011).
- **Broad network access:** Computing resources are made available via a network, either the organisation's network or the Internet, and are accessible from various locations (Mell & Grance, 2011; Marston et al., 2011). The ubiquitous nature of these resources allows them to be independent for end-user devices, so the user can acquire the services by using different devices such as: workstations, smartphones, tablets, etc. (Marston et al., 2011).
- **Resource pooling:** Computing resources provided by a service provider are pooled and shared by many consumers without having any control or knowledge of the exact management of the resources (Calabrese & Cannataro, 2015). The resources are either physical or virtual resources and are assigned and reassigned dynamically based on consumer demand (Mell & Grance, 2011).
- **Rapid elasticity:** Computing capabilities are elastically provisioned and released up or down based on customer demands (Mell & Grance, 2011).

- **Measured service:** The services used are measured by metering capabilities and parameters such as storage, processing and bandwidth in order to determine the actual usage (Calabrese & Cannataro, 2015). The measured usage then can be used for charging or for controlling the allocation of the resources (Mell & Grance, 2011).

2.5 Enabling Technologies of Cloud Computing

Cloud Computing is not a stand-alone phenomenon in the IT industry, and consequently some primary technologies need to be explained to support the understanding of Cloud Computing. This section provides an explanation of the enabling technologies of Cloud Computing as illustrated in Figure 2.3.

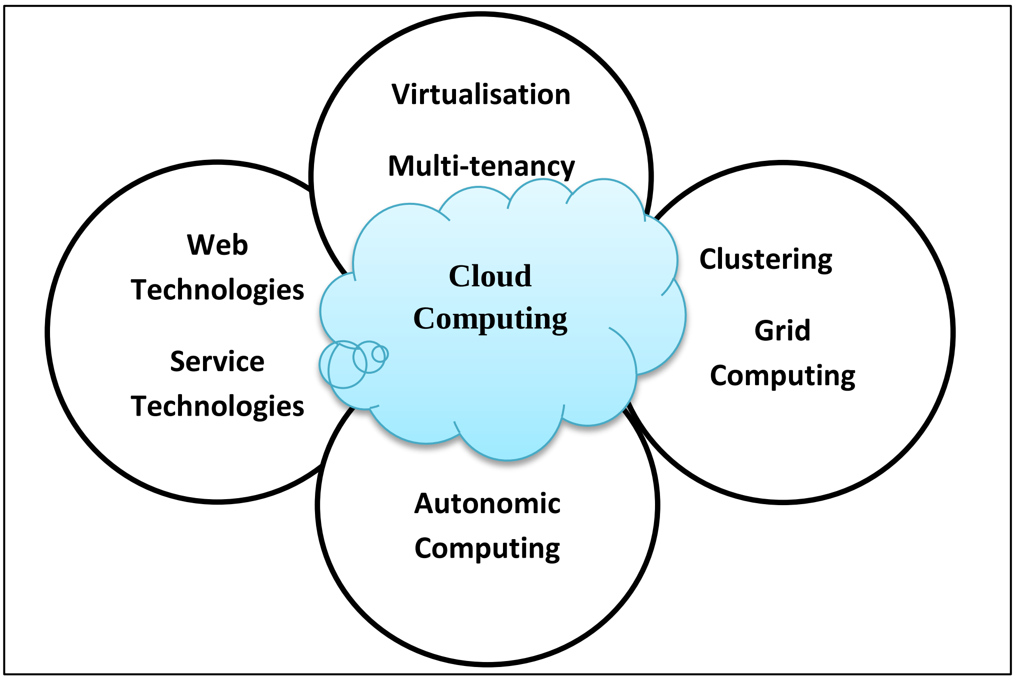


Figure 2.3 Enabling Technologies of Cloud Computing (adapted from Voorsluys et al. (2011)

2.5.1 Virtualisation

Virtualisation is a key technology that has inspired many Cloud Computing characteristics and mechanisms (Sajid & Raza, 2013). It acts as a mask that hides the physical characteristics of computing resources to enhance the simplicity for other systems, applications, or end users interacting with those resources (Erl et al., 2013). Virtualisation means converting one physical

IT resource to multiple logical IT resources (Sultan & van de Bunt-Kokhuis, 2012). This technology provides many benefits, such as: cost effectiveness, elasticity and scalability, hardware independency, customisation, etc. (Sajid & Raza, 2013). In addition, many physical types of IT resources can be virtualised, such as: servers, storage, network, power, etc. (Erl et al., 2013).

2.5.2 Clustering

A cluster is a set of independent IT resources that are connected to work together as a single system (Sadashiv & Kumar, 2011). This technology reduces system failure rates while increasing availability and readability, and these advantages are core to cloud platforms (Erl et al., 2013).

2.5.3 Grid Computing

In grid computing, many computing resources are cooperating together to achieve specific goals, usually to solve computationally complex problems such as advanced scientific research problems (Dillon et al., 2010). Moreover, grid computing uses software called middleware which is responsible for load balancing, control, and configuration management (Erl et al., 2013). Although Cloud Computing is recognised as a descendent of grid computing, there are significant differences between the two (Dillon et al., 2010). While grid computing focuses more on multi-scientific issues, Cloud Computing is driven by specific small-to-medium business requirements. Furthermore, grid computing always attempts to achieve maximum computing capacity while Cloud Computing focuses on on-demand services where scalability is up or down based on user requirements.

2.5.4 Multi-tenancy

Multi-tenancy refers to a principle where a single instance of a particular piece of software runs on a server and it can serve multiple customers (tenants) simultaneously (Anstett et al., 2009). This technology is an important aspect of Cloud Computing. It provides cost efficiency since it decreases maintenance and upgrading costs (Dillon et al., 2010) and promotes customised services for the customers (Anstett et al., 2009).

2.5.5 Web Technologies

Web technology is generally used to provide management tools and medium for cloud services (Erl et al., 2013) since these services are provided over the network using a Web browser (Sajid & Raza, 2013). Some examples of basic web technologies are Uniform Resource Identifiers (URIs) (Yang et al., 2014), Hypertext Transfer Protocol Secure (HTTPS) and Extensible Markup Language (XML) (Mather et al., 2009).

2.5.6 Service Technologies

The main idea of Cloud Computing is to deliver IT as services. Consequently, service technologies are vital for Cloud Computing because they provide a common mechanism for the delivery of services (Buyya et al., 2010). A web service is defined as a software system designed to support interoperable machine-to-machine interaction over a network (Warmer et al., 2009). Two examples of web-based services are REpresentational State Transfer (REST) (Rimal et al., 2011) and Simple Object Access Protocol (SOAP) (Mather et al., 2009). Another type of related technology is the Application Programming Interface (API), which is related to software-to-software communication (Erl et al., 2013). Mashups, where data from multi-web services are integrated together, are important technology for Cloud Computing (Buyya et al., 2010). An example of a mashup service is the Google Maps application which is used to add location information to other applications. Service technologies are also important in Cloud Computing because they provide interoperability.

2.5.7 Autonomic Computing

Autonomic computing seeks to reduce human interaction with systems so that systems can cooperate with limited human guidance (Buyya et al., 2010). Concepts of autonomic computing may eliminate some concerns about Cloud Computing, such as privacy and security. This technology will enable self-provisioning of services, which is one of the main features of Cloud Computing.

2.6 Cloud Computing Service Models

A cloud service model represents the services and the capabilities that will be offered via the cloud. The fundamental service models based on the NIST definition are Software as a Service

(SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) (Mell & Grance, 2011), which are discussed as follows:

2.6.1 Software as a Service (SaaS)

Software as a Service (SaaS) delivers applications running on a cloud infrastructure online and makes them accessible from different types of user devices, usually through the Internet (Mell & Grance, 2011). In this model, there is no need to install and run the application on the user's computer and all maintenance and update procedures will be carried out by the service provider (Voorsluys et al., 2011). The SaaS model also eliminates upfront cost investment while providing users with business-specific capabilities such as email and document management (Marston et al., 2011). In this model, the users have control over their data only, while the service provider has full control of the underlying cloud infrastructure (Mell & Grance, 2011).

SaaS offers advantages over traditional packaged software as it lowers the cost of implementing the applications since there is no upfront cost required (Voorsluys et al., 2011). Additionally, maintenance and upgrade costs are decreased because these operations are carried out on the provider's site (Mather et al., 2009). Scalability is another advantage of SaaS because organisations can scale their services based on consumer demand, using simple software configurations in a short time (Marston et al., 2011). This feature is also important for start-up and small- and medium-size organisations with minimal software requirements at the start, and can be scaled up later.

Issues regarding SaaS are mainly related to the security and confidentiality of the data since the organisation does not control the cloud infrastructure (Mather et al., 2009). Other potential issues associated with SaaS include ensuring service availability, since the access to an SaaS application is through the Internet (Mather et al., 2009); integration with other services and applications (Gupta et al., 2013); and vendor lock-in SaaS model, since the data format will be dependent on the service provider format (Phaphoom et al., 2015). When organisations plan to use cloud solutions, they often consider an SaaS model. A study by IDG Enterprise reported that SaaS applications are responsible for 67% of the organisations' cloud payment (IDG Enterprise, 2016).

2.6.2 Platform as a Service (PaaS)

Platform as a Service (PaaS) offers services for the users to develop and deploy applications in the cloud environment (Mell & Grance, 2011). This model allows the users to maintain the complete application development lifecycle from designing until debugging the application (Hudaib et al., 2014). In this model, the users have control over their data and applications under development while the service provider has full control of the underlying cloud infrastructure (Mell & Grance, 2011). The potential users of PaaS are software developers since this model provides them with programming language execution environments, web servers and databases (Dai et al., 2012). PaaS enables rapid development of software applications at low costs (Mather et al., 2009). It is also useful in developing specific applications that require powerful computing resources such as Big Data analysis (Dai et al., 2012). The PaaS model can provide standardisation for application development since it allows different teams to work on a single platform (Mather et al., 2009). Additionally, some cloud providers offer consultancy in SaaS or PaaS platforms for organisations (Hudaib et al., 2014).

Cloud provider requirements are considered an issue when working with PaaS since, for example, it may be that only specific programming languages can be used (Voorsluys et al., 2011). As with SaaS, lack of portability is also considered an issue with PaaS adoption (Phaphoom et al., 2015). Since the PaaS model is relevant to a specific type of activities (i.e. application development), it is less popular than other types of cloud service models (Chuang et al., 2015). However, this model is becoming more popular in some countries with less developed IT infrastructures, such as in some Asian and Latin American countries. A study by Oxford Economics and SAP (2015) found that 58% of Asia-Pacific organisations and 34% of Latin American organisations offered PaaS platforms to their developers, compared to 23% of North American organisations.

2.6.3 Infrastructure as a Service (IaaS)

Infrastructure as a Service (IaaS) offers IT resources such as operating systems, servers and storage devices as a service through the Internet (Mell & Grance, 2011). In this model, the consumer can control storage, operating systems and applications but does not have any control over the underlying cloud infrastructure (Mell & Grance, 2011). The resources in this model will be utilised as virtualised resources and the consumer can control them using Virtual

Infrastructure Manager (Voorsluys et al., 2011). In IaaS, computing services are offered as utility services and the user pays for the amount of computing resources used as a pay-per-use model where there is no need for upfront IT investment (Mather et al., 2009).

The IaaS model offers advantages over the traditional IT model since it provides scalability features where IT resources can be scaled up based on actual demands more quickly than in traditional IT (Pauly, 2011). IaaS also provides cost savings because it does not require capital expenditure investment and the cost of infrastructure management comes under the cloud provider's responsibilities (Marston et al., 2011). The IaaS model allows an organisation to reach Best-of-Breed technology and services which are usually not available to organisations, either for financial or technical reasons (Mather et al., 2009).

One concern with using IaaS is the possibility of losing governance of the infrastructure, which may lead to security issues (Lin & Chen, 2012). Although security aspects are considered as a challenge for most cloud service models, security is seen as a more challenging issue in an IaaS environment because the organisations – rather than the service provider – are responsible for all aspects of their application security (Mather et al., 2009). Another issue with the use of IaaS is related to the type of user because an IaaS approach requires users with specific system administration skills (Hudaib et al., 2014). Thus, the IaaS model is more suitable for larger organisations with existing IT capabilities (Hsu et al., 2014). The IaaS model serves more consumer types (i.e. end users, IT professionals with or without specialised system administration skills) than the PaaS model but less than the SaaS model (Chuang et al., 2015), and IaaS has been recognised by many organisations as providing a cloud service model with more promising benefits, although requiring more technical skills. A study by IDG Enterprise (2016) found that the studied organisations allocated 30% of their cloud budget to the IaaS model.

Table 2.1 presents a comparison between the three Cloud Computing Service Models. Cloud Computing support delivers other capabilities as services which are referred to as X Service (XaaS); examples include Data as a Service, Security as a Service, Business Processes as a Service, etc. (Dai et al., 2012; Loebbecke et al., 2011; Armbrust et al., 2009). The three models (SaaS, PaaS, IaaS) are the fundamental service models based on the NIST definition (Mell & Grance, 2011).

Table 2.1 Comparison between Cloud Computing Service Models

Features	SaaS	PaaS	IaaS
Control of resources (for all models, there is no control over the underlying cloud infrastructure)	Control is over the data only	Control is over the data and deployed applications	Control is over operating systems, storage, deployed applications and data
Consumer type	End users without high-level IT skills	Software developers without specialised system administration skills	IT professionals with specialised system administration skills
Industrial Examples	Salesforce, NetSuite, Google Apps, Office 365	Microsoft's Azure Services Platform, Salesforce's Force.com, Google AppEngine	Amazon's Simple Storage Service (S3), Microsoft's Azure Services Platform

2.7 Cloud Computing Deployment Models

The term Cloud Deployment Model refers to the type of cloud environment with variations in management, ownership, access and physical location (Voorsluys et al., 2011). Based on the NIST definition (Mell & Grance, 2011), there are four deployment types, which are outlined as follows:

2.7.1 Public Cloud

A public cloud is the cloud infrastructure that is available over the Internet from a third-party cloud provider and can be accessed and used by the general public (Mell & Grance, 2011). The cloud provider can manage, own and operate the cloud infrastructure, which exists in the prover’s premises (Rimal et al., 2011; Mell & Grance, 2011). A public cloud can be used by different types of consumers such as organisations of all sizes and individuals, based on a pay-per-use model (Marston et al., 2011). The provider of a public cloud can be commercial, academic or a government organisation, or some combination of them (Mell & Grance, 2011). Popular commercial cloud providers include Amazon, Microsoft, Google and Rackspace (Voorsluys et al., 2011). Examples of Cloud Computing initiatives at governmental level are G-Cloud in the UK, Kasumigaseki Cloud in Japan and the European Union’s EuroCloud (Maqueira-Marín et al., 2017).

public cloud services can offer cost savings to organisations, as they will not need to invest in upfront IT costs and will pay for their actual usage as a pay-per-use model (Marston et al., 2011). Self-provisioning features of a public cloud can provide elasticity and scalability advantages since services are provisioned and released up or down based on customers' real needs (Pauly, 2011). A public cloud also presents good opportunities for small- and medium-sized organisations because it enables them to use advanced computing resources that were previously available only to large corporations without the need for upfront capital investment (Marston et al., 2011). According to Marston et al. (2011), a public cloud can help countries that lack powerful IT resources, such as third-world countries, and allow them to provide better IT services. Some large organisations are also starting to use cloud-based solutions to accomplish certain specific jobs such as data recovery and research and development activities. For example, a global biotechnology enterprise such as Pfizer has used Amazon services to conduct scientific data processing (Cianfrocco & Leschziner, 2015).

The adoption of public cloud services is still facing some concerns regarding security, vendor lock-in and regulatory compliance. Security becomes a key concern when adopting public cloud since organisations have to move their data outside their premises and have less control over both physical and virtual assets (Mohapatra & Lokhande, 2014). Legal considerations regarding data protection and privacy regulations and data locations are obstacles to public cloud adoption (Marston et al., 2011). The lack of cloud standards leads to concerns about vendor lock-in, which restricts the ability of organisations to change cloud providers (Phaphoom et al., 2015). Other concerns about a public cloud may include availability of cloud services and the hidden costs of implementing such a model (Lin & Chen, 2012). Nonetheless, some organisations are considering public cloud services. A study has shown that 30% of the surveyed organisations have adopted some public cloud services and the market for the public cloud is expected to grow from US$75 billion in 2015 to US$522 billion by 2026 (North Bridge, 2016).

2.7.2 Private Cloud

Private cloud refers to a cloud infrastructure used exclusively by a single organisation. A private cloud is managed and operated internally by the organisation or by a third-party provider within or outside the organisation's premises (Mell & Grance, 2011). The private cloud differs from traditional IT due the implementation of virtualisation technologies and self-service interfaces that allow scalability and per-usage metering features (Voorsluys et al., 2011). The private cloud can be classified based on location and management control into different types such as: classic, managed, dedicated and virtual (Shimba, 2010; Loebbecke et al., 2011; Marston et al., 2011). A private cloud can provide advantages over traditional IT such as: cost reduction in software and maintenance activities, better transparency about the Total Cost Ownership (TCO), improved IT agility and better resource utilisation (Marston et al., 2011). It can also offer benefits over a public cloud since it allows for more security control over the organisation's data, enhanced Quality of Service and better compliance with regulations (Christian et al., 2011). Concerns about private clouds include high capital expenditure of IT infrastructure (Marston et al., 2011), cost of migration (Lin & Chen, 2012) and lack of resources and expertise (Mohapatra & Lokhande, 2014).

The private cloud is considered to be applicable for large organisations that have sufficient resources since it provides the benefits of a public cloud with better security and control over the infrastructure (Marston et al., 2011). A report has shown that the percentage of private cloud implementation increased by 13% between 2015 and 2016 (RightScale, 2016).

2.7.3 Community Cloud

Community cloud refers to a cloud infrastructure where computing resources are shared by several organisations that have shared concerns and requirements (Mell & Grance, 2011). In this model, a group of organisations or a single organisation can handle and operate the cloud environment or even use a third-party provider, and the cloud may exist on or off their premises (Mell & Grance, 2011). Community clouds usually support specific tasks and goals such as academic and science activities (Barker et al., 2014). For example, the Open Cirrus Project is a community cloud where a consortium of academic institutions and large cloud providers are collaborating to offer access to large-scale computing resources to individual academic institutions (Barker et al., 2014). Another example of a community cloud that supports specific requirements is the implementation of a community cloud by the US Federal Government (Marston et al., 2011).

A community cloud can offer the benefit of sharing computing resources and IT infrastructure which is regarded as one of the benefits of the public cloud (Mell & Grance, 2011). It also offers flexible architecture at a cheaper cost than when compared to an individual private cloud because the cost is divided among many organisations (Carroll et al., 2011). Additionally, this type of cloud deployment allows for more control of security requirements when compared to public cloud deployment (Mell & Grance, 2011). Environmental sustainability is another benefit of a community cloud since it will lead to less energy consumption compared to a dedicated private cloud (Marinos & Briscoe, 2009). The issues relating to the community cloud are around managing the heterogeneous systems of the community members, and control over resources between the members (Marinos & Briscoe, 2009). However, the interest in community Cloud Computing is growing and some public cloud vendors and academic institutions are working to provide more community cloud support (Barker et al., 2014).

2.7.4 Hybrid Cloud

A hybrid cloud is a cloud infrastructure that combines two or more different cloud infrastructures (i.e. public, private and community) (Mell & Grance, 2011). In this model, a private cloud is usually complemented by computing resources from public cloud providers (Voorsluys et al., 2011), which allows organisations to gain the benefits of each style of cloud model. A hybrid cloud offers organisations the ability to keep critical services and data internally and outsource non-critical services to the public cloud (Marston et al., 2011).

The hybrid cloud provides organisations with advantages similar to the public cloud such as on-demand scalability, cost savings and extra resources support (Chang et al., 2014a; Mohapatra & Lokhande, 2014). The hybrid model can offer better security and legal requirements since sensitive data will be inside the organisation's boundaries (Mohapatra & Lokhande, 2014). The hybrid model can also be used to support specific activities such as backup and recovery and testing processes (Mohapatra & Lokhande, 2014). Hybrid cloud implementation still faces some difficulties such as ensuring compatibility between different applications and devices (Rimal et al., 2011). Integrating the different cloud architectures could lead to additional complexity in maintenance and configurations (Chang et al., 2014a). Although use of a hybrid cloud decreases the data security concerns associated with a public cloud, there are still some concerns regarding security issues such as authorisation and identity management (Toosi et al., 2014).

The hybrid cloud is an emerging model and some researchers argue it will become the leading cloud deployment model (Ferrer et al., 2012; Yigitbasioglu, 2015). A report showed that the percentage of hybrid cloud model use increased from 58% in 2015 to 71% in 2016 (RightScale, 2016).

Table 2.2 shows a comparison between the four types of Cloud Computing Deployment Models.

Table 2.2 Comparison between Four Types of Cloud Computing Deployment Models adapted by the author (Rimal et al., 2011)

Features	Public Cloud	Private Cloud	Hybrid Cloud	Community Cloud
Payment Model	Pay-per-use model	TCO	Combination of pay-per-use model and TCO	TCO
Management	Public cloud provider	The organisation or third-party provider	Public cloud provider and the organisation	One or more organisations in the community or third-party provider, or some combination of them
Location	Outside the organisation's premises	On or outside the organisation's premises	On and outside the organisation's premises	On or outside the organisation's premises
Cost	Low: no upfront cost	High: upfront cost	Medium	Relatively cheaper than private and hybrid cloud
Security	Some security concerns	Fewer security concerns	Some security concerns but less than Public Cloud	Some security concerns
Consumer Base	Public (i.e. organisations of different sizes, individuals)	Single organisation (usually large organisations)	Single organisation	Group of organisations

2.8 Drivers of Cloud Computing

In the literature and industrial reports, researchers and practitioners have recognised many benefits and advantages that drive organisations to adopt Cloud Computing, and the key advantages of Cloud Computing include the following:

2.8.1 Technical Benefits

Technical benefits are indicated in many studies and reports as important drivers for organisations to adopt Cloud Computing (Carroll et al., 2011). The technical advantages of implementing cloud solutions are discussed as follows:

- **Scalability and elasticity:** Cloud Computing scalability feature has led many organisations to implement this model. This feature refers to the ability of the system to perform well when dealing with an increasing load on it (Gupta et al., 2013). Scalability was identified as the main driver for Cloud Computing adoption in North Bridge Future of Cloud Computing surveys in 2011, 2015 and 2016 (North Bridge, 2016) and the second most important factor in other reports (IDG Enterprise, 2016; Cloud Industry Forum, 2016). This feature is linked to elasticity, which refers to the ability of computing resources to be elastically provisioned and released up or down based on customers' real needs (Khanagha et al., 2013). Both features are important for organisations, allowing them to react to customers' needs quickly without the need to invest in extra IT resources (Pauly, 2011). The scalability feature is useful especially for Start-up and Small and Medium Sized (SME) organisations which can start with limited computing capabilities and expand these capabilities only when required (Chuang et al., 2015). Elasticity also provides cost savings for organisations since they can use a pay-per-use model and only increase their computing resources when there is a demand (Pauly, 2011). About 70% of finance executives who participated in a survey stated that Cloud Computing implementation improved their organisation's ability to add, remove and modify IT capabilities on demand (CFO, 2012).

- **Improve IT agility:** Cloud Computing also improves organisations' IT agility as it enables them to reduce the time between identifying the need for a new IT resource and delivering it (Oliveira et al., 2014). This capability has been reported as one of the main drivers for adopting Cloud Computing solutions in a Harvard Business Review report (Harvard Business Review, 2015).

- **Faster and better access to IT resources:** Cloud Computing can offer organisations access to the most current and cutting-edge IT resources without these having to be physically available at the organisations (Durao et al., 2014). In one study, 70% of the organisations surveyed were satisfied with the ability of Cloud Computing to grant them access to the best and newest technologies (CFO, 2012). Cloud Computing is a facilitator and a platform to use and develop advanced techniques and technologies like Big Data and Internet of Things (IoT) (Raghupathi & Raghupathi, 2014).

- **Improve availability of IT resources:** Cloud Computing delivers increased flexibility in using IT resources and improves availability of IT resources and business services by increasing system availability (up time) (Weinman, 2012). For example, some Cloud Computing providers achieve 99.9994% uptime (i.e. only three minutes of unavailability each year) (Cloud Standards Customer Council, 2012). Data availability can be improved also through Cloud Computing backup services, which will increase service availability (Weinman, 2012).

- **Improve the performance of IT departments:** Cloud Computing can improve the performance of IT departments by reducing maintenance time and efforts (Chang et al., 2014a). For example, the IT department at the Government of Maharashtra in India uses Cloud Computing services to complete planned maintenance without requiring any downtime of their applications (Mohapatra & Lokhande, 2014). Cloud Computing could also allow IT departments to gain access to the specialised technical skills and services of the cloud vendor, which could increase organisations' IT competences and capabilities (Sultan, 2014).

- **Better IT resources utilisation:** Cloud Computing also helps enterprises to enhance their IT resources utilisation rates (Marston et al., 2011). For example, a study showed that organisations' servers are only using 10 to 30% of their available computing power (Durao et al., 2014) while this percentage has been shown to increase to more than 70% when using Cloud Computing (i.e. private and hybrid models) (Garg & Buyya, 2012). Consequently, higher utilisation rates will lead to improving energy reduction, which supports green computing efforts and provides extra cost savings (Marston et al., 2011).

- **Green Computing:** Public cloud providers can adopt practices that make their data centres support green computing, such as using renewable energy resources. cloud service providers can improve the power efficiency of their data centres by 40% compared to traditional data centres (Garg & Buyya, 2012).

- **Better backup and disaster recovery services:** Cloud Computing can also improve backup and disaster recovery services since data may be stored in multiple locations at the same time, which will minimise the risk of the data being lost (Hsu et al., 2014). In one study, 59% of USA and UK organisations indicated that Cloud Computing had improved their disaster recovery and business continuity (Nicholson et al., 2013).

2.8.2 Economic Benefits

Cloud Computing can provide many financial and economic benefits which can be quantified in terms of money either generated or saved. Economic considerations have been found to have a significant influence on an organisation's decision to move towards the Cloud Computing model. Factors related to business are considered as the main drivers for Cloud Computing adoption in many surveys (Carroll et al., 2011). The following section will outline the economic benefits of adopting Cloud Computing:

- **Cost Reduction:** For many organisations, cost saving is one of the main reasons to adopt Cloud Computing solutions (Armbrust et al., 2010; Marston et al., 2011). For example, the North Bridge Future of Cloud Computing Survey in 2011 showed that cost was the second driver for organisations to move to Cloud Computing and it was still ranked as the third primary driver in the 2016 survey (North Bridge, 2016). A study showed that 37% of organisations had the potential to achieve cost saving when implementing Cloud Computing solutions (RightScale, 2015). Cloud Computing can offer cost optimisations for organisations in different areas such as hardware costs, software costs, IT labour and energy consumption costs (Carroll et al., 2011). However, the selected delivery and service of the Cloud Computing model will determine the actual cost saving. While the public cloud delivery model can reduce the cost of hardware, the private cloud delivery model can lead to cost savings in other areas such as software and maintenance activities (Carroll et al., 2011; Chang et al., 2014b). A study conducted by Google and CFO Research indicated that 79% of the interviewed finance executives anticipated that implementing a Cloud Computing project would lead to a 20% to 15% cost reduction in their organisation's IT budget (CFO, 2012). The participants of the CFO survey showed cost reductions in different categories such as hardware-related costs (71% of the participants), costs related to system backup and data recovery (66%), software-related costs (66%) and IT labour costs (59%) (CFO, 2012). Another example of cost saving is the Maharashtra Government in India, which saved Rs. 500 million (approximately £5m) by using Cloud Computing solutions (Mohapatra & Lokhande, 2014).

- **Moving CapEx to OpEx:** Another economic benefit of Cloud Computing arises from converting **Cap**ital **Ex**penses (**CapEx**) to **Op**erating **Ex**penses (**OpEx**) (Armbrust et al., 2009). A "Pay per use" model allows organisations to pay for Public Cloud Computing provision according to the actual consumption of computing resources without the need to invest in costly IT capital expenses (Chuang et al., 2015). This advantage was reported by many organisations' executives as an important business factor to consider when implementing Cloud Computing solutions. For example, 23% of surveyed UK organisations have gained a reduction in capital IT expenditure by adopting Cloud Computing (Cloud Industry Forum, 2016). Consequently, organisations can spend more on core business activities by reducing IT upfront capital expense (Armbrust et al., 2009).

- **Improving TCO:** Total Cost of Ownership (TCO) for IT services in organisations is estimated to be reduced by between 10% and 30% by using Cloud Computing (Thakur et al., 2014). The implementation of a private cloud will increase the level of transparency regarding TCO with some cost savings in operational expenses (Marston et al., 2011). Improved transparency can be achieved using a Cloud Computing model which allows for measuring and monitoring the resources usage and IT operational expenses at a business unit level more precisely (Marston et al., 2011). Lowering TCO has been shown to be a driver of Cloud Computing adoption for 29% of UK organisations (Cloud Industry Forum, 2016).

- **Increased Revenue:** A study by the Harvard Business Review found that 40% of enterprises using Cloud Computing have increased their revenue and 36% increased their profit margin (Harvard Business Review, 2015). The study also showed that, as well as providing cost savings, Cloud Computing can also allow the organisations to provide new services and products and to expand their market segments.

2.8.3 Organisational Benefits

Cloud Computing offers the organisations additional benefits besides the economic and technical benefits, which will be discussed as follows:

- **Lower IT barriers to innovation:** Many studies have shown that Cloud Computing can inspire innovation culture in organisations in many ways (Armbrust et al., 2009). For example, 50% of the respondents to the Harvard Business Review survey claimed that Cloud Computing increased their organisation's ability to innovate (Harvard Business Review & Oracle, 2015). Cloud Computing can lower IT barriers to innovation by providing organisations with access to the latest technologies that were not previously accessible because of price and availability issues (Marston et al., 2011).

- **Allowing more time to be spent on innovation and development:** Cloud Computing also frees an organisation's IT staff to spend more time on strategic initiatives and innovation. For instance, 60% of surveyed USA and UK organisations reported that Cloud Computing had allowed their IT staff to focus more on strategy and innovation activities instead of operational and maintenance activities (Nicholson et al., 2013).

- **Allowing more financial support for innovation:** Cloud Computing implementation can support the innovation process in organisations since it offers them financial savings and allows them to reinvest the money in product and service innovation. About 50% of surveyed USA and UK organisations expected that the money saved from Cloud Computing adoption would be reinvested in innovation activities (Nicholson et al., 2013).

- **Enabling a flexible workforce:** The ubiquitous nature of the cloud offers more flexibility for employees to work independently from any device and location (Hsu et al., 2014). Enabling flexible and mobile access to information was found to be one of the benefits that drive business transformation into Cloud Computing (KPMG, 2014; CFO, 2012).

- **Allowing the delivery of new services, applications, and business models:** Cloud Computing helps organisations to provide new services that were not possible before due to the previously higher costs for IT solutions (Marston et al., 2011). This was found to be one of the main benefits of Cloud Computing adoption in 28% of a number of surveyed UK organisations (Cloud Industry Forum, 2016). Services and applications related to Big Data, mobile technology and Internet of Things are examples of candidate services supported by Cloud Computing (Botta et al., 2016). Additionally, Cloud Computing can support organisations in the movement towards new business models and new markets (Shayan et al., 2013; Marston et al., 2011). For example, 44% of senior business and IT executives in the Oxford Economics and SAP report indicated that their organisations will rely on Cloud Computing to introduce new business models (Oxford Economics & SAP, 2014).

- **The ability to react quickly to changing and dynamic business conditions:** Another benefit of implementing Cloud Computing is the ability to react quickly to changing and dynamic business conditions by providing real-time information about the business, such as health informatic applications which are linked to sensors (Kuo, 2011). For example, 23% of the participants in an IDG survey outlined that Cloud Computing solutions provide their organisations with the flexibility to respond to changing market conditions (IDG Enterprise, 2016).

- **Improving employees' collaboration:** The studies also indicated that the adoption of Cloud Computing will improve collaboration between an organisation's employees by using features such as mobile access and version control (Morgan & Kieran, 2013). A Harvard Business Review report showed that increased collaboration was the top benefit of implementing cloud solutions (Harvard Business Review, 2015).

Evaluating the literature and industrial reports shows that technical and economic benefits are the main drivers of Cloud Computing adoption. However, organisational benefits such as delivering new services and applications, ability to react quickly to changing market conditions and enabling innovation have been recognised in many studies, and the strategic values of Cloud Computing increase as it matures. Figure 2.4 shows the results of a study by IDG where organisational benefits were considered among the most highly cited drivers of Cloud Computing implementation (IDG Enterprise, 2016).

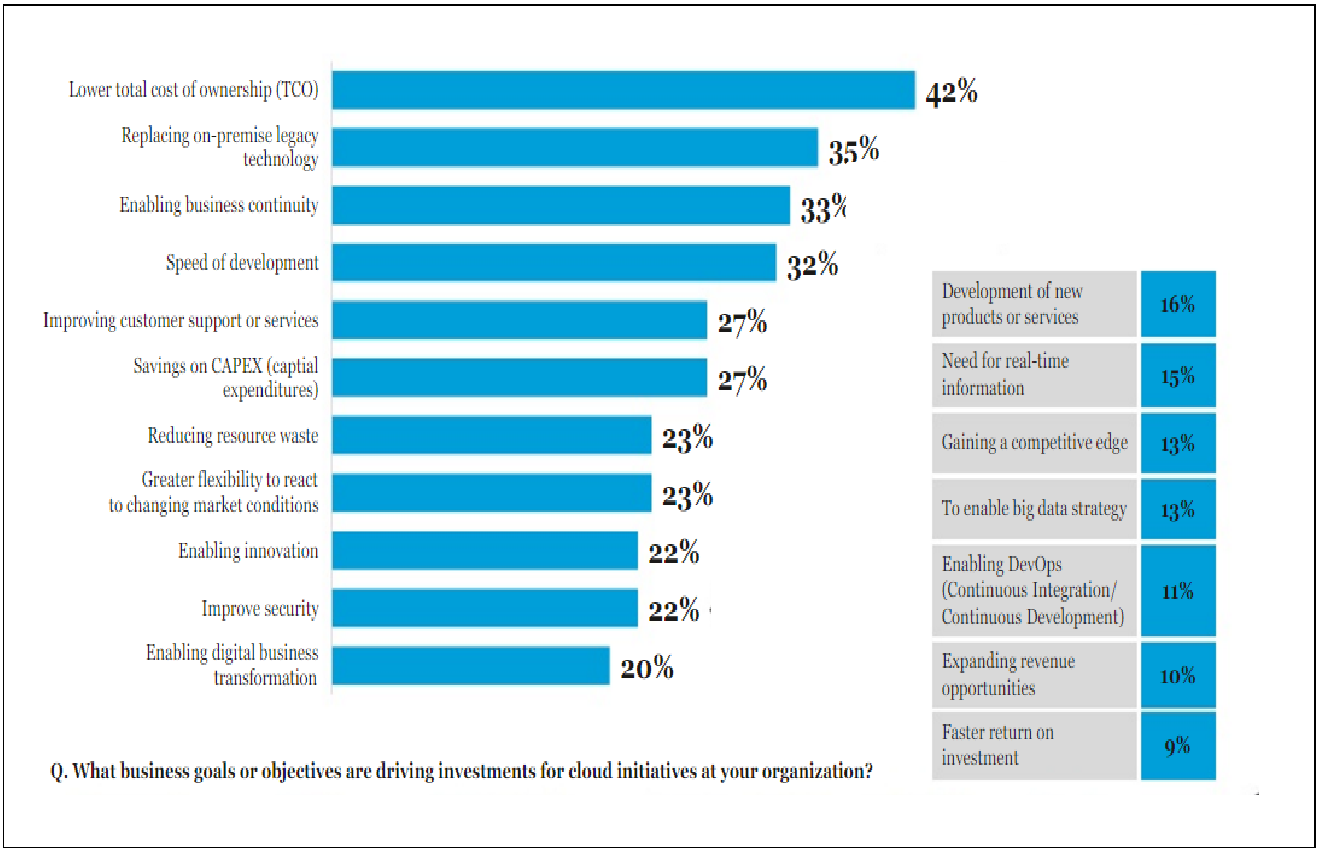


Figure 2.4 Drivers of Cloud Computing (IDG Enterprise, 2016)

2.9 Issues with Cloud Computing

Although Cloud Computing delivers various benefits and advantages to enterprises, there are still some issues that may hinder its adoption. These concerns are divided in this research into three main categories, which are Security Concerns, Technical Concerns and Non-Technical Concerns (Chen et al., 2011).

2.9.1 Security Issues

Although security concerns can be part of technical concerns, they will be discussed separately since several studies have mentioned that they are one of the main challenges of Cloud Computing adoption (Phaphoom et al., 2015; Carroll et al., 2011). Security concerns are discussed as follows:

- **General security concerns:** A North Bridge Future of Cloud Computing Survey in 2012 showed that 55% of interviewed experts and users consider security challenges to be an inhibitor for Cloud Computing adoption (North Bridge, 2012). However, this percentage had decreased to 38.6% in the 2016 survey (North Bridge, 2016), probably as adoption increased. However, a study by the Harvard Business Review (2015) showed that business and technology leaders continue to have concerns about security issues (62%). A study conducted by Phaphoom et al. in (2015) found that security challenges were a big concern for non-adopters of Cloud Computing. A Cloud Forum report found that 75% of UK organisations surveyed stated that security concerns were the main reason for not migrating to Cloud Computing (Cloud Industry Forum, 2016). An example of a security incident is the data breach that occurred for BitDefender, a security firm using a public cloud, which led to the release of sensitive information about an undisclosed number of customers (Cloud Security Alliance, 2016). Some possible security risks associated with the cloud-based development are related to the PaaS model which includes the possibility of a service provider being able to access any objects or application that reside on its hosts, an attack by a third party, an attack by the tenants at the same host (Sandikkaya & Harmanci, 2012). There are proposed solutions for such challenges such as Trusted Computing Base (TCB), Encrypted objects and Proxy Certificates (Sandikkaya & Harmanci, 2012).

- **Loss of control over data:** Although different types of cloud deployment models involve different security protocols, most of these considerations are related to the adoption of a public cloud model or any model that involves service providers (Carroll et al., 2011). A possible explanation may be the loss of control over security mechanisms since most of these critical mechanisms come under the cloud provider's responsibilities (Phaphoom et al., 2015). Although some IT professionals argue that security challenges have always been part of the IT environment (Borgman et al., 2013), Cloud Computing has brought new security challenges; these include issues related to data confidentiality, integrity and availability (Benslimane et al., 2014; Carroll et al., 2011).

- **Data confidentiality:** Data confidentiality refers to the prevention of unauthorised collection or disclosure of data (Avižienis et al., 2004). In a Cloud Computing environment, organisations use the cloud provider's infrastructure to store data at the risk of exposure to a third party, which increases the risk of data breach (Mather et al., 2009). However, confidentiality risks can be reduced by applying additional technical solutions such as encryption, Key-based Trust Models and a robust access control framework (Mather et al., 2009; Rathi & Kumari, 2015).

- **Data integrity:** A study conducted by SAP and Oxford Economics showed that 40% of IT leaders have some concerns about unauthorised access to sensitive data (Oxford Economics & SAP, 2015). Although some argued that data integrity – which is about protecting the data from unauthorised alterations (Avižienis et al., 2004) – can be maintained effectively in a Cloud Computing environment via Secure Digital Signatures tools (Mather et al., 2009), some cloud technologies such as virtualisation can lead to additional risks (Cloud Security Alliance, 2016).

- **Availability of cloud services:** Although it has been argued that risks associated with the availability of data and services are not new to information technology industries (Mather et al., 2009), these issues have increased in Cloud Computing (Carroll et al., 2011). Assuring high availability of cloud provider services is one of the threats that face Cloud Computing adoption. The overall industry yearly average of uptime for all cloud providers is 99.999% of uptime, which is only three minutes of unavailability each year (Gupta et al., 2013; Alami et al., 2015). However, some cloud providers have experienced service outages, for example, the service outage in the Amazon Web Service (AWS) public cloud which occurred in 2012 (Cloud Security Alliance, 2016) and in 2017 (Smolaks, 2017). Another issue related to availability is the possibility of cloud providers leaving the business market in the future (Mather et al., 2009). For example, Google Health, which was a Cloud-based personal health record system, was discontinued in 2011 and this forced users to download or transfer their data to other providers (Ekonomou et al., 2011).

- **Data privacy:** Data privacy related to security has also been found as a challenge to Cloud Computing adoption (Phaphoom et al., 2015). According to a KPMG cloud report, 53% of the participants clarified that data loss and privacy risks are the challenges affecting their organisation's implementation of cloud solutions (KPMG, 2014).

Although security concerns have been reported as a main concern in relation to Cloud Computing, these concerns have become less challenging and cloud adopters are able to address some of them via better governance, security practices and robust Service Level

Agreements (SLAs), and proven adoption (Mather et al., 2009; Borgman et al., 2013). It has been argued that leading cloud providers are able to provide advanced data security measures better than some organisations (Kumar et al., 2015). For example, a RightScale report showed that the top challenge for adopting Cloud Computing is not security: security challenges were cited by only 32% percent of the respondents (RightScale, 2016). Another report showed that 99% of 250 senior IT and business decision-makers have not experienced any breach of security when implementing Cloud Computing in UK organisations (Cloud Industry Forum, 2016).

2.9.2 Technical Issues

The spread of Cloud Computing solutions has raised some technical concerns. These concerns are issues that are related to the technical side of Cloud Computing implementation (Phaphoom et al., 2015). The technical concerns of Cloud Computing implementation are divided as follows:

- **Integration with existing IT infrastructure:** Integrating Cloud Computing solutions with existing IT infrastructure is a challenge for some organisations since they have already invested in IT resources. Thus, the movement towards Cloud Computing for some organisations will require additional effort in terms of configuration management to ensure compatibility and integrity (Durao et al., 2014). A survey conducted by KPMG showed that Cloud Computing integration with existing IT architecture was found to be challenging by 46% of the survey respondents (KPMG, 2014).

- **Reliability:** Reliability is another concern for organisations that are planning to adopt Cloud Computing because they need to ensure constant operation of their IT services (Güner & Sneiders, 2014). Reliability refers to the capability of the cloud provider to offer continuity of IT services in the case of system disruption; reliability can be improved via utilisation of redundant resources (Chang et al., 2014a).

- **Performance**: Another issue related to the technical side of Cloud Computing is performance, which refers to the ability to deliver a specified job within a given time (Chang et al., 2014a; Phaphoom et al., 2015). Performance was mentioned by only 9% of the participants in a Harvard Business Review report as a barrier to Cloud Computing adoption (Harvard Business Review, 2015). Performance could be affected by factors, such as internal IT infrastructure and bandwidth (Chung, 2014).

- **Vendor lock-in:** Other technical issues are related to the dependency on cloud services vendors, and these issues are portability and interoperability. While portability refers to the ability of organisations to move their data between different cloud vendors or back in house (Phaphoom et al., 2015), interoperability is the ability of different systems to exchange information (Lupşe et al., 2012). Both issues can lead to vendor lock-in, where customers can be locked into a single cloud vendor and unable to switch vendor without considerable cost and technical difficulties (Toosi et al., 2014). Vendor lock-in concerns were considered by 25% of UK organisations to be an inhibitor of cloud adoption (Cloud Industry Forum, 2016). However, there are efforts to provide standardisation and initiatives to create an inter-cloud environment that supports both interoperability and portability (Toosi et al., 2014). Additionally, traditional SLAs may not provide a high level of transparency, so it is the client's responsibility to manage the IT resources through robust SLAs (El-Gazzar et al., 2016).

2.9.3 Non-Technical Issues

In addition to the technical challenges, there are non-technical issues that may affect Cloud Computing adoption. Non-technical concerns relating to Cloud Computing are discussed as follows:

- **Legal concerns** The implementation of cloud solutions by external providers can introduce legal concerns for many organisations, such as data protection and privacy aspects (Ferrer et al., 2012). Concerns about legal and compliance requirements have been identified as challenges for organisations planning to adopt Cloud Computing in many studies. For example, in one study, legal and regulatory compliance was cited by 46% of the respondents as a challenge to adopting cloud solutions (KPMG, 2014). A study by the Harvard Business Review showed that compliance requirements were reported by 25% of the participants as barriers to cloud adoption (Harvard Business Review, 2015). An example of legal considerations relating to Cloud Computing is the compliance with data confidentiality regulations such as the USA Health Insurance Portability and Accountability Act (HIPAA). European countries require organisations to store data physically within European Union countries or in other countries that ensure an adequate level of protection (Bowen, 2011). Although both Cloud Computing providers and the organisation must comply with regulations that monitor security and data privacy issues, it is the organisation's responsibility to make sure that the provider applies appropriate security controls and complies with regulatory laws (Schweitzer, 2011). For example, HIPAA regulations require American organisations to have a clause in their IT projects' contracts confirming that the provider will follow specific security rules and processes (Schweitzer, 2011).

- **Hidden costs:** Organisations planning to adopt Cloud Computing Services could face some issues regarding the hidden costs of implementing such services, which may include application migration cost, human resource cost and integration cost (Lin & Chen, 2012). For example, public cloud providers apply bandwidth charges for outbound data transfers (i.e. data going out of the provider's data centres) and the charges could be higher for large data transactions (Desai, 2016). There is also the possibility of open-ended revenue commitments if the organisation does not carefully specify its requirements. Concerns regarding these costs have been found in some studies; for example, 13% of the participants in the Harvard Business Review report (2015) and 18% of the participants in the Cloud Industry Forum report (2016) had such concerns. Organisations are advised to conduct an economic analysis to ensure the economic benefits of implementing cloud solutions are not overestimated (Schweitzer, 2011). Although there are some concerns about the hidden cost of Cloud Computing, certain studies have shown that Cloud Computing is more cost-effective in terms of TCO (Dhar, 2012; Marston et al., 2011; Ajeh et al., 2014).

- **Change resistance:** Cultural resistance is an organisational concern that could affect Cloud Computing implementation. A study found that 16% of the participants reported that concerns about employee adoption are a barrier to Cloud Computing adoption in their organisations (CFO, 2012). Resistance to technology is considered from two potential reasons, which are the fear of staff losing their jobs or the potential increase in workload (Mohapatra & Lokhande, 2014). However, effective change management can mitigate these concerns and allow for a successful transition to Cloud Computing (Mohapatra & Lokhande, 2014).

- **Lack of resources and expertise:** Another concern related to the adoption of Cloud Computing is the lack of resources and expertise in managing Cloud Computing implementation. This concern was cited as the first challenge for Cloud Computing adoption (RightScale, 2016). However, this challenge can be addressed by providing additional training for the appropriate adoption of cloud solutions (Mohapatra & Lokhande, 2014).

Reviewing Cloud Computing concerns showed that, as organisations become familiar with Cloud Computing solutions and gain more experience, their concerns decline and move from security aspects to other managerial aspects.

Figure 2.5 presents results from an industrial report about Cloud Computing challenges which showed that, although security concerns are still one of the main concerns when adopting Cloud Computing, organisations also had other concerns such as availability of human resources and regulation compliance (RightScale, 2016).

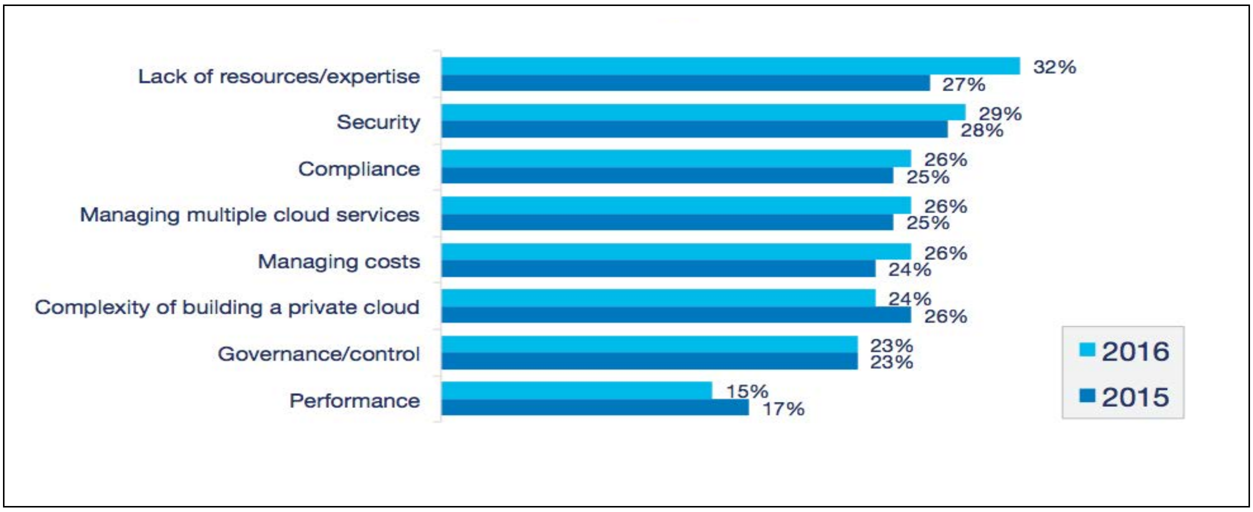


Figure 2.5 Cloud Computing over two years, 2016 and 2015 (RightScale, 2016)

Despite the concerns relating to Cloud Computing adoption, it is still growing, since, according to a 2016 report, 70% of surveyed organisations had at least one application or part of their IT resources in the cloud and an extra 16% were planning to adopt cloud solutions in the next year (IDG Enterprise, 2016). The IDC report also predicted that organisations will spend half of their IT budget on cloud solutions by 2018 and the total spending on cloud services will be tripled to reach US$500 billion in 2020 (IDC, 2015). Cloud Computing will continue to be a focus for IT leaders since spending on the different cloud deployment models is predicted to increase in 2017 as follows: hybrid cloud (47%), public cloud (42%) and private cloud (40%) (IDG Enterprise, 2017).

2.10 Relationship between Service-Oriented Architecture, Outsourcing and Cloud Computing

Cloud Computing is a paradigm that evolved from previous computing paradigms. Thus, Cloud Computing overlaps with other existing topics in the information system field, such as Service-Oriented Architecture (SOA) and Outsourcing. The next sections will provide a critical comparison between these three concepts, as follows:

2.10.1 Service-Oriented Architecture (SOA)

Achieving alignment between organisational IT and the organisation's business strategy is critical to business success (Bleistein et al., 2006). Service-Oriented Architecture (SOA) is an architectural pattern that provides the ability for businesses to use software resources more effectively (Tsai et al., 2010). In SOA, each service embodies at least one business function that is implemented in a software component (Papazoglou, 2003). SOA is a software architecture based on the concept of a service, so its main focus is to support service orientation (Goyal, 2012).

Cloud Computing and SOA share many common characteristics. Their main focus is service orientation, so they deliver IT as a service (Sriram & Khajeh-hosseini, 2008). Both concepts support business agility via making IT services align with business requirements (Chang et al., 2013). The IT services that are delivered by either Cloud Computing or SOA are network-based (Goyal, 2012). Loose coupling and reusability are also common features of both concepts, either directly in SOA or indirectly in Cloud Computing via scalability and elasticity (Wu, 2013).

Although Cloud Computing and SOA have many similarities, they also have some differences. SOA focuses only on software components while Cloud Computing covers many IT resources which may include software, hardware and platform (Chang et al., 2013), and consequently Cloud Computing can cover other aspects such as business processes (Anstett et al., 2009). One of the main features of Cloud Computing is virtualisation, which is not required in SOA (Zhang & Zhou, 2009). The IaaS layer in Cloud Computing provides an infrastructural abstraction for self-provisioning features which is not available in SOA (Chang et al., 2013).

Cloud Computing and SOA are distinct concepts but several studies have focused on combining them. Zhang et al. (2009) developed a Cloud Computing Open Architecture (CCOA). The CCOA is a Cloud Computing-centric service-oriented architecture framework which has been built based on seven architectural principles and 10 architectural modules, by integrating the power of service-oriented architecture (SOA) and virtualisation technology of Cloud Computing. Tsai et al. (2010) proposed a Service-Oriented Cloud Computing Architecture (SOCCA). This architecture is based on both SOA and Cloud Computing to support interoperability between different Clouds. Tang et al. (2010) combined Cloud-centric enterprises with Enterprise Service-Oriented Architecture (ESOA) principles and governance in order to improve the quality of cloud services and support the standardisation of Cloud Computing. Table 2.3 shows a comparison between the two concepts.

Table 2.3 Comparison between Cloud Computing and SOA

Criteria	SOA	Cloud Computing
Reusability	Supported	Supported
Business and technical approach	Supported	Supported
IT resources	Only software	many IT resources such as software, hardware, storage and platform
Network-based applications	Supported	Supported
Service concept	Supported	Supported
Loose coupling	Supported	Supported
Self-provisioning	Not supported	Supported
Virtualisation	Not required	Required

2.10.2 Outsourcing

IT outsourcing is a traditional method of delegating or transferring some or all IT functions to a third party based on a contractual agreement (Dhar, 2012). Outsourcing methods have been applied in IT markets from the early 70s and have evolved to have strategic implications for a business (Ho & Atkins, 2006a). The benefits of IT outsourcing may include cost reduction, access to specialised expertise and improving the focus on core business (Ho & Atkins, 2006a; Dhar, 2012). However, outsourcing is associated with some risks, such as the loss of organisational competencies, vendor lock-in, loss of control over the data, security issues and scalability (Ho & Atkins, 2006a; Dhar, 2012).

Cloud Computing and outsourcing share some similarities since both transfer some or all internal IT operations to external providers. Both models offer cost-effectiveness for customers by moving some operational and management burdens to the provider (Zhong & Myers, 2016). IT resources in both models are delivered by external partners based on customer requirements where the provider is responsible for backup systems and disaster recovery processes (Dhar, 2012). Additionally, organisations benefit from the access to specialist resources available on the provider sides of cloud and outsourcing (Dhar, 2012). In both models, security and loss of control are implementation issues (Dhar, 2012; Zhong & Myers, 2016).

Although there are similarities between Cloud Computing and traditional outsourcing, there are also some fundamental differences. While traditional outsourcing uses the traditional way of paying for the services (i.e. traditional billing), Cloud Computing allows the users more flexible payment options (i.e. pay-per-use) (Böhm et al., 2011). IT outsourcing usually requires upfront capital investment in terms of physical resources but in Cloud Computing usually no upfront investment is required (Böhm et al., 2011). Additionally, Cloud Computing models provide on-demand scalability with minimum human interaction whereas IT outsourcing requires more time and some negotiations to provide extra resources (Mell & Grance, 2011). The relationship between the provider and the consumers is another difference between Cloud Computing and outsourcing. While the Cloud Computing services are more standardised with minimum need for communication between the service provider and the customer, the client-vendor relationship is a central feature of traditional outsourcing (Zhong & Myers, 2016). Thus, traditional outsourcing services are more customised than Cloud Computing ones, and the contract is usually longer (>10 years) (Dhar, 2012). Data location in IT outsourcing is usually specified by the customer while there is no guarantee about the location of the data in Cloud Computing unless the customer requests a specific location (Dhar, 2012; Marston et al., 2011). Table 2.4 summarises the similarities and differences between the two models. While some researchers understand Cloud Computing as a new form of IT outsourcing (Dhar, 2012), others consider it as a disruptive technology (Marston et al., 2011). In this research, Cloud Computing is understood as a new business model for delivering innovative IT services and applications with some features of the traditional IT outsourcing model (Zhong & Myers, 2016), and Cloud Computing can be studied as a distinct concept.

Table 2.4 Traditional outsourcing and Cloud Computing, similarities and differences

Criteria	Outsourcing	Cloud Computing
Similarities	• Cost-effectiveness • Services delivered by third party • Access to specialist resources • Security, loss of control issues	• Cost-effectiveness • Services delivered by cloud vendor party • Access to specialist resources • Security, loss of control issues
Differences	• Traditional payment options • Initial upfront capital investment • Usually specifies data location • High level of customisation • More time and some negotiation to provide extra resources.	• Flexible payment options • No upfront investment • Usually no specific data location • Less customisation • On-demand scalability

2.11 Current Cloud Adoption Decision-Making Models

Adopting Cloud Computing is a decision-making problem that raises several critical and vital issues for management, so it requires strategic tools and frameworks that support multiple domains. Several researchers have attempted to provide a strategic framework for Cloud Computing decision-making and there are various Cloud Computing adoption frameworks and models (Khajeh-hosseini, 2012; Chang et al., 2014a; Alhammadi, 2016; Alkhalil, 2016). In analysing the studies found in the literature, Cloud Computing-related frameworks can be categorised as follows:

2.11.1 Cloud Computing Risks and Benefits Assessment Frameworks

Assessing the benefits and risks of implementing Cloud Computing solutions is an important topic and has been discussed in many studies. For example, Khajeh-Hosseini (2012) introduced the Cloud Adoption Toolkit which acted as a benefits and risks assessment tool to help decision-makers in identifying the advantages and concerns of adopting public clouds. This tool combined Cost Modelling and Technology suitability analysis techniques to provide an organisation's decision-makers with initial assessment of the benefits and risks of adopting public cloud solutions. However, this tool focused on cost and risk analysis and the technical side of adopting public Cloud Computing without discussing other organisational factors and it is also limited to the IaaS model (Alhammadi, 2016; Alkhalil, 2016). Azeemi et al. (2013) applied the IS Success Model to measure the success of Cloud Computing migration without providing specific measurements or evaluations. Chang et al. (2013) developed the Cloud Computing Business Framework to resolve issues around cloud adoption challenges.

2.11.2 Selecting Service Providers and Service Orientation

Selecting service providers is another area that attracted scholars when developing Cloud Computing models and frameworks. For instance, Garg et al. (2011) developed the SMICloud framework, which is based on the Service Measurement Index (SMI). This framework allows the cloud customers to compare different cloud providers based on specific requirements. They defined 11 quantifiable indicators such as response time, accuracy and cost, etc. However, this framework considers the technical aspect only since it deals with the effective measurement of Quality of Service (QoS); it ignores qualitative indicators such as organisational issues. Ferrer et al. (2012) presented a holistic approach to cloud services and addressed five concerns that affect the adoption of Cloud Computing. The researchers focused on two stakeholders, service providers and infrastructure providers. However, although this study provided a holistic approach, it is focused on vendor services. Whaiduzzaman et al. (2013) studied the selection of cloud service providers and discussed 11 Multiple Criteria Decision Analysis (MCDA) techniques in detail and presented many examples regarding the use of those techniques in Cloud Computing. However, although the study is well documented, it focuses only on the implementation level and mainly on the technical aspect. Other important aspects such as regulations and the higher strategic level point of view are not presented.

2.11.3 Cloud Computing Decision Support Systems

Cloud Computing Decision Support Systems (DSSs) aim to support decisions about cloud migration by automating information collection and decision-making processes (Alkhalil, 2016). However, most of the frameworks in this category focus on supporting migration processes such as provider and services selection and they require detailed information to support the selection process (Alkhalil, 2016). Manzel and Ranjan (2012) proposed CloudGenius as a tool to automate the decision-making process and support the selection of cloud providers and application migration process. Alkhalil (2016) provided a systematic decision-making model which focused on technical aspects of cloud migration. From a Knowledge Management view, Alhammadi (2016) developed a Knowledge Management Based Cloud Computing Adoption Decision Making Framework (KCADF) to support processes such as: Cloud Adoption Decision Model, Cloud Deployment Selection and Cloud Service Model Selection. However, this framework is still in its prototype design and it did not include organisational factors such as top management support when evaluating the criteria and sub-criteria of cloud adoption decision process and focused on Cloud Computing migration process.

2.11.4 Assessment of Organisational Readiness

In the literature, a number of researchers have introduced methods to determine an organisation's cloud readiness. Loebbecke et al. (2011) presented the Magic Matrices Method as a Cloud Readiness assessment tool. The Magic Matrices Method focuses on the operational level of the organisation by investigating selected IT services. The Cloud Computing Assessment Criteria used in this method are: (1) Core Business/Competitive Position, (2) Importance/Availability, (3) Standardisation, (4) Degree of Distribution within the organisation, (5) Network Connectivity, (6) Identity Management, and (7) Compliance. The IT services assessed by this method were categorised into three categories: (1) ready for cloud, (2) not ready or (3) ready in the next years. Although this method provides an in-depth understanding of the technological side of Cloud Computing adoption, it focuses more on the operational level and ignores the strategic level of decision-making. Kauffman et al. (2014) proposed A Metrics Suite for Firm-Level Cloud Computing Adoption Readiness. The Metrics Suite has four main categories: technology and performance, organisation and strategy, economics and valuation, and regulation and environment. However, it provided a proposed tool without detailing the implementation. The researchers also did not include factors such as the attitude towards Cloud Computing adoption, service level agreements and soft financial analysis. The tool also requires detailed information which makes it unsuitable for strategic level decision-making. Idris et al. (2015) developed an Adoption Assessment tool for Cloud Computing adoption based on the Cloud Computing Maturity Model. This tool focuses on seven categories: Business and Strategy, Architecture, Infrastructure, Information, Operations, Projects and Organisation. It is more focused on the operational capabilities of organisations and ignores some important aspects of Cloud Computing adoption, such as human, legal and security aspects.

2.11.5 Factors in Cloud Computing adoption

Several scholars have attempted to identify factors affecting cloud adoption in different domains and countries, such as Oliviera et al. (2014), Borgman et al. (2013), Bhatiasevi and

Naglis (2015) and Lumide (2014). One limitation of these studies is the reference to factors without discussing how to implement them for Cloud Computing decision-making based on multiple perspectives, and they are usually limited to technologically developed countries (Senyo et al., 2015; Güner & Sneiders, 2014; Alhammadi, 2016).

2.11.6 Industrial Cloud Computing adoption frameworks and models

Commercial cloud providers offer tools to support Cloud Computing decision-making process such as Oracle Consulting Cloud Computing Services Framework (OCCCSF), IBM Framework for Cloud Adoption (IFCA), and other industrial cloud maturity models (Khajeh-hosseini, 2012; Chang et al., 2014a; Alhammadi, 2016; Alkhalil, 2016). One major limitation of such frameworks and models is the difficulty in implementing them for non-customers of commercial cloud providers (Chang et al., 2014a). The commercial tools are closed proprietary tools which are developed for marketing purposes and require consultancy fees (Khajeh-hosseini, 2012).

2.11.7 Cloud Application Migration

Studying the cloud migration process is another active research area. For example, Kundra (2011) has suggested a decision framework for cloud migration. This paper presents a strategic perspective for US agencies in terms of consideration of and planning for cloud migration. However, this framework is too high level and focused on the technical side of the migration decision-making process and is limited to the US government sector. Alonso et al. (2013) presented a Cloud Modernisation Assessment Framework to support the legacy application migration process of Cloud Computing by analysing two perspectives, technical and business. Although this framework provided a technical and business feasibility analysis and maturity assessment tool, it only considered two contexts of the organisations (i.e. technology and business) and focused only on the legacy applications. Jamshidi et al. (2013) developed the Cloud Reference Migration Model (Cloud-RMM) migration reference model to support systematic migration to the cloud. However, the framework is categorised as a theoretical framework, lacking systematic procedures for the implementation (Alkhalil, 2016). Figure 2.6 shows this model.

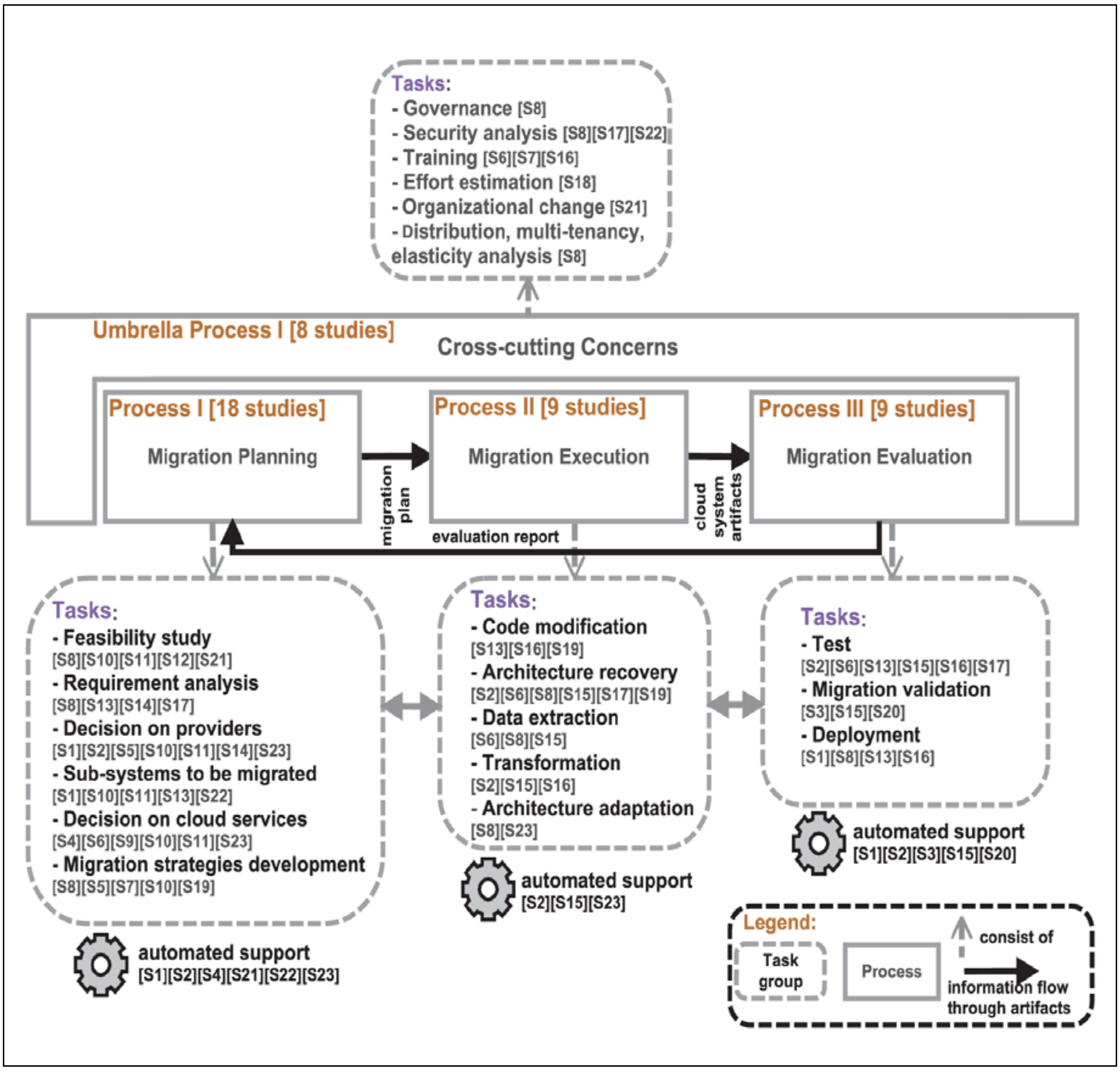


Figure 2.6 Cloud-RMM: migration reference model (Jamshidi et al., 2013)

2.11.8 Strategic Cloud Computing Frameworks

This category includes models and frameworks that focus on the strategic-level decision-making of Cloud Computing. Kuo (2011) recommended four aspects to be assessed when adopting health Cloud Computing: management, technology, security and legal. Kuo also proposed a Healthcare Cloud Computing Strategic Planning (HC2SP) model. This model could act as a SWOT analysis for health organisations to determine how to migrate from traditional health services to cloud-based services, and does not focus on the decision-making process. Kaisler et al. (2012) proposed a decision framework for Cloud Computing to assist small to medium businesses in making decisions about Cloud Computing adoption without detailing the implementation. Qian and Palvia (2014) studied Cloud Computing's impact on IT strategies and developed the Cloud Impact Model without focusing on the decision-making process.

Table 2.5 categorises current Cloud Computing Adoption Frameworks and Models with a brief description about each category and examples of the frameworks from the literature.

Table 2.5 Categorisations of current Cloud Computing Adoption Frameworks and Models

Category	Description of the Category	Framework Examples
Risk and Benefit Analysis	Assessing the benefits and risks of implementing Cloud Computing solutions.	Khajeh-hosseini (2012) Azeemi et al. (2013) Chang et al. (2013)
Selecting Service Providers and Service Orientation	Frameworks and models related to service provider selection process.	Garg et al. (2011) Ferrer et al. (2012) Whaiduzzaman et al. (2013)
Cloud Computing Decision Support Systems	Systems to aid and support the decision process for migrating to Cloud Computing.	Menzel & Ranjan (2012) Alkhalil (2016) Alhammadi (2016)
Assessment of Organisational Readiness	Methods and tools to determine an organisation's cloud readiness.	Loebbecke et al. (2011) Kauffman et al. (2014) Idris et al. (2015)
Cloud Application Migration	Supporting the migration process to Cloud Computing	Kundra (2011) Alonso et al. (2013) Jamshidi et al. (2013)
Factors in Cloud Computing Adoption	Identifying factors affecting the cloud adoption decision-making process in different domains and countries.	Oliveira et al. (2014) Borgman et al. (2013) Bhatiasevi & Naglis (2015) Olumide (2014)
Industrial Cloud Computing Adoption Frameworks and Models	Commercial tools provided by cloud vendors to support Cloud Computing decision migration.	Oracle Consulting Cloud Computing Services Framework IBM Framework for Cloud adoption
Strategic Cloud Computing Frameworks	Models and frameworks focusing on strategic planning for Cloud Computing.	Kuo (2011) Kaisler et al. (2012) Qian & Palvia (2014)

2.11.9 Evaluation of Current Cloud Computing Decision-making Frameworks

Evaluating the existing frameworks for Cloud Computing decision-making shows that they have a number of limitations. The frameworks themselves are limited (i.e., they do not cover multiple perspectives), since current models and frameworks mainly focus on only the operational and tactical level (i.e., ad hoc frameworks). Furthermore, while most of the frameworks emphasise the technical side of Cloud Computing, they ignore the other sides, such as business and organisational. There is also a lack of quantitative measures in the reviewed frameworks. The use of quantitative measures within a framework is important because they make the decision-making process more accurate and objective (Ho & Atkins, 2006b). Additionally, when some researchers discussed the factors affecting Cloud Computing adoption, they referred to them without discussing how to implement them for Cloud Computing decision-making based on multiple perspectives. Although some Cloud Computing concepts will be generic, others will be different due to variation in the contexts and country requirements. Cloud Computing adoption also varies across countries and industries. Although researchers identify Cloud Computing as a global IT phenomenon, they also highlight that factors affecting Cloud Computing adoption play different roles across different economic environments. Legal factors such as data protection laws are different between countries, even when the countries are in the same region (Marston et al., 2011). For example, although there is a compliance requirement for companies in the European Union (EU) with regard to data protection, it is left to the individual countries to administer the system (El-Gazzar, 2014). Government support for Cloud Computing is also different between countries. While some technologically advanced countries have realised the potential benefits of Cloud Computing and have launched Cloud Computing initiatives such as G-Cloud in the UK and Kasumigaseki Cloud in Japan, other countries such as Saudi Arabia still have not yet undertaken a national Cloud Computing initiative. Cloud Computing research in the literature focuses mainly on technologically developed countries and fewer empirical studies have been conducted in developing countries (Senyo et al., 2015; Güner & Sneiders, 2014). Cultural and organisational characteristics may affect how different countries adopt Information Technology projects (Aldraehim & Edwards, 2013). Examining the impact of cultural and organisational factors across different industries and countries represents a contribution to the body of knowledge about Cloud Computing adoption. Although Low, Chen and Wu (2011) pointed out that the influences of environmental and organisational factors on Cloud Computing adoption vary across different industry contexts, most of the frameworks are designed to be general and do not focus on specific sectors. Healthcare industry environments, for example, may vary across different countries. As a result, each country must be considered on an individual, case-by--case basis (i.e., private and public health care). For example, Cloud Computing applications must comply with Health Insurance Portability and Accountability Act (HIPAA) privacy and security rules in the USA (Klein, 2011).

Evaluating the existing frameworks for Cloud Computing decision-making indicates that there is a need to develop a strategic framework for Cloud Computing decision-making processes which emphasises a multidisciplinary holistic view of factors affecting Cloud Computing adoption.

2.12 Conclusion

This chapter has provided a literature review of Cloud Computing covering the fundamental aspects of the cloud model, which is an emerging model of delivering IT services. The development of ICT, Cloud Computing and various Cloud Computing definitions were reviewed and discussed. The essential characteristics of Cloud Computing were presented, followed by a brief description of its enabling technologies, such as virtualisations and multi-tenancy. Then a critical discussion of various deployment models (i.e. public, private, hybrid and community) and service models (IaaS, SaaS and PaaS) was also provided. The main drivers of Cloud Computing adoption were discussed and they were divided into three main categories: economic, technical and organisational. The issues relating to implementation of Cloud Computing solutions were studied and they were outlined from three perspectives: security, technical and non-technical concerns, and some of the solutions that could address them were discussed. Finally, a critical evaluation of current Cloud Adoption Decision-Making frameworks was conducted and the analysis showed that, although this area is an active research area, there is still a need for an holistic framework that will help decision-makers when making Cloud Computing adoption decisions, particularly in economically developing countries such as Saudi Arabia. The analysis also indicated that Cloud Computing adoption varies between different industry and country contexts. Thus, the next chapter will discuss electronic health and will examine the use of Cloud Computing in this domain, with a special focus on Saudi Arabia.

3 From E-health to E-health Cloud

3.1 Introduction

This chapter discusses the challenges of traditional healthcare systems and the need to move towards e-health solutions. This is followed by a discussion of different e-health systems, their benefits and the challenges they present. E-health in Saudi Arabia is outlined and the different initiatives and challenges identified. The chapter then considers the movement from e-health to e-health cloud and the opportunities and concerns relating to the implementation of Cloud-based solutions in the healthcare domain are presented. Cloud Computing decision-making in healthcare organisations is discussed. Finally, Cloud Computing and E-health Cloud in the Saudi Arabian context are reviewed and evaluated.

3.2 Migration of Traditional Healthcare System to E-Health System

Improving the healthcare system is one of the main priorities for many governments; however, traditional healthcare systems are facing many issues, for example, the increase in human life expectancy. Life expectancy in Canada is 82.2 years, in Saudi Arabia (KSA) it is 74.5 years, while in the UK it is 81.2 years and in the USA it is 79.3 years. Figure 3.1 shows a comparison of the life expectancy between 2000 and 2015 in the four countries (World Health Organisation, 2016).

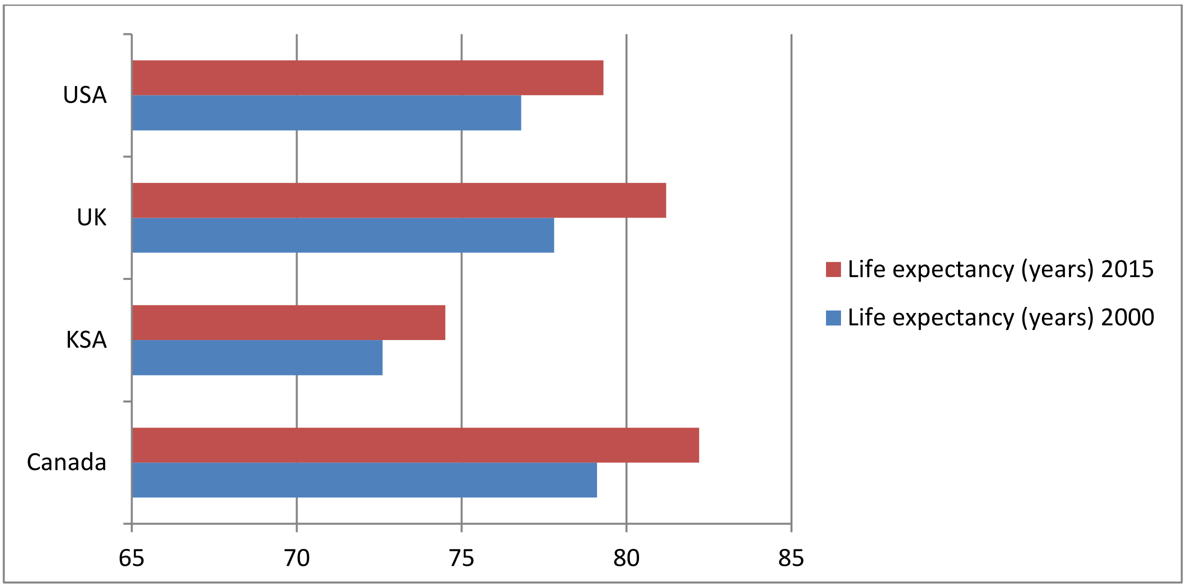


Figure 3.1 Comparison of the life expectancy between 2000 and 2015 in four countries (World Health Organisation, 2016)

Geography is an obstacle for the development of the health system for many nations. For example, Canada is spread unevenly across 10m km^2 of the Earth's surface, and yet has only 36m people (Worldometers, 2016). Providing the same quality of healthcare for all citizens is placing healthcare organisations under pressure. Providing medical services to rural areas is also another challenge for traditional medical services (AbuKhousa et al., 2012). The shortage of healthcare professionals such as physicians, nurses and pharmacists is a further challenge for traditional healthcare systems (Almalki et al., 2011). The increase of chronic diseases, such as diabetes, hypertension, and heart diseases, and childhood obesity is also contributing to pressures on healthcare systems (Almalki et al., 2011). For example, in Europe about 80% of the disease burden is due to chronic conditions and diseases (Honka et al., 2011). These factors contribute the highest operational cost of health services provision and total expenditure on health has increased in many countries. Figure 3.2 presents the increase of total expenditure on health as a percentage of gross domestic product (GDP) from 1995 and 2014 in the four countries discussed in this context.

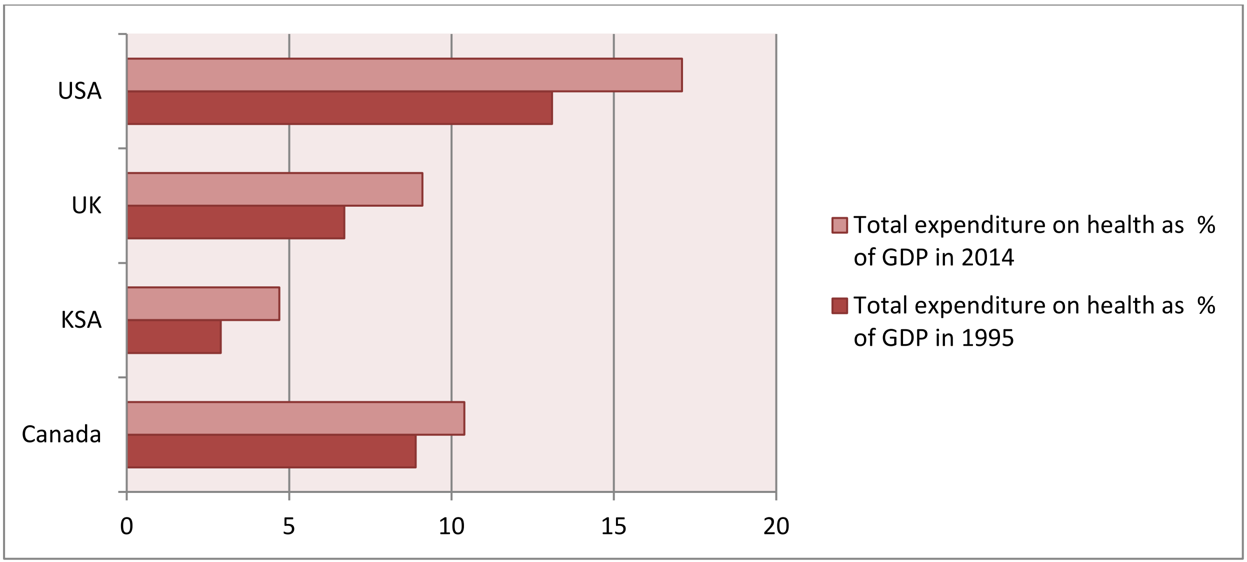


Figure 3.2 Total expenditure on health as a percentage of gross domestic product (GDP) from 1995 and 2014 in four countries (The World Bank Group, 2014)

3.3 Electronic Health

Many initiatives have been implemented to deal with these challenges and find ways to reform the healthcare system, for example, privatisation of healthcare services and the movement towards preventive healthcare. Another initiative is the use of information and communication technology in health organisations to deliver healthcare more efficiently and effectively. This movement towards applying ICT in healthcare systems is referred to by the term e-health.

Eysenbach (2001) defined e-health as "*an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterises not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology*". This definition is favoured in this research because it takes e-health beyond the technology aspect (Chen et al., 2014). It covers other aspects that may affect healthcare such as business and organisational issues. Although this definition was presented in 2001, new technologies such as smartphones and Cloud Computing also fit well into it.

E-health encompasses many applications, systems and services, and its scope includes any use of information and communication technologies (ICT) in the health environment (World Health Organisation, 2011). Health Information Technology (HIT) is defined in the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 as "*hardware, software, integrated technologies or related licenses, intellectual property, upgrades, or packaged solutions sold as services that are designed for or support the use by healthcare entities or patients for the electronic creation, maintenance, access, or exchange of health information*" (Zeng et al., 2009). Thus, HIT intersects with e-health in many areas so the terms e-health and HIT are used exchangeably in research (Weiner et al., 2013). Different systems of e-heath have different functions and different stakeholders' perspectives (Yusof et al., 2008; Cunningham et al., 2014a), and the systems can be classified as:

- Patient-centred information systems, which are the electronic forms of patients' information such as Electronic Medical Record (EMR) and Electronic Health Record (EHR) (Yusof et al., 2008).
- Administrative information systems, which cover administrative tasks within healthcare organisations such as patient admission, discharge and scheduling. The systems can also perform other processes that are related to financial processes such as billing, reporting, staffing and payroll, and other management aspects (WHO, 2013; Yusof et al., 2008).
- Radiology Information System (RIS), which supports the management and storage of radiological requests as well as administrative procedures relating to the radiology department' (Altuwaijri, 2008; Yusof et al., 2008).

- Laboratory Information System (LIS), which manages, records and stores samples and laboratory tests (Altuwaijri, 2008).
- Pharmacy Information System (PIS), which manages and automates prescription of medicines and alerts physicians about any negative impact from a prescribed medicine (Altuwaijri, 2008).
- Clinical Decision Support System (CDSS), which analyses and evaluates patients' information to support clinical decision-making (Simon et al., 2007).
- Hospital Information System (HIS), which integrates various systems to provide comprehensive hospital information to support all the hospital's requirements including clinical and non-clinical information (Ismail et al., 2010).
- Mobile Health (m-health), which refers to the delivery of healthcare services with the support of mobile technology (Van Dyk, 2014). M-health applications can be part of the HIS or can be independent applications such as physical activity monitoring applications, diet applications, smoking cessation applications, etc. (Free et al., 2013).
- Telemedicine is the use of Information Technologies to exchange health information and to provide healthcare services at a distance (Ahmed et al., 2014).

Figure 3.3 provides general view of various e-health systems and applications (Van Dyk, 2014; Zakaria et al., 2010; Yusof et al., 2008).

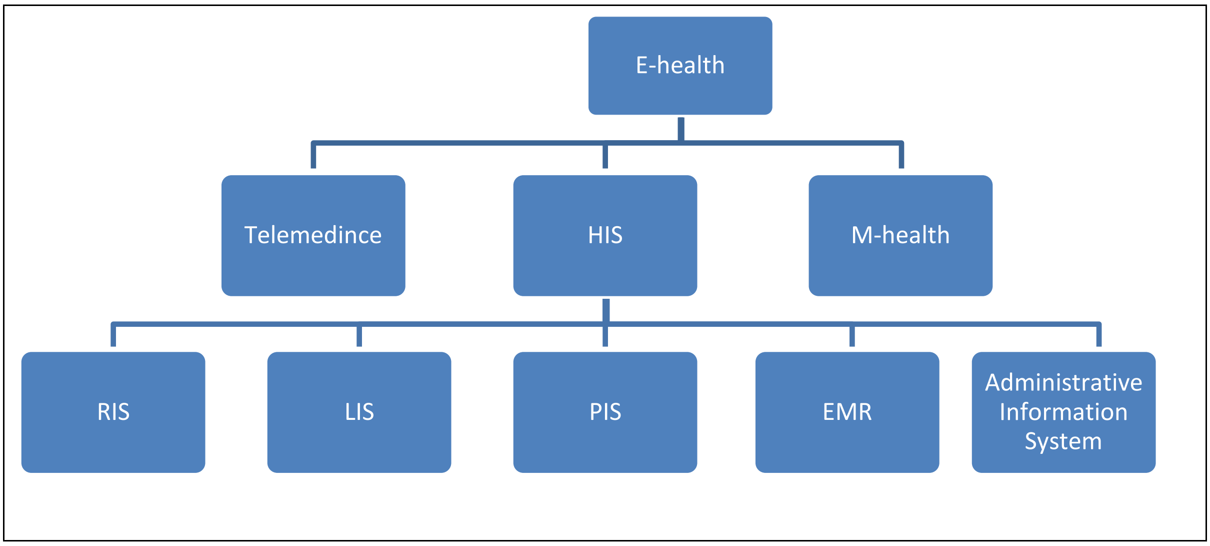


Figure 3.3 General view of various e-health systems and applications

3.4 E-health Benefits

E-health or Health Information technology (HIT) provides many benefits for health organisations and patients, which are outlined as follows:

- **Enhancing Information Sharing:** E-health solutions allow for new way of sharing and managing patients' information between healthcare organisations. The use of EHR allows the immediate transferral of patients' information, combating the long waiting times associated with traditional methods (i.e. paper-based healthcare records) (Black et al., 2011). It also allows the patients to see their laboratory and other results and histories and details of recent care online, which allows them to be updated about their healthcare (Cunningham et al., 2014b). E-health tools such as monitoring devices can help in managing chronic illnesses and support elderly people with health issues without the need to visit hospital regularly (Archer et al., 2011).

- **Improving Healthcare Quality:** E-health systems can enhance quality of care by providing relevant information for healthcare specialists. The Clinical Decision Support System improves access to appropriate clinical information for healthcare professionals based on a repository of clinical information and thus improves clinical decision-making (Black et al., 2011). EHR systems improve healthcare quality by reducing duplication of effort, since the patient is not required to repeat the same tests for the same health problems in different healthcare facilities (Altuwaijri, 2008).

- **Improving Healthcare Safety:** E-health solutions can improve patient safety in different ways. The E-prescribing system provides real-time alerts to notify physicians regarding possible negative drug interactions (Altuwaijri, 2008) and reduces medication errors resulting from handwritten prescriptions (Black et al., 2011).

- **Medium for education and behaviour change:** Many e-health applications have been used as a medium for education and behaviour change for both patients and physicians (Cunningham et al., 2014a). These applications have been used as powerful media to support the transformation to a patient-centric healthcare system which emphasises the participation of patients in their own healthcare (Hu & Bai, 2014) and improved delivery of preventive care (Black et al., 2011). For example, mobile applications are implemented to provide patients with motivational messages or to monitor behaviour change regarding specific issues (e.g. diet, fitness) (Free et al., 2013).

3.5 E-health Challenges

Current e-health practices face many challenges, from development to implementation. The challenges of e-health projects can be categorised into five general categories (Economic, Technical, Organisational, Behavioural and Environmental) (Tanriverdi & Iacono, 1998; Altuwaijri, 2008; Paré & Trudel, 2007; Khalifehsoltani & Gerami, 2010; Boonstra & Broekhuis, 2010), as summarised in Figure 3.4.

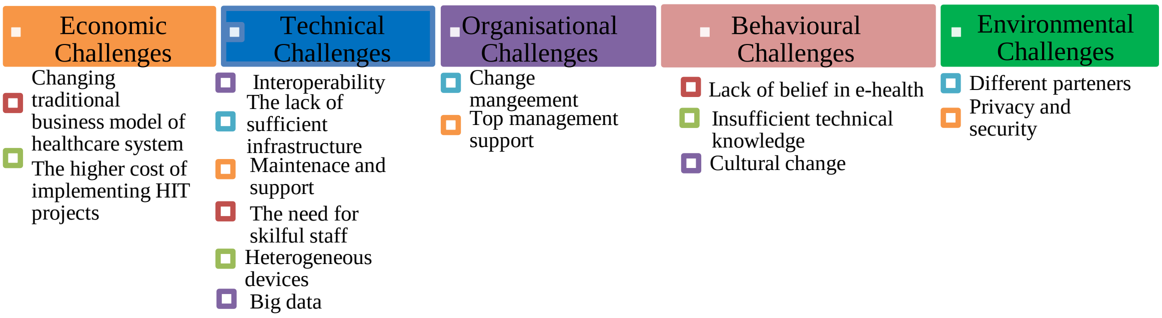


Figure 3.4 Summary of the e-health challenges

3.5.1 Economic Challenges

One of the key issues facing e-health is the need to change the traditional business model of the healthcare system. The current healthcare system is doctor-centred, reactive and focused on disease; it should be changed to patient-centred, proactive and preventive and focused on quality of life and well-being (Chen et al., 2014). A key to the success of this new business model is the ability to access information in the proper context (Chang et al., 2009). The higher cost of implementing HIT projects is considered another critical barrier for e-health. For example, in 2002, the UK established a 10-year NHS National Programme for IT (NPfIT) with a total cost of £12.4bn (Reimers et al., 2013). However, the UK government announced that the project had not been successful and it was finally cancelled (Reimers et al., 2013). It is very expensive to utilise IT systems in healthcare services due to the higher cost in terms of capital expenditure (CAPEX) and operational expenditure (OPEX). Capital expenditure includes: hardware purchases, building IT infrastructure, training and deploying the systems. Operational expenditure (OPEX) includes: maintenance, software, system upgrades, data storage and licensing. The cost is understood to be higher in rural areas where there is insufficient infrastructure (Khalifehsoltani & Gerami, 2010) supporting small- and medium-sized health centres. A recent report showed that 48% of American physician specialty practices faced financial difficulties when replacing their EHR systems (Black Book, 2016).

3.5.2 Technical Challenges

E-health usually encompasses many health information systems. The systems must communicate across the organisation or across different healthcare providers. Thus, providing interoperability between different systems is a major issue for e-health (Adler-Milstein & Bates, 2010). The lack of sufficient infrastructure in some areas is an obstacle for e-health services, especially in rural areas (Khalifehsoltani & Gerami, 2010). Maintenance, supporting and updating the ICT projects in health organisations are challenging and require additional effort (Hasanain & Cooper, 2014). For example, a study showed that the upgrade cost of some EHR systems is between 20% and 49% of the system's initial cost in American hospitals and the initial cost is between $700m and $1bn (Koppel & Lehmann, 2014). Another obstacle that faces some e-health projects is the need for skilled staff for the development, management and maintenance of ICT projects in healthcare organisations (Khalifehsoltani & Gerami, 2010). A HIMSS leadership survey reflected that the key barrier for implementing IT projects in health organisations is the lack of staffing resources (HIMSS, 2013). The presence of heterogeneous devices (e.g., smartphones, laptops, and other mobile internet devices) can also provide difficulties for e-health applications (AbuKhousa et al., 2012). Big data is also a technical challenge for healthcare organisations since the use of electronic health record (EHR) systems and digital images and other technologies has generated a large amount of data (Raghupathi & Raghupathi, 2014). The healthcare sector had produced 153 Exabyte by 2013 and is expected to produce 2,314 Exabyte (i.e. 2 trillion gigabytes) by 2020 (IDC, 2014). Big data is a challenging issue for healthcare organisations because of the difficulties of storing, securing and analysing vast amounts of data (Kruse et al., 2016).

3.5.3 Organisational Challenges

Implementing e-health systems involves complex processes of change at the user level for professionals and patients and at the organisational level for healthcare organisations. Yee et al. (2007) argued that having a strong, traditional and hierarchical system of healthcare organisations may affect the adoption of e-health negatively. Conservatively structured healthcare organisations require a long evaluation process before making any changes due to concerns about patient safety, which may delay the implementation of some e-health projects

(Zakaria et al., 2010). As a result, healthcare organisations need to re-engineer the hierarchical healthcare system in order to facilitate successful e-health implementation. Additionally, changes will be required to the healthcare providers' work procedures and routines, which will affect the healthcare services and the related administrative processes (Lluch, 2011). However, this issue has been overlooked by researchers (Boonstra & Broekhuis, 2010). Support from top management is also vital for widespread e-health adoption and this support can be hindered because of the high cost and other risks associated with HIT projects (Boonstra & Broekhuis, 2010).

3.5.4 Behavioural Challenges

The use of e-health will affect many different stakeholders, including physicians, patients, IT and administrative staff. A lack of confidence in the benefits of e-health can be a major issue in its acceptance (Boonstra & Broekhuis, 2010) and this disbelief may arise from not recognising relative advantages. For example, a Medical Economics report showed that about half (48%) of the physicians without an EMR believed that EMRs are unable to improve patient care or clinical outcomes, as stated by Mazzolini (2013). This reflects a resistance to change which may lead to resistance to e-health innovations (Lluch, 2011). Physicians with insufficient technical knowledge can be considered another barrier for e-health (Boonstra & Broekhuis, 2010). Additionally, clinical staff may be concerned about increases to their workload, and this concern may affect HIT implementation (Boonstra & Broekhuis, 2010). Cultural changes such as changing the face-to-face interaction between patient and healthcare professional to a new method, using electronic communication, can also be considered as a barrier to e-health adoption (Lluch, 2011).

3.5.5 Environmental Challenges

Healthcare organisations have a history of working with other parties in the healthcare industry, such as vendors, insurance companies, patients and government agencies. Thus, the use of e-health will be affected by the relationship between different parties. For example, healthcare professionals may be concerned that vendors will not be able to provide a proper service within the proper time (Boonstra & Broekhuis, 2010). Privacy and security are also considered to be the main concerns for many stakeholders in the healthcare system (Ajami & Bagheri-Tadi, 2013).

3.6 E-Health in Saudi Arabia

The Saudi government recognises the importance of using ICT to provide high-quality services to Saudi citizens. As a result, the first national E-government strategy was launched in 2005. Consequently, many healthcare services providers have adopted some ICT solutions in their facilities. In 2011, the Ministry of Health (MOH) launched the National E-health Strategy to support the primary MOH business goals (MoH, 2011). However, the adoption of HIT in Saudi healthcare organisations is still relatively low, for many reasons (Khalifa, 2013). Khudair (2008) discussed the implementation of ICT in healthcare organisations from the physicians' perspective. The researcher expounded the reasons as poor leadership, the weakness of the information system infrastructure and technical support, and the absence of an implementation strategy. Khalifa (2013) found that factors related to human dimensions such as shortage of health informatics specialists, lack of experience of using computer applications, and lack of experience and knowledge of using EMRs (Electronic Medical Records) are the main barriers that hinder successful implementation of EMRs in Saudi Arabia. The paper also stated that financial barriers such as the high initial cost of implementing EMRs and their high operation and maintenance costs are the second category of barriers that challenge EMR use in Saudi hospitals. Alkraiji, Jackson and Murray (2013) studied the barriers to the adoption of health data standards in Saudi Arabia. In addition to the barriers mentioned in Khalifa (2013), they indicated that issues relating to the technology context such as complexity, compatibility, system fragmentation and insufficient IT infrastructure could delay the adoption of health data standards. Hasanain and Cooper (2014) found that social barriers such as language and resistance to the use of new systems affected EMR implementation in Saudi hospitals. They also mentioned some technical and environmental barriers, such as: instability of EMR vendors and lack of computers for staff. As a result of these barriers, implementation of e-health services in Saudi Arabia still faces difficulties and 75% of healthcare IT projects in the country have failed completely or are regarded as uncompleted (Abouzahra, 2011). However, there are some success stories, such as the King Faisal Specialist Hospital and Research Centre (KFSH) which has almost fully implemented an EMR system (Hasanain & Cooper, 2014). Figure 3.5 summarises the e-health challenges in Saudi Arabia and highlights that there are five perspectives to be considered when adopting new technology in healthcare institutions. However, despite these barriers, healthcare providers in Saudi Arabia have demonstrated a willingness to implement and improve e-health services.

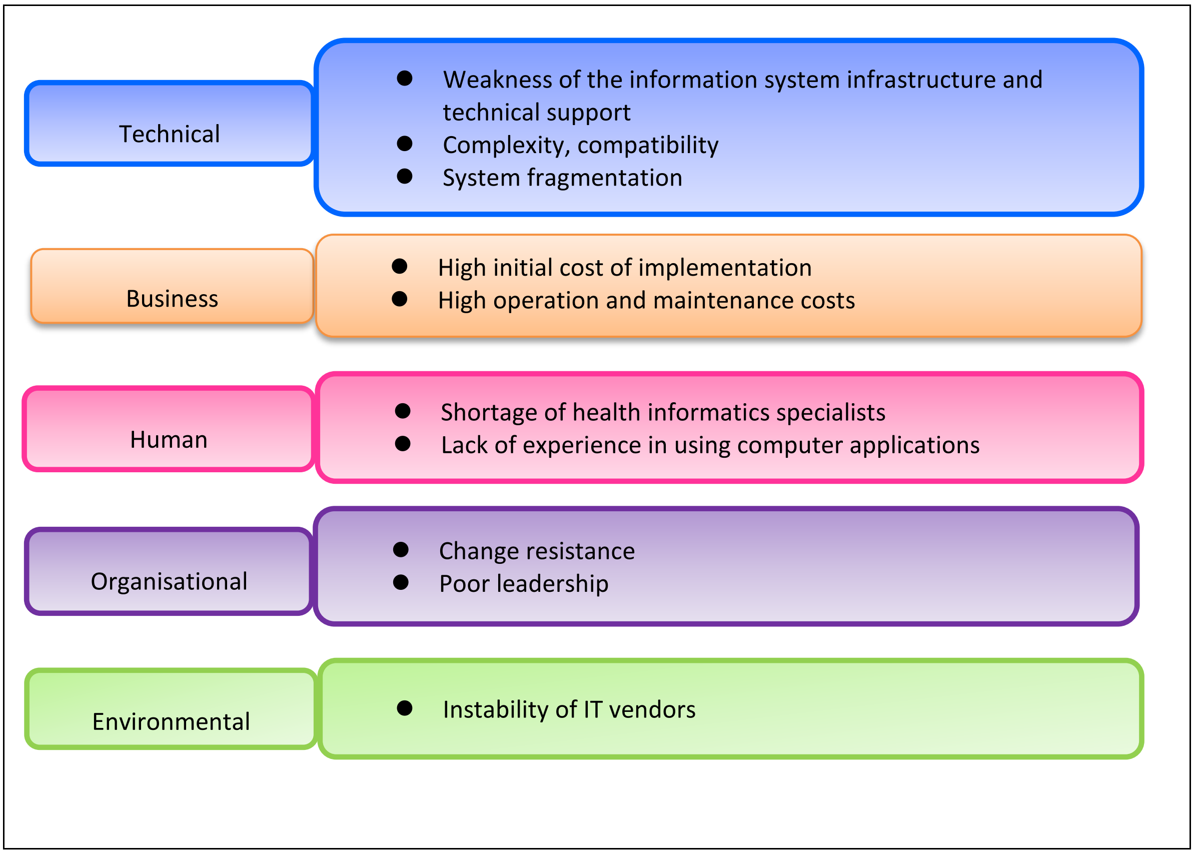


Figure 3.5 Challenges of e-health in Saudi Arabia

In 2011, the Ministry of Health in Saudi Arabia launched a National E-health Strategy to support the primary MoH business goals (MoH, 2011). The MoH's main goals are as follows (MoH, 2012):

- To care for patients.
- To connect providers at all levels of care.
- To measure the performance of healthcare delivery.
- To transform healthcare delivery to a consistent, world-class standard.

The MOH believes that e-health will be a useful tool with which to transform healthcare services in Saudi Arabia (MoH, 2011). Through the e-health initiative, the MOH will try to achieve the following:

- Interoperable Electronic Health Record (iEHR) for all patients.
- Patient health information to be available to clinicians in all health facilities.
- Provide an efficient system to transfer patients between health facilities.
- Deliver electronic services to all health facilities.

The e-health strategy will help MOH to move towards a patient-centric model where patients are linked with healthcare professionals anytime, anywhere and on any device. Advancements in ICT technology make this possible through technologies such as: smartphones, Internet of Things and Cloud Computing.

3.7 From E-health to E-health Cloud

To overcome e-health issues and problems, many healthcare organisations are moving towards new business models and leveraging technologies and one of the promising models is Cloud Computing. The Cloud Computing market in healthcare is predicted to reach more than $9.48bn by 2020 (Marketsandmarkets, 2015), which indicates that Cloud Computing will be one of the preferred solutions for healthcare organisations.

3.7.1 Opportunities Provided by Cloud Computing for E-health

Many researchers suggest that the healthcare industry should move towards Cloud Computing and have discussed the opportunities and advantages that it offers e-health (AbuKhousa et al., 2012; Kuo, 2011; Rijnboutt et al., 2013), which are outlined as follows:

- **Improved patient care**

Physicians and patients require access to the appropriate information to enhance the overall quality of care as current healthcare systems are fragmented and isolated, so information-sharing tasks are complex and inefficient. A possible reason for this fragmentation is the lack of an information-exchange infrastructure platform (Ratnam & Dominic, 2014), which can be solved through Cloud Computing. Allowing physicians to have aggregated information from various sources with historical information about patients' previous healthcare records can enable them to provide more suitable treatments (AbuKhousa et al., 2012). Large healthcare organisations have already discovered the opportunities that Cloud Computing can provide and have started to implement such systems. For example, the U.S. Department of Health & Human Services (HHS) Office applied a Cloud Shared Services strategy to support their mission and objective goals (Kuo et al., 2011). Cloud Computing creates the infrastructure for patient information sharing and gives patients the chance to communicate easily with their healthcare providers anytime, anywhere via various devices (Thuemmler et al., 2012). For example, the Trustworthy Clouds (TClouds) initiative was established by a consortium including IBM, Portuguese and Italian academics, and healthcare organisations to support homecare services and to monitor and assist patients outside the hospital (Kuo et al., 2011). The MUNICH platform is another project, at the hospital of the Technical University of Munich, Germany, which aims to store and analyse the data collected from smart devices in the operating theatres to improve the quality and safety of patient care and to automate the documentation processes (Thuemmler et al., 2012).

- **Cost savings**

Healthcare organisations try to deliver high-quality healthcare services with controlled budgets. Cloud Computing can offer economic savings and financial benefits by decreasing the initial and operational costs of e-health projects. Yoo et al. (2012) estimated that the return on investment (ROI) of a private cloud within Seoul National University Bundang Hospital (South Korea) will be 122.6% over a five-year operating period. In China, the 454th Hospital of People's Liberation Army (H454) migrated all of its hospital information systems to the Cloud-based VDI platform and the hospital established Cloud-provided hospital information software as a service (HI-SaaS) (Yao et al., 2014). Associated smaller healthcare institutions were allowed to share medical software with H545 via SaaS. According to the researchers, 89.9% of the medical clinics that participated saved on investment and maintenance costs (Yao et al., 2014) . Yao et al. also highlighted that the use of Cloud Computing services can increase resource utilisation and the efficient use of both hardware and software resources. Adopting Cloud Computing solutions allowed the Swedish Red Cross to reduce the costs of IT operations by about 20% and improved real-time communications (COCIR, 2012). Cloud Computing could also reduce the cost of healthcare organisations by allowing them to share IT resources. For example, Liverpool Women's Hospital in the UK and nearby Alder Hey Children's Hospital decided to share their IT resources via private cloud data centres (Caldwell, 2011). Cloud Computing could help at regional or national level by assisting in solving the healthcare information system' fragmentation and isolation problems.

- **Enhanced support for healthcare research**

Cloud Computing solutions can be used to support and accelerate research and development activities in the healthcare domain (AbuKhousa et al., 2012). Cloud Computing allows healthcare organisations to have access to powerful computing resources to carry out advanced research activities such as advanced analysis. For example, Clouds Against Disease is an initiative to support the discovery of new medicines by applying the IaaS model to analyse a trillion possible chemical structures, a task which requires massive computing resources at an acceptable cost (Priyanga & Muthukumar, 2015). Cloud Computing also makes the process of research and development quicker by empowering the capabilities of healthcare originations (Granados Moreno et al., 2017). For example, Pfizer, a large pharmaceutical company, combined a commercial cloud provider's capabilities with the company's High Performance Computing (HPC) facilities, which reduced the computational time to hours instead of weeks (Cianfrocco & Leschziner, 2015; Venkatraman, 2014). Cloud Computing improves the collaboration of various healthcare organisations and different healthcare stakeholders, which can lead to better knowledge sharing (AbuKhousa et al., 2012). For example, the 100,000 Genomes Project (100,000 GP) is a health project to improve the treatment and diagnosis of patients with rare diseases or cancers where 100,000 genomes are to be collected from the patients and their families (Granados Moreno et al., 2017). Cloud Computing solutions were implemented to store DNA sequencing, conduct advanced data analysis and allow healthcare professionals and other researchers to benefit from large volumes of data (Granados Moreno et al., 2017).

- **Allowing a Patient-Centric Healthcare Model**

Current healthcare systems are doctor-centred or hospital-centred models where disease and doctors are at the centre (Chen et al., 2014). These models focus on the role of physicians and the treatment of illness, which makes this a reactive approach and one that does not respond quickly to the patients' needs (Thuemmler et al., 2012). Thus, the movement is towards a model where the patients are the active actors in their healthcare management and this model is called the patient-centric healthcare model (Hu & Bai, 2014). This model empowers individuals to take for a larger role in their healthcare and allows for a more proactive and preventive approach (Chen et al., 2014), and encourages social care and home healthcare services outside of a hospital setting (Thuemmler et al., 2012). Figure 3.6 shows the healthcare model's transition from a doctor-centric to a patient-centric model.

Mobile devices can benefit from Cloud Computing architecture with some technical improvements such as memory size, battery lifetime and computation time (Bustamante-Bello et al., 2016). For example, Cloud capabilities can allow high computation tasks to be performed in the Cloud rather than on the mobile device and consequently the life battery of the device will be more sustainable (Botta et al., 2016). Thus, Mobile healthcare with the support of Cloud Computing is another area that has the potential to facilitate the patient-centric model (Lian et al., 2014a) and can support many public health initiatives (Thuemmler et al., 2012) and can support public health initiatives (Thuemmler et al., 2012). For example, self-healthcare management tools that combine Cloud Computing and the Internet of Things (IoT) have been implemented to help citizens manage their health status from home (Hu & Bai, 2014). Elderly patients and patients with chronic diseases can be monitored in their homes without the need for them to go to hospital all the time. For example, researchers have used Cloud Computing with mobile technologies to allow doctors to monitor discharged cancer patients and to provide real-time reporting, which was a cost-effective way of data storing and communication (Cheng et al., 2011). Cloud Computing can enable innovative ideas that support home healthcare to be implemented quickly and cheaply. For example, a mobile application has been developed to detect skin cancer at home and Cloud Computing offers complex data processing components for pattern recognition (Griebel et al., 2015).

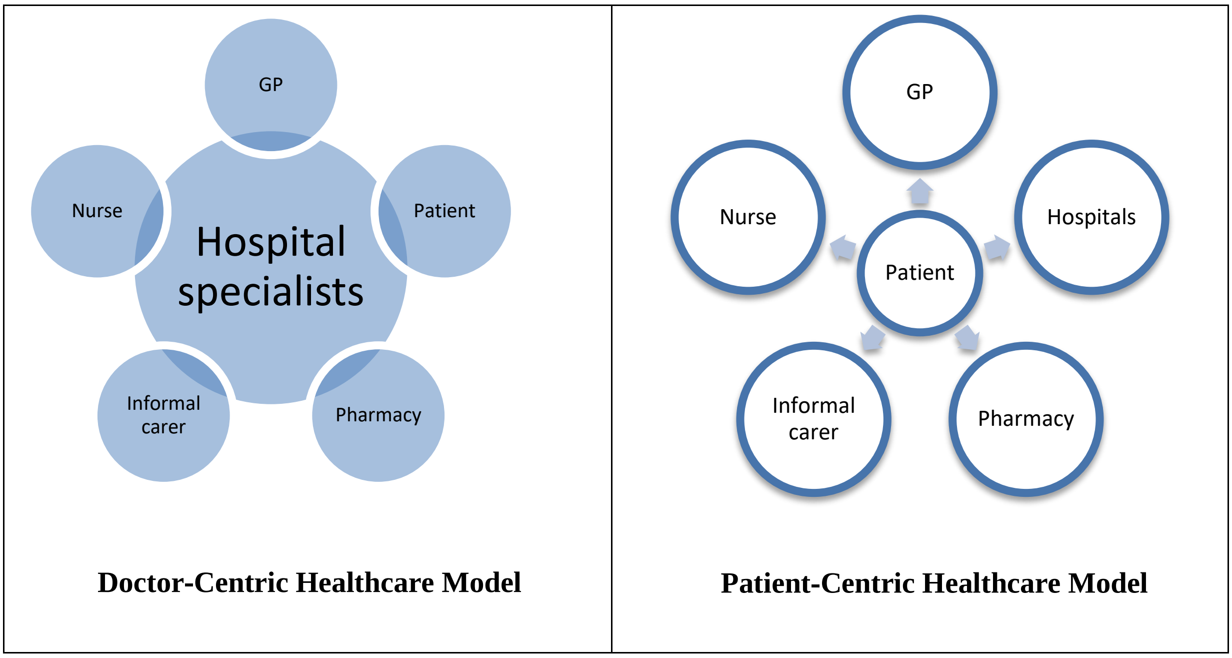


Figure 3.6 The transition of the healthcare model from a doctor-centric to a patient-centric model

- **Overcome the issue of shortage of resources**

Cloud Computing offers a possible to route to overcome staff shortages such as the shortage of IT technicians and healthcare professionals in healthcare organisations. Cloud Computing reduces the time spent by IT staff at healthcare organisations on maintenance and operational activities and allows them to work more on strategic tasks and supporting the core business of the organisations (AbuKhousa et al., 2012). For example, Cloud Computing allowed the Swedish Red Cross to free up to 25% of workers' time, which allowed them to focus more on strategic initiatives and improved collaboration between employees (COCIR, 2012). Cloud Computing can also mitigate the effects of a shortage of healthcare professionals by supporting and improving telemedicine solutions, particular in rural areas (Thuemmler et al., 2012). A Cloud Computing solution supported the 12-lead Electrocardiography (ECG) telemedicine implementation in Taiwan which allowed experienced cardiologists to consult with real-time data and enabled urban hospitals to support rural clinics (Hsieh & Hsu, 2012). Cloud Computing helps healthcare organisations to use computing resources that were not previously available to them due to the high cost of implementation (AbuKhousa et al., 2012). The Oshidori-Net2 project applies Cloud Computing solutions to allow six hospitals in Japan to share electronic patient records and Picture Archiving and Communication System (PACS) solution (Kondoh et al., 2013).

3.7.2 Concerns about Cloud Computing in E-health

Despite the many advantages that Cloud Computing can offer for healthcare organisations, there are still some concerns which may delay its adoption in the healthcare domain. Some of these concerns are related not only to the healthcare organisations but are also relevant to organisations in various other domains. However, certain issues relate mainly to healthcare organisations, which are as follows:

- **Security and data privacy concerns**

Security is a key concern in the implementation of any e-health system and by their nature healthcare organisations have many security requirements. Thus, the implementation of Cloud Computing solutions in healthcare organisations must reflect security and privacy requirements (AbuKhousa et al., 2012). Virtual infrastructure is an example of a Cloud Computing security risk; it is where patient data could be accessed via unauthorised persons because the hardware resource is used by more than one (Kuo, 2011). Protecting patient privacy is an important issue for healthcare organisations and it is still a challenge for them in Cloud Computing implementation (Granados Moreno et al., 2017). Therefore, developing secured solutions for Cloud Computing that provides better security and privacy protections for healthcare organisations is an important research area. For example, DACAR is the first e-Health cloud platform in Europe that has been developed to be a secure platform in the cloud to support Data Capture and Auto-Identification technology (AbuKhousa et al., 2012), and it has been implemented successfully in London’s Chelsea and Westminster Hospital (Sultan, 2014).

Cloud Computing can also potentially provide better security and privacy practices for some healthcare organisations since they will rely on large Cloud Computing providers that can afford advanced security solutions (Kuo, 2011).

- **Availability and reliability of cloud services**

E-health services and applications usually deal with patients, so good availability is required, especially in the event of an emergency. However, Cloud Computing services may have outages, especially when the services are provided by cloud providers (Kuo et al., 2011). However, the overall industry yearly average of uptime for all cloud providers is 99.999% of uptime, which equals three minutes of unavailability each year (Gupta et al., 2013; Alami et al., 2015). Furthermore, Cloud Computing providers could provide better availability of data than traditional IT operations since they have multiple data centre locations and better backup solutions, which ensures more replication of patients' data.

- **Regulation compliance**

Governments place great emphasis on protecting patient and medical data and there are various laws regarding data security and privacy. Examples include the US Health Insurance Portability and Accountability Act (HIPAA), the Canadian Personal Information Protection and Electronic Documents Act (PIPEDA) and the UK Data Protection Act of 1998 and Access to Health Records Act 1990 (Calabrese & Cannataro, 2015; Granados Moreno et al., 2017). Healthcare organisations in general are required by law to follow the regulations and it is their responsibility to ensure that their Cloud Computing solutions are not violated and there is adequate legislation (Schweitzer, 2011). Cloud Computing providers take into consideration the importance of security and privacy requirements and they follow specific measurements that are approved by a third party, such as ISO/IEC standards (Rezaeibagha et al., 2015). The MSSNG project (storing and analysis of DNA of 10,000 families affected by autism) is an example of a cloud healthcare project which specifies specific security and privacy standards and measurement (Granados Moreno et al., 2017). In this project, Google provides Cloud Computing solutions and it agrees to follow certain measures to ensure data privacy and security such as extra layers of encryption, notifying the project management about any security breach, complying with the ISO 27001, SSAE-16, SOC 1, SOC 2, and SOC 3 standards, and storing the project data in Google datacentres in the USA or Europe (Granados Moreno et al., 2017).

3.8 Work Relating to Cloud Computing in E-health

Several studies have discussed Cloud Computing decision-making procedures in healthcare (AbuKhousa et al., 2012). Kuo (2011) recommended four aspects that should be assessed when adopting e-health Cloud Computing: management, technology, security and legal. Kuo also proposed a Healthcare Cloud Computing Strategic Planning (HC2SP) model. This model could act as a SWOT analysis for health organisations to determine how to migrate from traditional health services to cloud-based services. However, this model did not focus on the decision-making process. Rijnboutt et al. (2013) categorised the challenges facing the use of Cloud Computing in e-health services into six categories (technical, privacy, legal, organisational, economical and medical). However, environmental issues were not considered and the paper did not focus on the decision-making process. Lian, Yen and Wang (2014b) studied the decision to adopt Cloud Computing in Taiwan hospitals. They integrated the Technology-Organisation-Environment (TOE) framework and Human-Organisation-Technology fit (HOT-fit) model to study the adoption of Cloud Computing in Taiwan. Their study indicated that the five most critical factors are: data security, perceived technical competence, costs, top manager's support and complexity. This study focused on small- and medium-sized hospitals in Taiwan which have a very high degree of e-healthcare maturity (Lian et al., 2014b) and it is not easy to generalise the results of this study to developing countries. The study also did not discuss issues such as technology readiness, change resistance and the availability of external expertise. Gao et al. (2016) proposed a framework to evaluate the adoption of Cloud Computing services in Chinese hospitals based on the HOT-fit model. The Gao et al. framework was developed from the literature and from interviews. However, their framework was designed to measure the degree of collaboration between healthcare organisations when adopting Cloud Computing and ignores other aspects of the decision-making process. Harfoushi et al. (2016) applied the TOE framework to study the factors affecting Cloud Computing adoption in Jordanian hospitals and found that all three perspectives (i.e. Technology, Organisational and Environmental) affect Cloud Computing adoption. However, their study did not show how these factors impact the decision about whether to adopt Cloud Computing and they did not study the sub-factors of each perspective. Osman (2016) examined the factors influencing Adopting Cloud Computing for 9-1-1 Dispatch Centres in the USA and he found that relative advantage, top management support, funding and firm size are the determinants of Cloud Computing adoption. However, the study ignored human and environmental aspects. Lian (2017) studied the quality-related factors that influence the successful adoption of Cloud Computing in Taiwanese hospitals based on the information systems success model. The researcher found that information quality, system quality and trust affected satisfaction with using Cloud Computing at the hospitals. However, Lian's study focused only on quality-related factors and did not consider decision-making activities.

Some researchers suggest that Cloud Computing in general and in e-health particularly is still in its early prototype stages and needs more research (AbuKhousa et al., 2012; Armbrust et al., 2010; Kuo, 2011; Griebel et al., 2015; Lian, 2017). Although there are many studies and projects about Cloud Computing in the health sector, most of them are focusing on the operational level. Successful Cloud Computing adoption in the health sector requires strategic planning to gain the full advantages of this new model (Kuo, 2011).

3.9 Cloud Computing in E-health in Saudi Arabia

This section discusses Cloud Computing in Saudi Arabian context with special focus of healthcare applications in the country.

3.9.1 General View of Cloud Computing in Saudi Arabia

Saudi Arabia is one of the largest ICT markets in the Middle East and the total ICT spend in the country is predicted to reach $33.8bn in 2017 (IDC, 2017). The Cloud Computing market in Saudi Arabia is also expected to grow to $70m in 2017 (Buller, 2016) and is expected to reach $126.9m in 2019 (Oxford Business Group, 2017). Figure 3.7 shows the total market for ICT and Cloud Computing in Saudi Arabia over four years (Al-Helayyil et al., 2016; Oxford Business Group, 2017). A possible explanation for the sharp change between 2017 and 2019 refers to the reduction of Saudi government budget due to the drop of oil prices and this budget may go back to normal expenditure in 2019 due to government programmes such as National Transformation Program 2020 (National Transformation Program 2020, 2016).

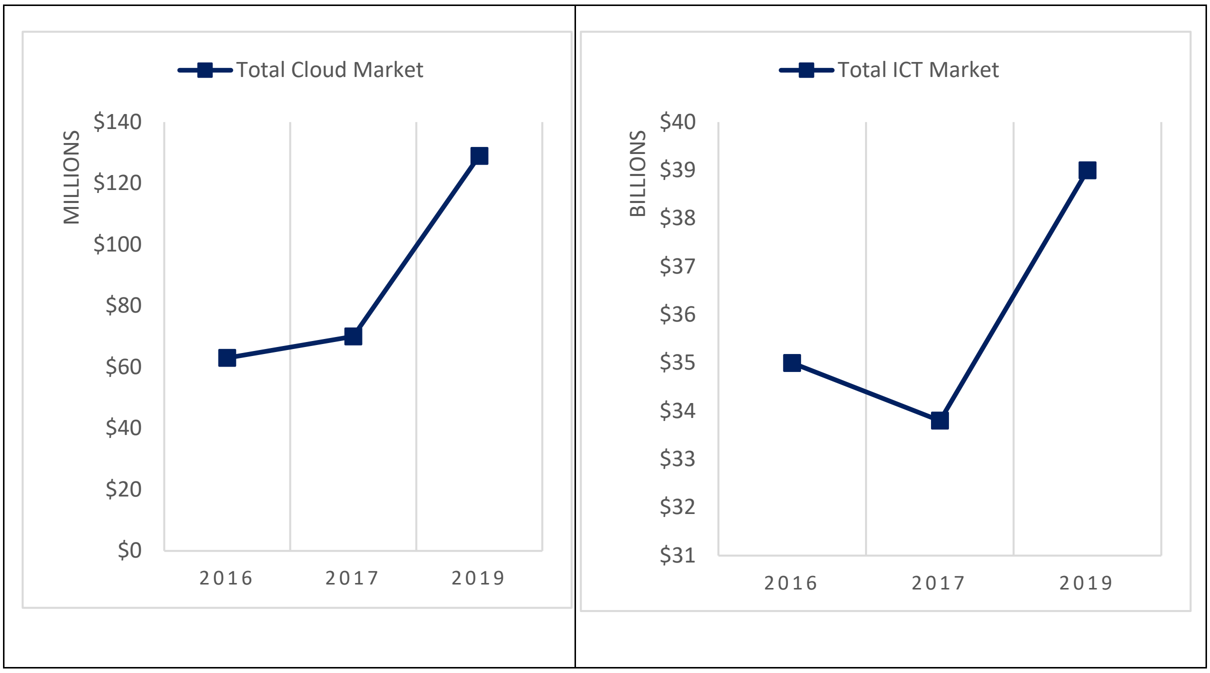


Figure 3.7 Total Market for ICT and Cloud Computing in Saudi Arabia for four years (adapted by author from (Al-Helayyil et al., 2016; Oxford Business Group, 2017))

The Cloud Computing market is expected to expand further in Saudi Arabia, reflecting Saudi government initiatives on reducing spending due to weak oil prices, and because of the benefits of potential cost savings (IDC, 2017). The Saudi government established the Vision 2030 initiative to support migration from an oil-based economy to a non-oil economy. The National Transformation Program 2020 (NTP) was announced as a part of this initiative (Vision 2030, 2016). The NTP aims to support Digital Transformation Initiatives and improve the effectiveness of public sector organisations (National Transformation Program 2020, 2016). ICT technologies can play important roles in facilitating this transformation by supporting innovative solutions that improve efficiency at lower costs (Almutairi & Thuwaini, 2015). Cloud Computing solutions particularly can provide support for the government initiatives by enhancing cross-government collaborations and providing the other benefits of Cloud Computing. However, Saudi Arabia has still not undertaken a national Cloud Computing initiative that could support the growth of Cloud Computing.

3.9.2 Studying Cloud Computing Adoption in Saudi Arabia

Cloud Computing in Saudi Arabia started to receive attention from 2013 (Yamin, 2013); before then, little research had been conducted on the implementation of Cloud Computing in the country. This sub-section discusses the research that has looked at the topic.

Alharbi (2012) and Alotaibi (2014) studied users' acceptance of Cloud Computing in Saudi Arabia based on the Technology Acceptance Model (TAM). Although the studies provided insights into the factors affecting Cloud Computing adoption in Saudi Arabia, both studies implemented TAM to predict users' acceptance of Cloud Computing which focused on the user level only. From an organisation level, Yamin (2013) completed a survey of Cloud Computing awareness in Saudi Arabia. The study showed that cloud technologies will be a new trend for Saudi organisations. However, this research provided only a general view of Cloud Computing adoption in Saudi Arabia.

Alkhater et al. (2014) investigated influential factors in the decision to adopt Cloud Computing in general. They indicated that many factors such as trust, relative advantage and technology readiness will influence the use of Cloud Computing technology. However, they did not investigate the effect of two dimensions – human and business – on the implementation of Cloud Computing. Another limitation of their study is the sample size, which was small (i.e. only 20 experts). Alsanea (2014) investigated the adoption of Cloud Computing in the government sector in general in Saudi Arabia. Their study indicated that there is a high possibility of Cloud Computing acceptance among Saudi government organisations since 86% of the participants supported the adoption of Cloud Computing in their organisations. The study also showed that Cloud Computing adoption in governmental sectors is positively affected by indirect benefits of the cloud, industry type, cost, trust and feasibility. However, the study provides views of the factors affecting Cloud Computing implementation in Saudi government organisations without providing specific information about the type of organisation, and it did not include human factors.

Tashkandi and Al-Jabri (2015) studied Cloud Computing adoption by higher education organisations in Saudi Arabia. The study focused on: technological, organisational and environmental factors. They found that relative advantage has a positive influence on the decision whether to adopt Cloud Computing. They also found that complexity and vendor lock-in have a negative influence on the decision. Their study has some limitations since it mainly focused on higher education organisations and the researchers do not include the business dimension, which is an important dimension in the adoption of Cloud Computing. Alhammadi et al. (2015) studied the determinants of Cloud Computing adoption in Saudi Arabia and found that factors influencing the decision whether to adopt Cloud Computing are security concerns, organisation readiness, top management support, firm status, government support and compatibility. This study was at organisation level and did not focus on a specific industry and did not provide information about the participants' roles. Alkhlewi et al. (2015) identified 15 factors for the successful implementation of a private government cloud in Saudi Arabia. However, the study focused only on government organisations and the sample size was small (i.e. only 30 experts) and the participants were mainly IT professionals. Albar and Hoque (2015) proposed a theoretical framework to study Cloud ERP Adoption in Saudi Arabia without applying the framework.

Noor (2016) examined the usage of Cloud Computing in Saudi universities; 300 participants from five different universities participated in the study. The study found that the key drivers of university IT department employees' cloud adoption were the ability to access the cloud via any device and the self-service feature of Cloud Computing. It also indicated that the main barriers to the adoption Cloud Computing were privacy, compliance, security, reliability and availability respectively. The study focused mainly on Saudi universities at the user level and ignored other aspects such as cost of adoption. Almutairi and El Rahman (2016) studied the impact of IBM Cloud Solutions on Saudi students and showed that the majority of the students knew about Cloud Computing; however, only 56% of the participants had used cloud solutions. Albugmi et al. (2016) proposed a theoretical framework for Cloud Computing adoption by Saudi government overseas agencies without testing the framework against specific respondents or case studies. Similarly, Mreea et al. (2016) proposed a Cloud Computing value model for public sector organisations in Saudi Arabia without testing the framework against specific respondents or case studies. Alharthi et al. (2017) investigated critical success factors for cloud migration in Saudi universities and identified six factors: security, reliability, interoperability, migration plan, regulation compliance and technical support with the Arabic language. The paper did not discuss business factors such as cost and technical factors such as infrastructure readiness.

3.9.3 Cloud Computing in the Saudi Healthcare Context

In the Saudi healthcare domain, few studies have discussed the use of Cloud Computing in Saudi healthcare organisations. Cloud Computing has been implemented by King Abdulaziz City for Science and Technology (KACST) to support the large Saudi Genome Project (Saudi Genome Project Team, 2015). Azzedin et al. (2014) developed the Disease Outbreak Notification System (DONS) in Saudi Arabia. However, both studies only considered the technical implementation of Cloud Computing and did not study the factors influencing Cloud Computing adoption in Saudi healthcare organisations.

Cloud Computing may assist in solving some of the management challenges of healthcare organisations in Saudi Arabia. Since financial issues are affecting e-health projects in the country, Cloud Computing can offer economic savings by decreasing the initial and operational costs of e-health projects in Saudi hospitals. Cloud Computing could help to reduce the problem of shortage of IT and health informatics technicians since the use of cloud technology means that fewer technicians will be required by the healthcare organisations (Sultan, 2014). Cloud-based medical applications will also enable IT departments in healthcare organisations to focus more on supporting the implementation of e-health projects by moving some of their responsibilities to the cloud providers' side, particularly in a public Cloud Computing environment. For healthcare organisations, Cloud Computing will enable better integration and exchange of medical records across multiple organisations (AbuKhousa et al., 2012). Using Cloud Computing in Saudi healthcare organisations will facilitate the provision of sufficient computing resources to deal with the large amount of data that is created by e-health services. This feature will also help Research and Development (R&D) departments in healthcare organisations at the national level (AbuKhousa et al., 2012). Cloud Computing used in collaboration with other technologies such as the Internet of Things, m-health and Big Data will help reshape healthcare services in Saudi Arabia. Cloud Computing solutions will be suitable technologies to support future demands on Saudi healthcare since the country's population is expected to increase from 30m to 37m by 2030 (International Futures, 2016). Cloud Computing technology will allow Saudi healthcare organisations to enhance their information-processing capacity by sharing IT resources which include software, hardware and expert skill sets. Cloud Computing could help in solving the fragmentation and isolation problems of the Saudi healthcare information system. Cloud Computing's elasticity feature, which is the ability to scale the IT services dynamically and quickly, could be appropriate for Saudi healthcare demands (Marston et al., 2011). A potential use of this feature could be during Hajj session when Saudi Arabia hosts from two to three million people for a specific time (i.e. one to three months) every year. Cloud Computing in collaboration with other technologies such as the Internet of Things, m-health and Big data could help reshape healthcare services in Saudi Arabia.

The literature review indicated that the adoption of Cloud Computing in Saudi Arabia in general (and in the healthcare sector in particular) needs to be investigated further (Yamin, 2013; Alkhater et al., 2014). Healthcare environments vary between countries depending on cultural, social and technical characteristics and method of financing. For example, in the United Kingdom and Australia, general taxes are the main sources of healthcare system funding (McDougall et al., 2003), whilst in other countries, such as France, Germany and Japan, social insurance schema are the main source of funding (McDougall et al., 2003). The role of the government is another factor that should be considered when making comparisons between different healthcare systems. While some governments act as regulator and insurer, as in the Japanese healthcare system, other governments – such as the New Zealand government – act as regulator, purchaser and provider of healthcare (McDougall et al., 2003). The use of IT also varies between countries. While some countries have reached a high degree of e-health maturity, in other countries e-health is still an emerging discipline. For example, Taiwan started an e-healthcare programme in 1995 (Liu et al., 2011), while Saudi Arabia launched the National E-health Strategy in 2011 (MoH, 2011). Culture also plays an important role in healthcare systems around the world. A study found that social barriers such as language and resistance to the use of new systems affected EMR implementation in Saudi hospitals (Hasanain & Cooper, 2014). As a result, each country must be considered as an individual case.

3.10 Conclusion

This chapter has discussed the issues that affect investigation of the adoption of Cloud Computing in the healthcare domain in general and in Saudi Arabia specifically. The chapter started by analysing the challenges faced by traditional healthcare systems; these challenges included the increase in human life expectancy, the need for wider geographical coverage, the shortage of healthcare professionals, the increase of chronic diseases and the consequently high cost of healthcare services. The chapter critically discussed the role of e-health, reviewing the benefits and the challenges of implementing e-health projects in healthcare organisations. Then, the role of Cloud Computing in relation to e-health was presented and the opportunities and challenges in using Cloud Computing in healthcare organisations were discussed. The situation in Saudi Arabia was analysed and e-health projects were explored along with an in-depth view of Cloud Computing research in general and the application of Cloud Computing in the healthcare domain in Saudi Arabia. The findings of this chapter have shown that there is a need for further investigation of the adoption of Cloud Computing in Saudi Arabia (and in the healthcare sector in particular), and that there is a need to develop a comprehensive strategic framework to assist healthcare organisations that are considering the adoption of Cloud Computing. The next chapter, Chapter four, discusses the development process of the Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS).

4 The development of an Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS)

4.1 Introduction

This chapter discusses the process of developing the HAF-CCS framework which addresses the need to develop a strategic framework to assist healthcare organisations to adopt Cloud Computing, as outlined in Chapters 2 and 3, by providing a detailed investigation of organisational aims and capabilities. The chapter starts by providing information about the theoretical frameworks that underpin the HAF-CCS framework. Three well-documented theoretical frameworks were chosen to support an holistic view of Cloud Computing adoption; these are the Technology-Organisation-Environment (TOE) Framework, the Information Systems Strategy (ISS) Triangle, and the Human, Organisation and Technology-fit (HOT-fit) Framework. This chapter also covers the structure of the HAF-CCS framework from both a conceptual and holistic viewpoint. The perspectives of the framework which are technology, organisational, environmental, human and business are explained in detail to show their relationship to Cloud Computing adoption for each perspective and each related sub-factor. Finally, the HAF-CCS framework is linked to the Cloud Computing adoption life cycle, which outlines the four phases of Cloud Computing adoption.

4.2 Framework Structure

The section provides an explanation of the concepts that underpin the framework development besides the theoretical frameworks. The reasons for applying the framework concept and holistic approach in the research are outlined as follows:

4.2.1 Framework Concept

The framework concept has been used widely in information systems within different contexts and meanings (Ho & Atkins, 2006a). For example, in the information system research community, a framework has been defined as providing guidance for research efforts that enhance communications among scholars and allow them to share research results in a well-defined standard way (Kirs et al., 1989). In software engineering, the framework concept refers to the reusability of all or part of a system or components (Johnson, 1997). In general, a framework is "*a systematic set of components fitted and joined together to support specific* *purposes*” (Jabareen, 2009). This definition will be implemented by this study because the HAF-CCS framework will be used for a specific purpose, which is Cloud Computing adoption decision-making. Furthermore, the framework developed in this study covers various issues (i.e. components) related to Cloud Computing adoption. A framework concept has been chosen for this study for many reasons. Firstly, the framework approach has been used widely in decision-making activities in the information systems field (Ho & Atkins, 2006a). Secondly, there is no need to use the framework components in a particular order or sequence during the framework implementation so they can be used flexibly, and this supports the approach used in the HAF-CCS framework (Jung & Joo, 2011). Thirdly, the framework concept allows any combination of the framework components to be made based on the framework user’s requirements (i.e. the framework users do not need to use all the framework components) (Jung & Joo, 2011). In the HAF-CCS framework, a ‘cards’ symbol is used to indicate a feature that can be added or deleted as required; this supports an agile approach, allowing the agile framework to be adapted to meet the user’s needs. This in turn allows the HAF-CCS framework to be used in different contexts. Additionally, organisations could add new components to the framework based on their requirements.

4.2.2 Holistic Approach

The findings of the literature, as discussed in chapters 2 and 3, indicate that there is a need for a framework that covers multiple perspectives to support Saudi healthcare migration towards Cloud Computing. An holistic approach considers the importance of the whole organisation rather than performing a separate analysis of isolated units (Van Gemert-Pijnen et al., 2011). Researchers have shown the need for a multidisciplinary holistic framework when studying the use of IT in healthcare organisations (Lluch, 2011; Paré & Trudel, 2007; Van Gemert-Pijnen et al., 2011). The dynamic nature of Cloud Computing requires an holistic framework to understand the Cloud Computing decision-making process that emphasises many factors influencing the adoption of Cloud Computing instead of focusing mainly on technical factors (Ferrer et al., 2012). Migrating towards the cloud needs a multiple perspectives strategy that supports Cloud Computing capabilities (Haddad et al., 2014). This research therefore adopts an holistic view to develop a framework that covers multiple perspectives; the HAF-CCS does not deal only with technology but also covers factors such as: Human, Business, Organisational and Environmental factors. Figure 4.1 illustrates the five dimensions (i.e. Technology, Human, Business, Organisational and Environmental) that will provide the holistic view of the framework by covering many aspects relevant to organisations and also links the dimensions with their theoretical bases.

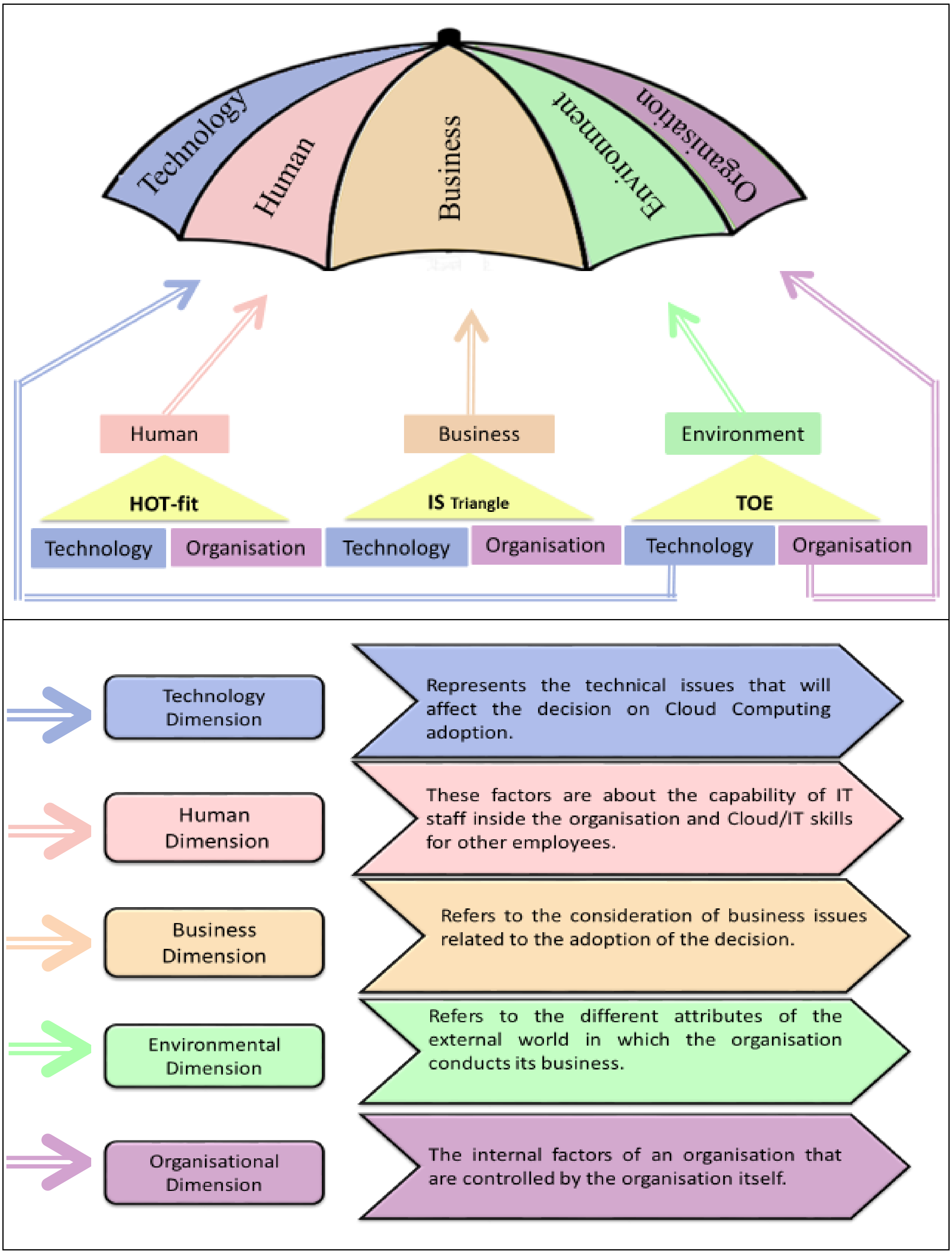


Figure 4.1 Holistic view of the framework

4.3 Theoretical Background

Many researchers have recognised the need to use holistic and multidisciplinary approaches when studying or designing Health Information Technology (HIT) frameworks in healthcare (Lluch, 2011; Van Gemert-Pijnen et al., 2011). The HAF-CCS framework is designed to support the decision-makers in health organisations by covering multiple perspectives. It is also designed in a flexible way to be adaptable to changing market conditions. The decision process when adopting Cloud Computing is potentially a complex one and consequently there are many perspectives to be considered. Thus, addressing the issues of cloud adoption requires a multiple perspective framework. The research framework chosen to support this study will integrate more than one theoretical framework to make the HAF-CCS framework more robust and cover multiple aspects relevant to an organisation. TOE has been chosen as an underpinning concept for this research together with Information System Strategic Triangle (IS Triangle) and HOT-fit. Figure 4.2 shows the relationship between HOT-fit, IS Triangle and TOE and the HAF-CSS framework, and the following sections explain this relationship in detail.

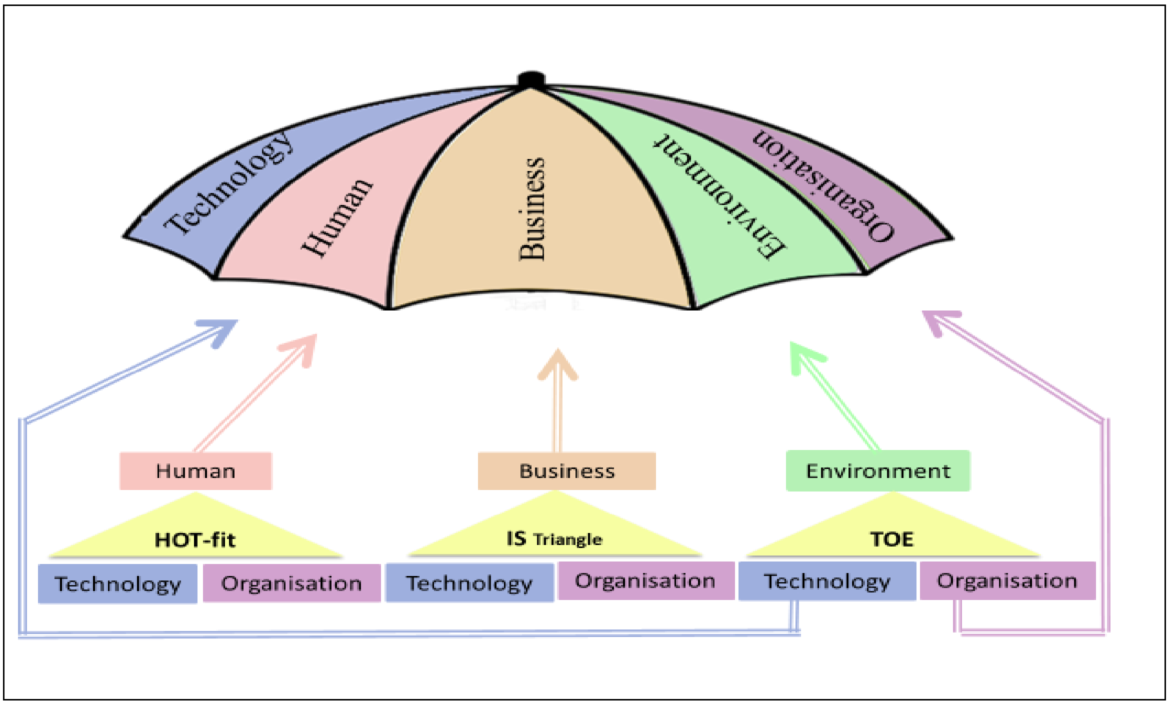


Figure 4.2 The relation between HOT-fit, IS Triangle and TOE and the HAF-CCS framework

4.3.1 Technology-Organisation-Environment (TOE) Framework

The appropriate framework for studying Cloud Computing adoption is a framework that is aiming to study innovation decision-making at an organisational level. The Technology-

Organisation-Environment (TOE) Framework was introduced by DePietroet al. (1990). This framework focuses on the process by which an organisation adopts and implements technological innovations and how the technological context, the organisational context and the environmental context can affect the implementation of the new innovation. Technological context refers to all the technologies that are used by the organisation or that are available in the market (Baker, 2012). Organisational context represents the organisation's internal characteristics and resources (Oliveira & Martins, 2011). Environmental context includes external elements that can affect the adoption of the technology such as government regulations and competitors (Baker, 2012). Oliveira and Martins (2011) suggested that the TOE framework is useful in studying the adoption decision-making process used with different types of IT innovation. TOE studies the adoption decision-making process at an organisation-level not at user-level, which makes it relevant for this project (Marston et al., 2011). Many researchers have studied technology innovation based on the TOE framework. Examples of this include RFID adoption in the healthcare environment (Lee & Shim, 2007), technology innovation in website development (Oliveira & Martins, 2008), in e-commerce (Liu, 2008), in Cloud Computing adoption by SMEs in England (Alshamaila et al., 2013), and in Cloud Computing adoption by hospitals in Taiwan (Low et al., 2011) and in developing countries (Senyo et al., 2015). The application of TOE covers features of the diffusion of innovation theory (DOI) such as innovation characteristics along with other factors, which makes TOE appropriate to support the study of Cloud Computing adoption in healthcare organisations (Alshamaila et al., 2013; Oliveira et al., 2014). Although the TOE framework has been implemented by many researchers for different technology innovations, some researchers argue that it does not contain all the required variables (Low et al., 2011). Researchers have combined the TOE framework with other theories to provide better understanding of IT innovation adoption (Oliveira & Martins, 2011; Baker, 2012). For example, Ibrahim and Jaafar (2015) combined the Model of External Influences on Environmental Awareness and Practices (MEAP) and Technology-Organisation- Environment Model (TOE) in an Environment Management System. Hence, for new complex technology adoption such as Cloud Computing, more than one theoretical framework is required to express a better understanding of the adoption decision (Low et al., 2011), as outlined in Figure 4.2.

4.3.2 Information Systems Strategy Triangle (ISST)

Business concepts must be taken into consideration by any decision-maker (Marston et al., 2011). One of the elements not sufficiently addressed in the TOE framework is business concepts and therefore the factors identified though TOE need to be extended by combining them with other factors, such as strategic considerations (Zhu & Kraemer, 2005). Thus, the strategic triangle will be combined with the TOE framework to add the strategic value to the HAF-CCS framework, as illustrated in Figure 4.2.

The Information Systems Strategy Triangle (ISST) is a concept that emphasises the importance for organisations to have an alignment between three strategic perspectives (Business, Organisation and Information) (Pearlson, 2001). In ISST, the business perspective is the main perspective which affects all other perspectives and it represents the organisation's business and financial drivers to adopt IT innovation, such as cost reduction and customer demand (Ho & Atkins, 2009). Organisational perspective refers to the internal issues of the organisation that can affect IT adoption (Pearlson, 2001). Information perspective includes technology capabilities and issues to be considered by the organisation (Ho & Atkins, 2009). Some researchers consider Cloud Computing as an innovative form of traditional IT outsourcing (Schneider & Sunyaev, 2014). This research will apply the business concepts of a strategic framework for outsourcing decision-making called Holistic Approach Business, Information, Organisation (HABIO) since other concepts are covered by the TOE framework. HABIO is a well-documented framework used for outsourcing (Alharbe et al., 2013; Ho & Atkins, 2006b, 2009).

4.3.3 Human, Organisation and Technology-fit (HOT-fit) Framework

Human factors are also critical in the adoption of any new IT innovation. Those factors should be considered carefully when making the decision to adopt Cloud Computing in a healthcare environment (Paré & Trudel, 2007). Researchers have argued that the TOE framework does not explain the effect of an individual or organisation's characteristics on the adoption of IT innovation (Baker, 2012). Hence, the Human, Organisation and Technology-fit (HOT-fit) framework will be integrated with previous frameworks. HOT-fit was introduced in Yusof et al. (2008) as an evaluation framework for health information systems, as illustrated in Figure 4.2.

In HOT-fit, three dimensions (i.e. technology, human and organisation) have been integrated to evaluate HIS systems (Yusof et al., 2008). Human factors of HOT-fit include those related to the individuals inside the organisation (Lian et al., 2014b). Technology dimension contains the technical factors that can affect the system's adoption (Yusof et al., 2008). Organisation dimension represents the impact of organisational attributes such as top management support and organisation culture on the adoption decision (Yusof et al., 2008). This research applies some of the concepts of the HOT-fit model that relate to human perspective issues encountered by IT staff in healthcare organisations as applied by Lian et al. (2014). Technology and organisation factors of HOT-fit are not integrated, to avoid duplication with similar factors of the TOE framework (Zainuddin et al., 2015). The integration of HOT-fit and TOE has been implemented in a study on the adoption of Cloud Computing in hospitals in Taiwan (Lian et al., 2014b; Lian, 2017).

4.4 Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS)

The framework is focused on five dimensions, which are Organisation, Technology, Environment, Human and Business, as identified in the chosen theoretical frameworks and as illustrated in Figure 4.1 and Figure 4.2.

The framework will help health organisations in their Cloud Computing adoption decision-making process by evaluating the factors affecting Cloud Computing adoption. The purpose of the framework is to help health organisations bridge the gap between their IT projects and providing better medical care with lower costs and high standards. The framework is developed from the literature where the critical factors from multiple perspective views affecting the decision regarding Cloud Computing adoption have been recognised. Table 4.1 summarises the factors and constructors identified in empirical studies of Cloud Computing adoption published in peer-reviewed journals.

Implementation of Cloud Computing in Saudi healthcare organisations can be recognised as a form of IT healthcare projects. Hence, factors affecting e-health projects in Saudi Arabia which were discussed in Chapter 3 in Section 3.4 are also considered to have an impact on the Cloud Computing adoption decision.

Table 4.1 Empirical studies of Cloud Computing adoption published in peer-reviewed journals

Reference	Theory	Factors/Constructors	Sector	Methods
Low et al. (2011)	TOE	*Relative advantage, Complexity, Compatibility, *Top management support, *Firm size, Technology readiness, *Competitive pressure, *Trading partner pressure	High-Tech industry in Taiwan	Questionnaire
Lin & Chen (2012)	DOI	*Relative advantage, Complexity, *Compatibility, *Trialability, Observability	IT professionals in Taiwan	Interview
Rahimli (2013)	NA	*Cost-effectiveness, *Need for cloud computing, *Reliability, *Security effectiveness	Malaysian organisations	Questionnaire
Alshamaila et al. (2013)	TOE	*Relative advantage, *Uncertainty *Geo-restriction, *Compatibility, *Complexity, *Trialability, *Size, *Top management support, *Innovativeness, *Prior IT experience, *Market scope, *Supplier computing support, Competitive pressure, *Industry	SME in the UK	Interview
Wu et al. (2013)	DOI & IPV	*Business process complexity, *Compatibility, *Entrepreneurial culture, *Application functionality	Manufacturing and retail industries in USA	Questionnaire
Nkhoma & Dang (2013)	TOE	Perceived benefit, Perceived environment barriers, Perceived technology barriers, * Adopter's style	Secondary data from survey of technology decision-makers	Secondary Data
Hsu (Hsu, 2013)	TOE	*Perceived benefits,*Business concerns, *IT capability, External pressure	Taiwanese firms	Questionnaire
Oliveira et al. (2014)	DOI & TOE	*Relative advantage, *Complexity, Compatibility, *Technology readiness, *Top management support, *Firm size, Competitive pressure, Regulatory support, Security concerns, *Cost savings	Service sector and manufacturing In Portugal	Questionnaire
Alsanea & Barth (2014)	TOE	*Service quality, *Usefulness, *Security concern, *Complexity, *Cost, *IT Infrastructure readiness, *Feasibility, *Trust, *Organisation culture, *Organisation structure, *Privacy risk, *Government support, *Regulatory concern, *External pressure, *Culture, *Industry type, *Direct benefits, *Indirect benefits	Government sector in Saudi Arabia	Questionnaire
Lian et al. (2014b)	TOE & HOT-fit	*Data security, *Compatibility, *Perceived technical competence, *CIO innovativeness, Cost, *Top manager support, *Adequate resources Complexity, Relative advantage	Taiwanese hospitals	Questionnaire
Tashkandi & Al-Jabri (2015)	TOE	*Relative advantage, *Complexity, Compatibility, Top management support, Vendor lock-in, *Data concern, Government regulations, Peer pressure	Higher Educational institutes in Saudi Arabia	Questionnaire
Harfoushi et al. (2016)	TOE	*Technology factors, *Organisational factors, *Environmental factors	Jordanian hospitals	Questionnaire
Lian (2017)	IS success model	*Information quality, *System quality, Service quality, *Trust	Taiwanese hospitals	Questionnaire

Note: *Significant Factors

The HAF-CCS framework, and the five perspectives of the framework, together with supporting factors, are presented in Figure 4.3. The following sections discuss the factors and their implications.

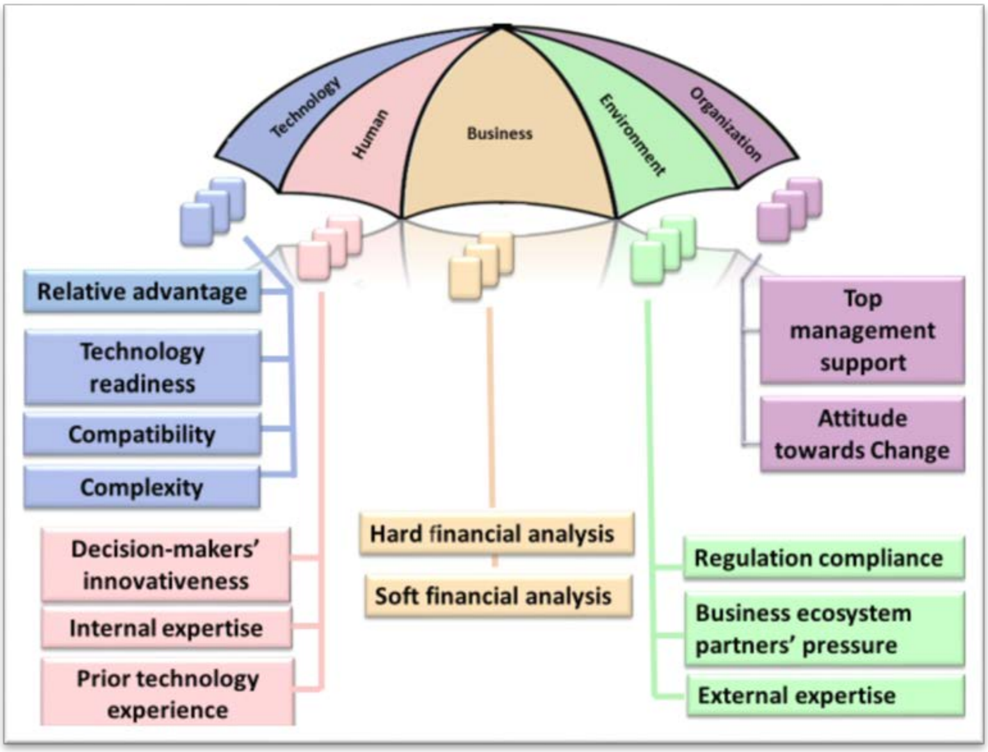


Figure 4.3 Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS)

4.4.1 Technology Context

The technology dimension represents the technical issues that will affect the decision on Cloud Computing adoption. This context relates to the technologies and practices of healthcare organisations that can influence decisions about specific IT adoption (Alshamaila et al., 2013). Technical factors can determine the scope of the organisation's technical changes since they represent its technological competence (Harfoushi et al., 2016). Health organisations intending to implement Cloud Computing need to assess their information technology infrastructure. Factors in the technology context are discussed as follows:

- Relative advantage

The relative advantage factor refers to checking if the adoption of Cloud Computing technology will have clear benefits over other technologies for the specified healthcare organisation. This factor is expected to be an important and positive significant factor for the decision on Cloud Computing adoption. Relative advantage includes the operational and strategic benefits that the healthcare organisation can receive by adopting Cloud Computing solutions (Hsu et al., 2014). Several studies in the context of Cloud Computing adoption have shown the importance of the perceived relative advantage in facilitating adoption (Oliveira et al., 2014; Lin & Chen, 2012). Alharbi (2012) showed that perceived usefulness will positively affect users' attitude towards adopting Cloud Computing in Saudi organisations. Relative advantage was found to have a significant and positive impact on Cloud Computing adoption in Saudi Arabia organisations (Tashkandi & Al-Jabri, 2015; Alkhater et al., 2014). Several benefits and advantages of implementing Cloud Computing were discussed in Chapter 2 (Section 2.8) and Chapter 3 (Section 3.7.1) which indicated that adopting Cloud Computing in healthcare organisations has technical and non-technical benefits over traditional IT.

- Technology readiness

Technology readiness could be an enabler factor in the decision whether to adopt Cloud Computing (Oliveira et al., 2014). For example, issues connected with existing infrastructure can have a negative impact on the adoption of Cloud Computing, as outlined by a study on the adoption of health data standards in Saudi Arabia (Alkraiji et al., 2013). However, Cloud Computing can help in solving the problem of the availability of IT resources (AbuKhousa et al., 2012). Saudi healthcare organisations will need to assess key IT infrastructure indicators (i.e., software, hardware, network security and Internet speed) before implementing Cloud Computing solutions (El-Gazzar, 2014; Grobauer & Walloschek, 2011). Many studies have identified technology readiness as an enabler factor that impacts Cloud Computing adoption (Lumsden & Anabel, 2013; Oliveira et al., 2014), so healthcare organisations will need to be more technologically ready for the adoption of Cloud Computing (Low et al., 2011). In Saudi Arabia, IT infrastructure readiness was reported as a factor that has a positive impact on Cloud Computing in the government sector (Alsanea & Barth, 2014). Internet bandwidth is an example of the infrastructure healthcare organisations need to assess because Cloud Computing adoption depends on a reliable Internet connection (Low et al., 2011). Limited Internet bandwidth and high cost of Internet services were stated as concerns relating to the adoption of Cloud Computing in higher education institutions in Saudi Arabia (Tashkandi & Al-Jabri, 2015). It is also important for the organisations to provide an inventory of their current applications and a hardware portfolio to support the Cloud Computing adoption decision-making process (Tsarchopoulos et al., 2017) since this allows more to be known about components of the infrastructure (Byrd & Turner, 2000). Figure 4.4 provides an example of a software inventory report (The Network Support Company, 2012).

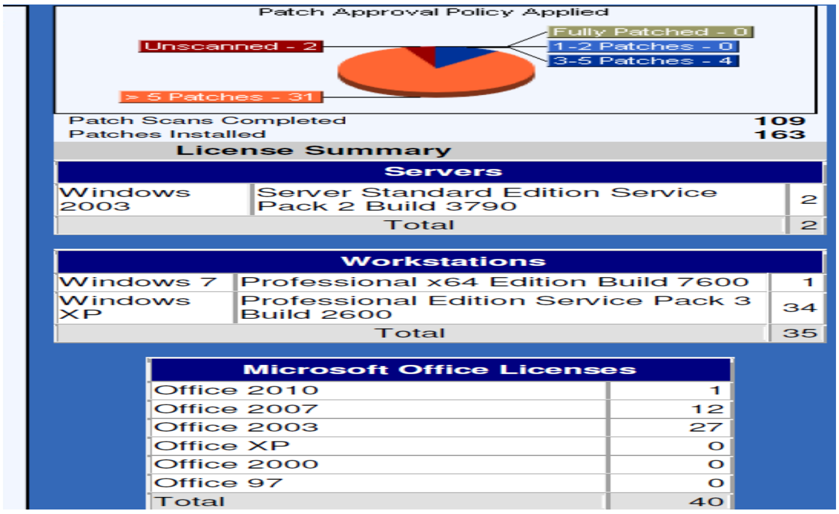


Figure 4.4 Example of a software inventory report (The Network Support Company, 2012)

- Compatibility

Compatibility refers to the degree to which the new technology fits with the organisation's values, present needs and previous practices (Alkraiji et al., 2013). Thus, compatibility of Cloud Computing implementation with existing IT systems, practices and needs inside the health organisation should be another factor to be considered when adopting cloud technology (Nkhoma & Dang, 2013). While some studies indicate that compatibility is negatively affecting the intention to adopt cloud computing (Wu et al., 2013; Lin & Chen, 2012), others indicate that this feature positively influences cloud computing adoption (Lumsden & Anabel, 2013; Oliveira et al., 2014). Compatibility was reported as an important factor regarding the adoption of health data standards in Saudi hospitals (Alkraiji et al., 2013) but was not found to have an impact on Cloud Computing adoption in higher education institutions in the country (Tashkandi & Al-Jabri, 2015). The nature of Cloud Computing supports the compatibility since it allows different devices to be used without affecting existing legacy systems (Durao et al., 2014), and this compatibility can increase as Cloud Computing solutions become more mature

(Oliveira et al., 2014). However, healthcare organisations must consider privacy and security concerns relating to Cloud Computing, so that it is compatible with healthcare values (Lian et al., 2014b).

- Complexity

The complexity factor represents how easy it is for an organisation to use and understand new innovation (Lin & Chen, 2012). E-health usually encompasses many health information systems, and integrating Cloud Computing with the existing systems could add some technical difficulties. Some Saudi healthcare organisations found difficulty in integrating new systems with their existing clinical systems (Barakah et al., 2014). However, while some studies have reported complexity as an inhibitor of Cloud Computing adoption (Oliveira et al., 2014), others have not indicated that complexity is a significant factor in the decision to adopt Cloud Computing (Lin & Chen, 2012; Low et al., 2011). For some Saudi Arabian organisations, the implementation of Cloud Computing technologies was not identified as complex (Alhammadi et al., 2015) but complexity was found to have a negative and significant effect on cloud computing adoption in the Saudi government sector (Alsanea & Barth, 2014). Some aspects of cloud complexity can be eased by better change management and extra training of organisation staff (Morgan & Kieran, 2013).

4.4.2 Organisational Context

Organisational factors also influence the success or failure of e-health projects. They are the internal factors of an organisation that are controlled by the organisation itself and they play an important role in the decision-making process (Oliveira et al., 2014). Adopting Cloud Computing could require some changes at the organisational level of healthcare organisations and affect different stakeholders. Social issues were found to have a large influence on e-health projects (Haux, 2006) and consequently these issues need to be assessed before Cloud Computing adoption. Organisational factors included in the study are investigated as follows:

- Top management support

Top management support can be a significant factor in cloud adoption and affect how executives identify the nature and functions of Cloud Computing technology and how this technology will affect the overall organisation (Alshamaila et al., 2013). The support of the management team is important when adopting new innovation because it offers the required resources and influences the attitudes of members of the organisation in favour of the new changes (Oliveira et al., 2014). Top management support was found as a determinant of Cloud Computing in several studies (Oliveira et al., 2014; Low et al., 2011). In the Saudi context, top management support was found as an enabler of Cloud Computing adoption and research showed that employees in managerial positions in Saudi organisations had positive attitudes towards Cloud Computing adoption (Alharbi, 2012; Alhammadi et al., 2015; Alkhater et al., 2014). However, the situation in healthcare organisations may be different due to the nature of such organisations and the top management support may be hindered due to certain concerns (Boonstra & Broekhuis, 2010). Managers' support was found to be a significant factor for Cloud Computing adoption in Taiwanese hospitals (Lian et al., 2014b). Lack of management support negatively affected e-health projects in Saudi Arabia and led to a communications gap between different departments in healthcare organisations (Khudair, 2008). Top management teams should identify the nature of Cloud Computing in order to recognise and support IT needs and to overcome any difficulty that the organisation may face in the adoption (Hsiao et al., 2008; Alshamaila et al., 2013).

- Attitude towards change

The successful adoption of new technologies requires various changes to be made to the organisational structure; such changes may face resistance from physicians, administrative and IT staff (Yusof et al., 2008). Studies have shown that resistance to the use of new systems is affecting Electronic Medical Record (EMR) implementation in hospitals in different countries (Hasanain & Cooper, 2014; Boonstra & Broekhuis, 2010). This factor should be considered when a healthcare organisation adopts a Cloud Computing solution. One possible reason for the resistance to change is related to the lack of knowledge about the new technology and how the change will affect current business processes (Oliveira et al., 2014). Healthcare organisations need to implement an effective change management process to increase the awareness and the knowledge of Cloud Computing among their members (Lam, 2011). Change management challenges were found to be inhibitors of Cloud Computing adoption, even though some of the changes were beneficial for the organisations (El-Gazzar et al., 2016). It is important to consider technical and non-technical changes that could be caused by applying Cloud Computing in healthcare organisations (El-Gazzar et al., 2016).

4.4.3 Environmental Context

Environmental context refers to the different attributes of the external world in which the organisation conducts its business (Lian et al., 2014b). The use of Cloud Computing technologies in e-health will be affected by the relationship between different parties such as governmental bodies, vendors and other healthcare organisations. The factors in this context can provide opportunities and constraints related to adopting Cloud Computing in healthcare organisations (Hsu et al., 2014), and they are outlined as follows:

- Regulation compliance

Government legislation and policies can affect the decisions of healthcare organisations trying to adopt new technology (Yusof et al., 2008). In the healthcare sector, data security and privacy protection are required not only by the patients themselves, but in most countries they are also required by law. Thus, data security is an essential factor that should be considered during any Cloud Computing implementation (Nkhoma & Dang, 2013). With the current security and privacy issues relating to the cloud, this factor must be considered carefully. Although both Cloud Computing provider and healthcare organisation must comply with regulations that monitor security and data privacy issues, it is the healthcare organisation's responsibility to make sure that the provider applies reasonable security controls and complies with regulatory laws (Schweitzer, 2011). For example, HIPAA regulations require American organisations to have a clause in their IT project contracts confirming that the provider will follow specific security rules and processes (Schweitzer, 2011). Regulations and policies are important for safe adoption of Cloud Computing in Saudi healthcare organisations (El-Gazzar et al., 2016). However, regulatory compliance can slow the adoption of Cloud Computing, as indicated in the Saudi context (Alsanea & Barth, 2014) and in other studies (El-Gazzar et al., 2016; Hsu et al., 2014). Anecdotal evidence shows that organisations that implemented Cloud Computing have addressed these reservations (Kuo, 2011).

- Business ecosystem partners' pressures

Healthcare organisations have many partners such as suppliers, vendors and government agencies that affect and are affected by each other. Organisations can be affected by the practices of other organisations either by discovering new opportunities or via personal communications between managers. This is illustrated by the fact that, for example, many large organisations started to consider outsourcing as a strategic choice after Kodak's implementation of the model (Bhattacharya et al., 2003). Industrial peer pressure will differ depending on the commercial nature of organisations, and highly competitive environments such as the high-tech industry tend to adopt new technologies quicker (Low et al., 2011). Perceived industry pressure was found to be a predictor of the adoption of Cloud Computing (Tan et al., 2012). Another pressure for Saudi healthcare organisations comes from the Saudi government, which is trying to reduce the cost of healthcare services, and this will lead to the implementation of cost-effective solutions such as Cloud Computing (Vision 2030, 2016). Success stories from early adopters of Cloud Computing can influence other organisations and the early adopters can act as opinion leaders who encourage others to adopt Cloud Computing (Hsu et al., 2014). Thus, business ecosystem partners will influence an organisation's decisions about implementing Cloud Computing solutions.

- External expertise

Additionally, most healthcare organisations rely on trading partners for their IT solutions so sufficient support from cloud vendors will be an influential factor affecting the decision to adopt Cloud Computing (Low et al., 2011). Instability of EMR vendors was found to be one of the barriers to EMR implementation in Saudi hospitals (Hasanain & Cooper, 2014). Another factor that is associated with the provision of sufficient support by the vendor is the availability of external expertise (Alshamaila et al., 2013; Alkraiji et al., 2013). E-health usually encompasses many health information systems and requires expertise from various domains such as medicine, IT and business processes. In a Saudi Arabian context, the shortage of healthcare professionals is considered to be a challenge to the successful implementation of e-health projects in the country. Thus, the availability of healthcare-related expertise on the Cloud Computing provider's side could be a factor which affects the decision on Cloud Computing adoption. Sufficient support from cloud vendors was found to be a facilitator of Cloud Computing adoption (Güner & Sneiders, 2014; Alshamaila et al., 2013) and Cloud Computing solutions offer the possibility of increasing the organisation's ICT capabilities by allowing the department to leverage the IT capabilities of the service vendor (Yigitbasioglu, 2015). The Service Level Agreement (SLA) is an important document which defines business and technical agreements between the cloud vendors and healthcare organisations (Chang et al., 2015). Healthcare organisations are also required to follow the best practices when evaluating their cloud vendors and assessing their SLAs (Illoh et al., 2015).

4.4.4 Human Context

The human dimension should be considered before the implementation of any IT project as it is one of the factors that influence the successful adoption of an innovative technology (Yusof et al., 2008). Human factors were identified as the main obstacles of successful implementation of EMR in Saudi healthcare organisations (Khalifa, 2013). The organisation's culture, which include values, belief and work routines, will be affected by the adoption of Cloud Computing and the related factors should be assessed (El-Gazzar et al., 2016; Lam, 2011). The human factors are discussed as follows:

- Decision-makers' innovativeness

Hospitals usually are slow in adopting new information technologies due to the decision-makers' characteristics, such as innovativeness, experience and risk affinity (Haddad et al., 2014; Zlatanović & Nikolić, 2017). Thus, the innovativeness of decision-makers considerably influences the decision to adopt Cloud Computing (Lian et al., 2014b). Decision-makers' innovativeness is their ability and inclination to try the latest technologies even though they have not been tried and tested in their sector (Tehrani & Shirazi, 2014). The openness and innovativeness of IT decision-makers in a healthcare organisation and their willingness to change can drive organisational innovativeness (Oliveira & Martins, 2011). They also can act as internal champions who offer the required information and assistance about the Cloud Computing adoption process (Hsiao et al., 2008). However, it is important to align any IT initiative with the healthcare organisation's strategy to make the initiative more successful (Malladi, 2014). The innovativeness of decision-makers was found to be a positive factor for Cloud Computing adoption (Alshamaila et al., 2013; Tehrani & Shirazi, 2014).

- Internal expertise

Another factor that will affect the decision concerning Cloud Computing adoption is the capability of IT staff inside the healthcare organisation to deal with such technologies (Lian et al., 2014b). Insufficient technical knowledge is considered to be a barrier for e-health projects in general (Boonstra & Broekhuis, 2010). Internal technical competence of organisations plays a motivative role in Cloud Computing adoption because an organisation with higher IT capability is more familiar with the latest trend in information technologies than one with lower IT capabilities (Hsu, 2013). Adopting Cloud Computing can lead to a change in IT department culture and IT staff responsibilities for introducing a cloud culture (Sultan & van de Bunt-Kokhuis, 2012). The movement towards Cloud Computing will also require internal expertise with skills related to cloud adoption such as security, negotiation and cloud management skills (El-Gazzar et al., 2016). Efficient IT capability was found to be an important and positive factor for Cloud Computing adoption (Hsu, 2013; Yigitbasioglu, 2015).

- Prior technology experience

Prior technology experience or the Cloud/IT skills of healthcare organisations' employees are also expected to impact the diffusion of Cloud Computing inside health organisations (Borgman et al., 2013). This factor represents the ability of the organisation's staff to deal with Cloud Computing technologies and similar technologies (Alshamaila et al., 2013). Hospital staff's lack of experience in using computer applications was found to be a barrier to implementing Electronic Medical Records (EMRs) in Saudi Arabia (Khalifa, 2013). Existing technology knowledge and skills among an organisation's staff was found to be a positive factor and determinant of Cloud Computing adoption (Alshamaila et al., 2013; Lin & Chen, 2012). Experience of using IT innovation was found to be a key factor in adopting new IT technologies in Saudi Arabia (Baabdullah et al., 2013). Organisation staff with better knowledge about new technology may be less resistant to its implementation (Alkraiji et al., 2014). The assessment of a healthcare organisation's technology skills allows the organisation to discover any need to provide extra training for its employees and introduce any skills development programmes (Althunaian, 2012).

4.4.5 Business Context

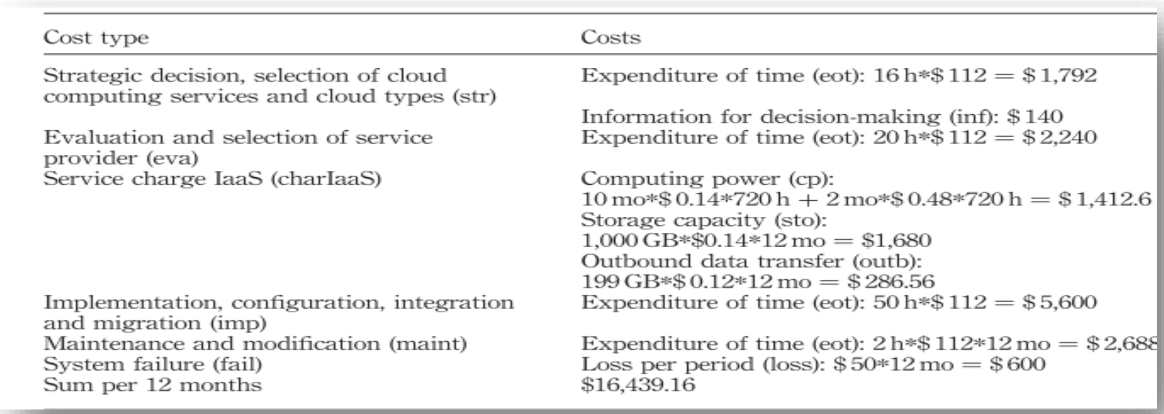
The business perspective refers to the consideration of business issues related to the adoption decision. The decision to adopt Cloud Computing requires approval from both business and information technology sides to make the transition to Cloud Computing successful (El-Gazzar et al., 2016). Cloud Computing adoption decision in healthcare organisations involves different types of financial analysis (i.e. tangible (hard) and intangible (soft) aspects) (Misra & Mondal, 2011), which are outlined as follows:

- Hard financial analysis

Hard financial analysis refers to financial analysis via the use of costing methods that utilise quantitative metrics (Ho & Atkins, 2006b). As in any IT investment, cost is an important factor which influences the decision about Cloud Computing adoption. The cost should be analysed in both capital expenditure (CAPEX) and operational expenditure (OPEX) (Misra & Mondal, 2011). The decision regarding which deployment models should be implemented also needs to be discussed carefully (Rijnboutt et al., 2013), and the organisation should have clear procurement strategies for Cloud Computing. Cost was found to be a factor that had a high impact on the decision whether to adopt Cloud Computing in Taiwanese hospitals (Lian et al., 2014b). High implementation and management cost of e-health projects in Saudi Arabia was found to be a barrier to implementing such projects in the country (Khalifa, 2013; Almuayqil et al., 2016). It is important for healthcare organisations to consider different methodologies to assess Cloud Computing investments such as the Return on Investment (ROI), Total Cost of Ownership and Activity Based Costing (ABC) (Rimal et al., 2011; Mohapatra & Lokhande, 2014). While ROI measures the efficiency of Cloud Computing adoption, TCO measures the direct and indirect cost of the adoption (Misra & Mondal, 2011). ROI of Cloud Computing can be calculated as follows:

$$Cloud\ Computing\ ROI = \frac{Cloud\ Benefits - Cloud\ Cost}{Cloud\ Cost} \qquad \text{(Kornevs et al., 2012)}$$

In a TCO approach, the cost of owning IT resources is not determined by purchasing cost only; other costs have to be included, such as integration with current systems, software licences, training, warrantee, maintenance and support (Walterbusch et al., 2013). Figure 4.5 shows TCO model application for the provisioning of a public IaaS Cloud Computing Service.



Cost type	Costs
Strategic decision, selection of cloud computing services and cloud types (str)	Expenditure of time (eot): 16 h*$ 112 = $ 1,792 Information for decision-making (inf): $ 140
Evaluation and selection of service provider (eva)	Expenditure of time (eot): 20 h*$ 112 = $ 2,240
Service charge IaaS (charIaaS)	Computing power (cp): 10 mo*$ 0.14*720 h + 2 mo*$ 0.48*720 h = $ 1,412.6 Storage capacity (sto): 1,000 GB*$0.14*12 mo = $1,680 Outbound data transfer (outb): 199 GB*$ 0.12*12 mo = $ 286.56
Implementation, configuration, integration and migration (imp)	Expenditure of time (eot): 50 h*$ 112 = $ 5,600
Maintenance and modification (maint)	Expenditure of time (eot): 2 h*$ 112*12 mo = $ 2,688
System failure (fail)	Loss per period (loss): $ 50*12 mo = $ 600
Sum per 12 months	$16,439.16

Figure 4.5 Example of a TCO model of Cloud Computing (Walterbusch et al., 2013)

Another financial metric in measuring Cloud Computing is the ABC cost method, where the measurement are based on the activities performed to accomplish the tasks (Mohapatra & Lokhande, 2014). Selecting the costing method for Cloud Computing depends on the organisation's customs and practices of cost measuring and accounting (Kornevs et al., 2012).

- Soft financial analysis

Cloud Computing technologies could add strategic value to healthcare organisations which could be measured through a soft financial analysis of the Cloud Computing adoption decision such as customer satisfaction improvement (Ho & Atkins, 2006b). Adopting Cloud Computing will give the possibility of new classes of applications and the delivery of services that were not possible before, such as mobile health, telemedicine and big data (AbuKhousa et al., 2012). For example, the Cloud Computing environment reduces the cost of IoT sensor integration with mobile devices to allow healthcare organisations to improve patient safety and report any abnormal information (Ting et al., 2011). Another related issue is the impact of the adoption of Cloud Computing on medical and business processes (AbuKhousa et al., 2012). The absence of an implementation strategy has negatively affected e-health projects in Saudi Arabia (Khudair, 2008). It has been argued that the use of Cloud Computing will help the hospitals to move from the traditional healthcare model (doctor-centred model) to the new healthcare model (patient-centred model) by facilitating the sharing and access of patients' medical data and increasing patients' engagement (Chang et al., 2009). Healthcare organisations need to integrate Cloud Computing solutions in a way that is linked to their business model to gain the broad benefits of moving to Cloud Computing (El-Gazzar et al., 2016). Cost Benefit Analysis (CBA) is a technique used to calculate the financial value of intangible costs and the benefits of implementing Cloud Computing (Agrawal & Kearney, 2010). The Balanced Score Card (BSC) is another technique that combines traditional financial measures with other non-financial qualitative performance indicators. The BSC is implemented by a wide range of healthcare providers and facilities at all levels of the health system and for different purposes, and is the preferred technique of Saudi healthcare organisations (Althunaian, 2012). Figure 4.6 shows an example of applying the BSC technique for Cloud Computing adoption (Udoh et al., 2014).

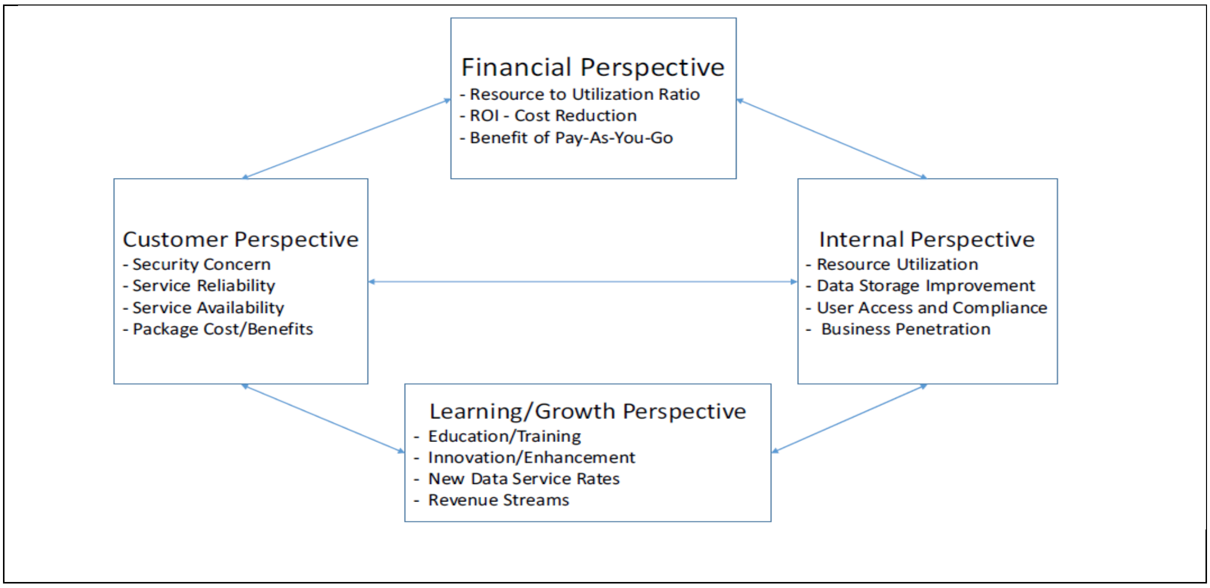


Figure 4.6 Applying the BSC technique for Cloud Computing adoption (Udoh et al., 2014)

4.5 Cloud Computing Adoption Strategy

This research followed a Cloud Computing adoption strategy that consists of four phases (Shimba, 2010; Okai et al., 2014). Figure 4.7 shows the relation between HAF-CCS and the Cloud Computing adoption stages recommended by Shimba (2010) and Okai et al. (2014) where HAF-CCS is applied at the assessment phase. Cloud Computing adoption phases are as follows:

- Assessment Phase

In this phase, the healthcare organisation starts to understand its position regarding Cloud Computing adoption. It also includes assessing the capabilities of the healthcare organisation's IT infrastructure. The Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS) is applied in this phase to help the healthcare organisation identify organisational strengths that can be used to support Cloud Computing initiatives. Deciding whether to adopt Cloud Computing is potentially a complex process and consequently there are many perspectives to be considered.

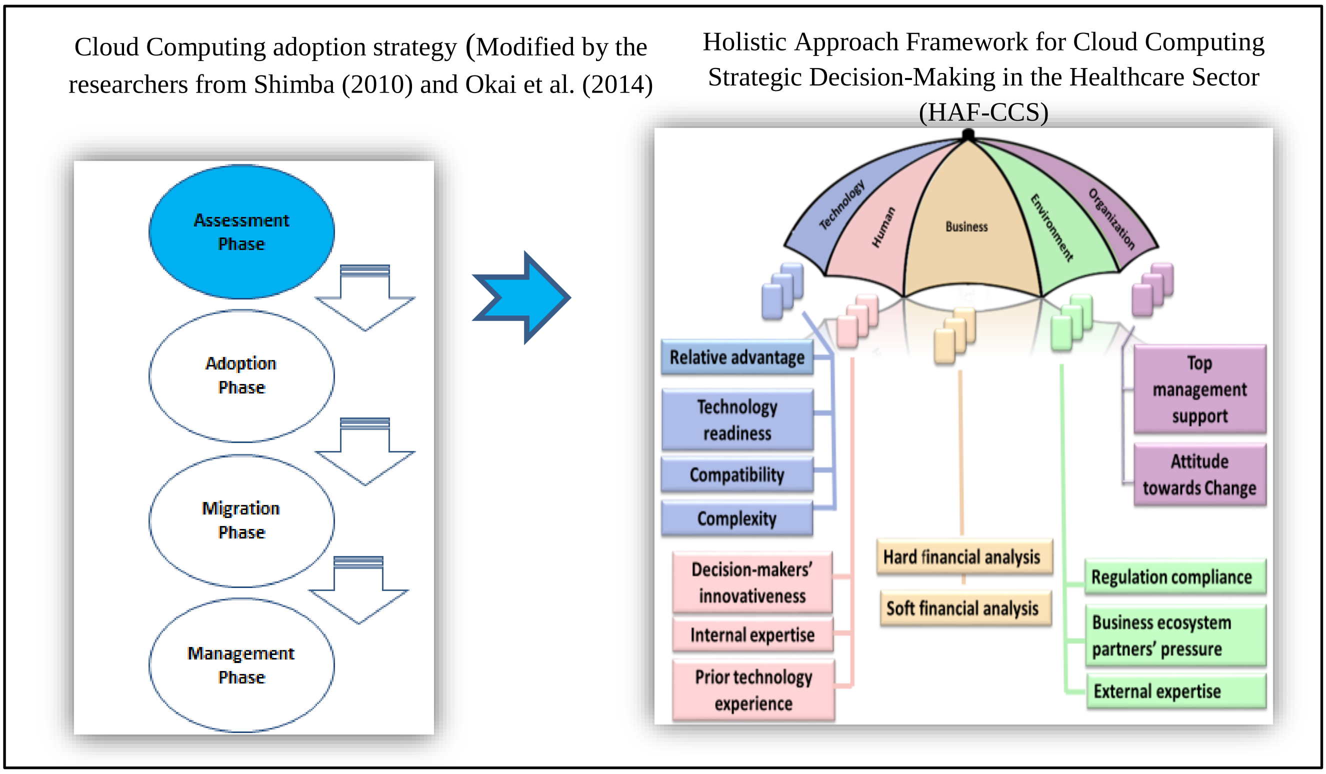


Figure 4.7 The Relationship between HAF-CCS and Cloud Computing Adoption Strategy

Thus, HAF-CCS will be applied to support the assessment process in the healthcare organisation. This phase also includes setting benchmarks to measure the financial and operating performance of the proposed Cloud Computing transformation (Joha & Janssen, 2012). The assessment process will increase the awareness of Cloud Computing among different stakeholders in the healthcare organisation (Oliveira et al., 2014).

- Adoption Phase

In this phase, appropriate cloud deployment models and cloud service models will be selected. The outcome of the assessment phase will be utilised as a guideline that supports the adoption of Cloud Computing. This phase includes the financial and cost management planning as well as the Service Level Agreements (SLAs). The outcome of this phase will include the actual migration plan that contains systems and applications to be moved to the cloud platform (Shimba, 2010). The selection of Cloud Computing vendors is also accomplished at this stage.

- Migration Phase

This is the actual stage of moving towards Cloud Computing and final implementation. After the assessment is completed and the plans are finalised, IT resources can be mapped to selected cloud deployment models. Applications and data migration will be completed in this phase. This phase also involves the integration process where Cloud Computing solutions are integrated with the existing IT infrastructure (Okai et al., 2014).

- Management Phase

This phase will be the operational phase since the system will be running (Shimba, 2010). The benchmarks that were set during the assessment phase will be utilised to discover the success or the limitations of the new system. In this phase, management and information best practices are developed and documented to be used for similar projects.

This research covers the assessment phase in detail by discussing the application of the Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS).

4.6 Conclusion

The chapter has introduced the Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS) to support healthcare organisations in Saudi Arabia in their movement towards Cloud Computing. It started by presenting the theoretical frameworks that underpin the development of the framework. Three theoretical frameworks – TOE, IS strategy triangle and HOT-fit – were combined to provide an holistic view of the new framework. Framework perceptions were also outlined to provide the fundamentals of the HAF-CCS framework. Then, five perspectives of the framework – technology, organisational, environmental, human and business –and their sub factors were discussed in detail based on the literature review. The internal technical characteristics of the organisation including relative advantage, compatibility, technology readiness and complexity were explained. Then, organisational factors – the support of the management and the change attitude – were considered. Environmental influences of Cloud Computing adoption in Saudi healthcare organisations were also discussed, followed by the human aspects that can affect Cloud Computing adoption. The business context was also considered by outlining hard and soft financial factors of Cloud Computing in healthcare organisations. Relating the HAF-CCS framework to the Cloud Computing adoption strategy was also discussed in the chapter. The following chapter will present the empirical research conducted to validate the HAF-CCS framework's for suitability in the Saudi healthcare context.

5 Understanding the Determinants of Cloud Computing Adoption in Saudi Healthcare Organisations

5.1 Introduction

This chapter presents an investigation to understand the factors affecting Cloud Computing adoption in healthcare organisations in Saudi Arabia. It starts by explaining the purpose of the study and relates the study to previous chapters. The chapter describes the process of developing and managing the questionnaire that is used as a study tool. It also shows the data analysis process and the different statistical tests that are used to provide insights and useful information about the questionnaire data. This is followed by a discussion about the Determinants of Cloud Computing Adoption in Saudi Healthcare Organisations. Finally, the chapter updates and modifies the previous HAF-CCS framework based on the results and discussion of the study.

5.2 Purpose of the Study

The purpose of the study is to investigate the factors that will affect Cloud Computing adoption in healthcare organisations in Saudi Arabia. The study also explores the current status of Cloud Computing adoption in Saudi healthcare organisations. The literature demonstrates that there is limited academic research addressing the Cloud Computing phenomenon in the Saudi Arabian healthcare context. This study statistically analyses the developed framework presented in Chapter 4, which was built based on extensive secondary research into the critical factors influencing the decision concerning Cloud Computing adoption, as recognised from multiple perspective views and outlined in Figure 4.3.

The study also seeks to provide an holistic view by allowing multiple stakeholders to participate in the survey. This study applies a survey method to examine the factors identified from the literature review. Then, the research applies statistical procedures to empirically evaluate the factors in the framework.

5.3 Research Design

The researcher used a survey technique to accomplish the research objectives and to measure the factors affecting Cloud Computing adoption in Saudi Arabian healthcare organisations. This section describes the process of conducting the survey study, which is outlined as follows:

5.3.1 Questionnaire Development Process

A questionnaire was developed to examine the factors affecting Cloud Computing adoption in Saudi healthcare organisations identified from the literature. This study followed the questionnaire development process that is mentioned in Moore and Benbasat (1991), where the development of the questionnaire is divided into three stages: item construction, questionnaire reviewing process and questionnaire testing stage.

- **First Stage: Item Construction**

In this stage, the constructors of the study are recognised by identifying the existing studies that can provide similar measurements of them. The study integrates Cloud Computing adoption factors with other factors to provide an holistic view of Cloud Computing adoption. Based on the HAF-CCS framework which is outlined in Chapter 4 and illustrated in Figure 4.3, 14 factors are identified to explore the possible items that can be used to measure the identified factors. The items of the questionnaire are built based on five-point Likert scales, which are recommended when implementing self-administered surveys (Hair et al., 2006) and have been used widely in the healthcare context (van Dyk, 2014). The Likert scale is an interval scale which is used to capture the respondents' opinions regarding a given subject or topic (Boone & Boone, 2012). Table 5.1 presents the procedure of coding the Likert scale items applied in this research (Brown, 2011; Alshamaila et al., 2013). Table 5.2 shows the measurement items for the factors and their literature sources.

Table 5.1 Likert Scale Item Coding

Likert scale item	Code
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

Table 5.2 Questionnaire Measurement items

Constructs	Items		Reference
Relative advantage	RA1	Cloud Computing will allow my organisation to accomplish specific tasks more quickly.	Oliveira et al. (2014), Lin & Chen (2012), Low et al. (2011), Lian et al. (2014b)
	RA2	The use of Cloud Computing will provide real benefits for the patients.	
	RA3	Cloud Computing will increase the productivity of organisation's staff.	
Technology readiness	TR1	My organisation has provided Internet access to all its members.	Oliveira et al. (2014), Low et al. (2011), Lumsden & Gutierrez (2013)
	TR2	The IT infrastructure of my organisation can support the adoption of Cloud Computing.	
	TR3	My organisation makes good use of IT to achieve its goals.	
Compatibility	CO1	Cloud Computing services will be compatible with the current business strategy of my organisation.	Oliveira et al. (2014), Lin & Chen (2012), Lian et al. (2014b), Alshamaila et al. (2013)
	CO2	Cloud Computing technology is compatible with the current IT infrastructure (Hardware/Software) of my organisation.	
	CO3	Cloud Computing is compatible with the healthcare values and goals.	
Complexity	CX1	Integrating Cloud Computing with current IT systems in my organisation will be easy.	Oliveira et al. (2014), Lin & Chen (2012)
	CX2	Developing and maintaining Cloud Computing requires a lot of specialist resources (i.e. workforce).	
Decision-makers' innovativeness	CI1	My organisation usually tries to use the latest technologies.	Lian et al. (2014b), Alshamaila et al. (2013)
	CI2	My organisation is open to experimenting with the latest technologies.	
Internal expertise	IE1	My organisation has enough human resources with necessary skills to adopt Cloud Computing services.	Oliveira et al. (2014), Lian et al. (2014b)
	IE2	IT staff in my organisation will find it easy to learn about Cloud Computing applications and platforms.	
Prior technology experience	PE1	Staff in my organisation are familiar with Cloud Computing services.	Alshamaila et al. (2013), Lian et al. (2014b)
	PE2	IT staff in my organisation have previous experience in Information System/Information Technology project development.	
Top management support	TP1	The organisation's top management involves itself in the process when it comes to IS/IT projects.	Oliveira et al. (2014), Low et al. (2011), Lian et al. (2014b)
	TP2	The organisation's top management supports the adoption of Cloud Computing.	
Attitude towards Change	CR1	The implementation of Cloud Computing will be accepted by IT staff in my organisation.	Yeboah-Boateng & Essandoh (2014), Turan & Palvia (2014), Alkraiji et al. (2013)
	CR2	The implementation of Cloud Computing will be accepted by healthcare professionals in my organisation.	
Regulation compliance	RC1	Government regulations in Saudi Arabia are sufficient to protect the users from risks associated with Cloud Computing.	Oliveira et al. (2014), Lian et al. (2014b), Morgan & Kieran (2013)
	RC2	There are Saudi laws regarding ownership and responsibility for patient data.	
	RC3	The use of Cloud Computing allows sensitive data to be protected from unauthorised people.	
Business ecosystem partners pressure	TP1	Cloud Computing is recommended by the government of Saudi Arabia.	Oliveira et al. (2014), Low et al. (2011) Alshamaila et al. (2013), Hsu et al. (2014)
	TP2	In Saudi Arabia, many healthcare organisations are currently adopting Cloud Computing.	
	TP3	Using Cloud Computing will allow my organisation to easily switch its IT providers.	
External expertise	EE1	In Saudi Arabia, there are many IT providers with experience in healthcare systems.	Alshamaila et al. (2013), Nkhoma & Dang (2013), Yeboah-Boateng & Essandoh (2014)
	EE2	In Saudi Arabia, there are many IT providers with good credibility and reputation.	
Hard financial analysis	HA1	Cloud Computing can reduce the operating cost of Information Technology in the healthcare organisations.	Lian et al. (2014b), Güner & Sneiders (2014), Oliveira et al. (2014)
	HA2	My organisation has sufficient financial resources to develop Cloud Computing technology.	
	HA3	The use of Cloud Computing will provide new opportunities for the organisation.	
Soft financial analysis	SA1	The use of Cloud Computing will allow the organisation to provide services that could not be provided before.	Oliveira et al. (2014), AbuKhousa et al. (2012), Chen et al. (2014)
	SA2	The adoption of Cloud Computing will affect business processes in my organisation positively.	
	SA3	Cloud Computing will affect medical services in my organisation positively.	

*Note: All items are based on a five-point scale.

Technology | Human | Organisation | Environment | Business

- **Second Stage: Questionnaire Reviewing Process**

The second stage is the reviewing process, which ensures the content validity of the questionnaire. Content validity is the process of ensuring that the items in the questionnaire represent their constructors (Saunders et al., 2009). This can be achieved by identifying the items carefully from the reviewed literature and experts' judgement (Saunders et al., 2009; Moore & Benbasat, 1991). Therefore, in this stage in the current study, a comprehensive literature review was conducted and the questionnaire was evaluated and reviewed by experts who have experience in both healthcare and IT. Health Informatics department members in Saudi University reviewed the questionnaire utilised in this study. After ascertaining its content validity, the questions were translated into Arabic, which is the main spoken language for most of the prospective participants. The translation was performed by the researcher, and then it was reviewed by a panel of Arabic professors at an English department in two Arab universities, one in Saudi Arabia and the other one in Egypt.

- **Third Stage: Questionnaire Testing**

The final stage is testing, where the questionnaire is tested before its final distribution (i.e. the pilot study). In this stage, the questionnaire was distributed among two groups. The first group was a health professional group, to check the clarity of the questionnaire. The second group were PhD students, to assess the timing issues and usability of the online tool that was being used for distributing the questionnaire.

At each stage of the questionnaire development process, the recommendations were reviewed and the required changes were made before moving to the next stage. Please see Appendix A for the full questionnaire.

5.3.2 Questionnaire Design

The questionnaire consists of 44 questions and is divided into five parts, as follows:

- **Part 1:** The first part acts as the cover letter and consent form for the questionnaire. It also provides information about the study and the researcher. It includes a definition of Cloud Computing to clarify the topic for the participants. This section also provides the contact information for the researcher and his supervision team to allow the participants to raise any concern about the questionnaire. This section also indicates that Staffordshire University's code of ethics is followed during all the phases of this research.
- **Part 2:** The second part is to ascertain demographic information such as: the role of the participant in the organisation, the type of organisation, the size of the organisation, the

location of the organisation, and the participant's experience. Demographic information is important because it determines that the participants represent the target population. No personal details are required so the data collection is collected in an anonymous and confidential manner and individuals will be non-identifiable.

- **Part 3:** The third part focuses on Cloud Computing Adoption status inside the organisations. In this study, Cloud Computing adoption refers to the extent of Cloud Computing adoption status in Saudi Healthcare organisations. The approach taken by Oliviera et al. (2014) and Lian et al. (2014) was adopted to measure Cloud Computing adoption status. This item is a category scale in the questionnaire and responses to this question were classified as follows:
    - I do not know.
    - We have already adopted some Cloud Computing services.
    - We intend to adopt Cloud Computing services in the next two years.
    - We do not intend to adopt any Cloud Computing services for the foreseeable future.

  The option 'I do not know' was used as an indicator to ascertain the amount of staff engagement in the organisation concerning the Cloud Computing adoption decision-making process. This section also includes information about the possible IT services and applications which are recommended by the participant in moving to the cloud.
- **Part 4:** The fourth part investigates the different dimensions that could influence Cloud Computing adoption in healthcare organisations in Saudi Arabia. The questions in this part were measured on a five-point Likert scale ranging from 'Strongly Agree' to 'Strongly Disagree'.
- **Part 5:** The final part was for additional comments by the participants. This part includes an open-ended question to encourage the respondents to provide suggestions to enrich the research.

5.3.3 Population and Sample of the Study

The research population is a well-defined collection of people or objects which is studied by the researcher (Saunders et al., 2009). However, for some types of research, it is not practicable to collect data about the whole population of the study due to the large population size. Thus, sample size is an alternative way of collecting data that represents the population of the study (Saunders et al., 2009). Since adopting Cloud Computing will affect the whole organisation (Chang et al., 2014a), the population of this study includes IT, health professionals and administrative staff in Saudi healthcare organisations. Multiple stakeholders have been chosen for this study to emphasise the holistic approach that the study has adopted. Additionally, Alshammari (2009) found that 69% of managers in the Ministry of Health (MOH) in Saudi Arabia are physicians or other allied health professionals.

5.3.4 Administration and Distribution of the Questionnaire

An online questionnaire was used to collect the data. Qualtrics.com, an online tool, was selected to design and develop the online questionnaire. An online questionnaire was chosen for this research because it provides some advantages for the researcher and the participants. For the participants, an online questionnaire can protect their privacy and give them the opportunity to participate in the questionnaire at a convenient time for them with enough time to understand the questions (Singleton, 2009). For the researcher, the advantages of using an online survey include saving time by easing data-processing activities and eliminating the interviewer bias (Selm & Jankowski, 2006).

A Snowball approach was utilised to target employees of public and private healthcare organisations in Saudi Arabia. Snowballing is a purposive sampling technique that uses social chain referral to identify more participants (Saunders et al., 2009). The snowball technique is implemented in this study for two reasons. Firstly, snowballing has been applied in the Saudi context in other studies (Alkraiji et al., 2013; Aldraehim & Edwards, 2013). Secondly, the technique also allows the researcher to identify other key informants who can influence the Cloud Computing adoption decision (Yusof et al., 2008). One possible disadvantage of the snowball technique is the possibility of bias, since there is a likelihood of the respondents sharing the same characteristics (Saunders et al., 2009). However, the researcher can avoid this by selecting initial informants with a diversity of roles to ensure that the survey will be filled in by various staff members (Given, 2008).

An invitation letter containing a link to the online questionnaire was distributed to 100 participants who mainly work in Saudi healthcare organisations, based on the researcher's contacts in Saudi Arabia. The author also used his personal profiles on Twitter and LinkedIn to contact other participants. Participants were asked to participate and invite appropriate people in their organisations to participate. The invitation message was written in English and Arabic and included a brief summary of the research project.

5.4 Data Analysis

The goal of the study is to identify the factors that will affect Cloud Computing adoption in healthcare organisations in Saudi Arabia. After completing all the procedures for the questionnaire development, the questionnaire was distributed to the targeted audiences. 354 responses were received during the period from 4/2/2015 to 15/3/2015. Although 206 surveys were returned completed, only 201 respondents were accepted for this study because five surveys were filled in by participants who are not working in healthcare organisations. Therefore, the questionnaire response rate was 56.8%. A sample size above 100 is sufficient to perform many statistical tests such as factor analysis as suggested by statisticians (Williams et al., 2012). All the online collected data was converted to Statistical Package for the Social Sciences (SPSS) format for analysis. The questionnaire was coded within SPSS version 22. In SPSS, each question in the questionnaire was typed as a variable with coding options where applicable. The Likert scale was coded from 1 – 5, with 1 representing ‘Strongly Disagree’, and 5 representing ‘Strongly Agree’.

5.4.1 Sample Characteristics

Table 5.3 represents the demographic characteristics of the participants and each characteristic is outlined as follows:

Table 5.3 The Demographic Characteristics of the Participants

Characteristic		Frequency	Percent
Role in the organisation:	IT specialist	57	28.3%
	Health professional	114	56.7%
	Administrative	18	9.0%
	Other	12	6.0%
Organisation type:	Ministry of Health organisation	127	63.1%
	Other governmental health organisation (e.g. NGHA, Military Hospitals, etc.)	59	29.4%
	Private healthcare organisation	15	7.5%
Organisation location:	Central Province	114	56.7%
	Western Province	59	29.4%
	Eastern Province	9	4.5%
	Southern Province	6	3.0%
	Northern Province	13	6.4%
Organisation size:	Less than 50 employees.	24	11.9%
	50 to 500 employees.	51	25.4%
	More than 500 employees.	117	58.2%
	I do not know.	9	4.5%
Participants’ experience:	Less than 2 years	32	15.9%
	Between 2 and 5 years	52	25.9%
	Between 5 and 10 years	50	24.9%
	More than 10 years	67	33.3%

- **Participants' Role in the Organisation**

This item represents the role of the respondents inside the healthcare organisations. While more than half of the participants (56.6%) are health professionals such as doctors, nurses or pharmacist, 28.4% are working as IT specialists in healthcare organisations. The other participants are from administrative staff or related areas. This is similar to the actual distribution in Saudi healthcare organisations, where health professionals make up the majority of the human resources (MoH, 2012). Figure 5.1 compares the questionnaire respondents based on their roles.

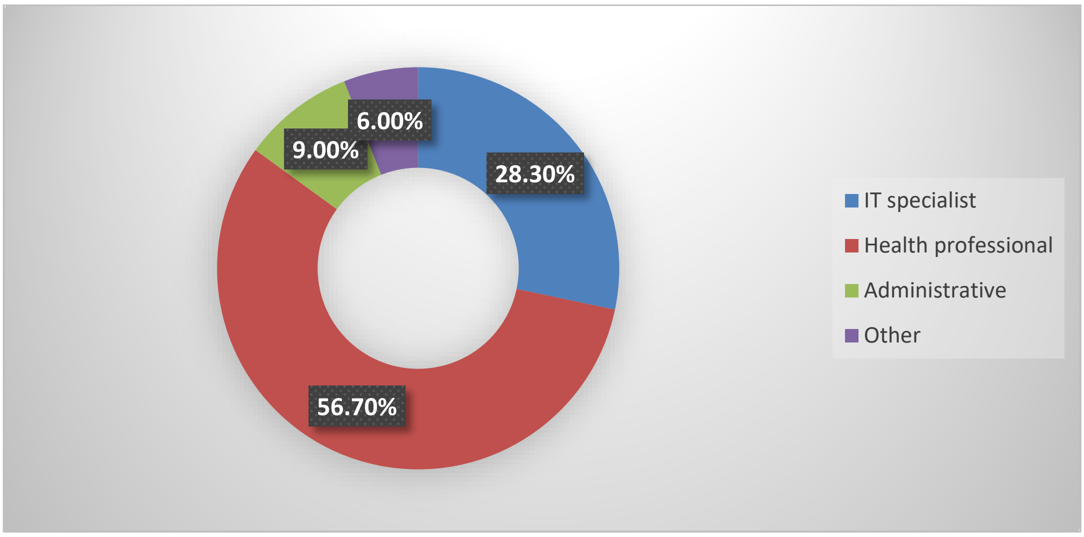


Figure 5.1 Participants' role in the organisation

- **Organisation Type**

The organisation type characteristic of the participants indicates where the participants work. The majority of the respondents are from the Ministry of Health (MOH) in Saudi Arabia (63%). The other participants (29%) are from other governmental health organisations such as military hospitals and National Guard Health Affairs (NGHA). Only 8% are working in private health organisations. This is similar to the actual situation in healthcare organisations in Saudi Arabia: 59% of health organisations in Saudi Arabia are MOH organisations, 32% are other governmental health organisations and only 9% are private organisations (MoH, 2012). Figure 5.2 shows the percentage of participants per type of organisation.

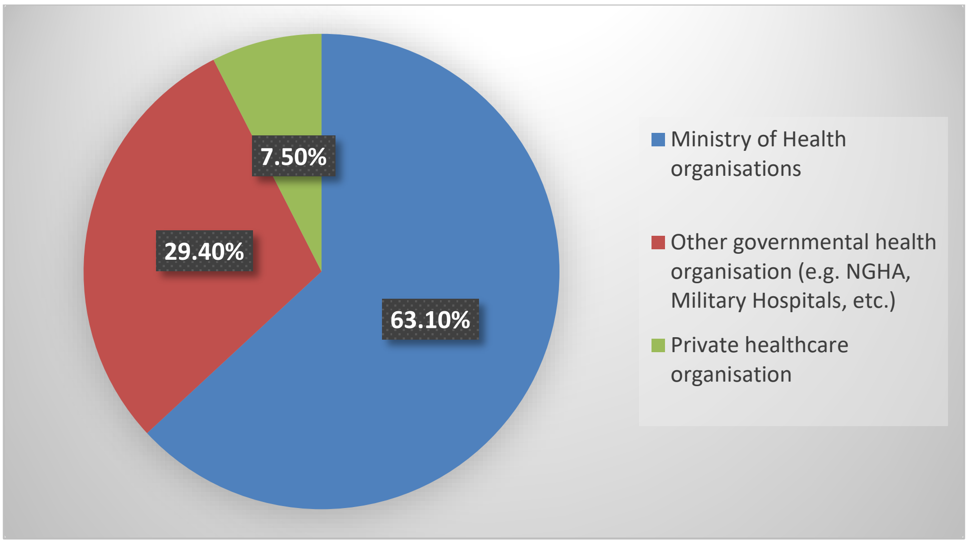


Figure 5.2 Percentage of participants per type of organisation

- **Organisation Size**

With regard to the size of the organisations, this study divided organisations based on their size into three categories: small (fewer than 50 employees), medium (50 to 500 employees) and large (over 500 employees) (Koyame-Marsh, 2016). The results showed that 58.2% of the participants are in large organisations that have more than 500 employees. Only 37.3 %of the respondents are in small and medium-sized organisations, whilst 4.5% of the respondents said they are not aware of the size of their organisation. Figure 5.3 classifies the participants based on organisation size.

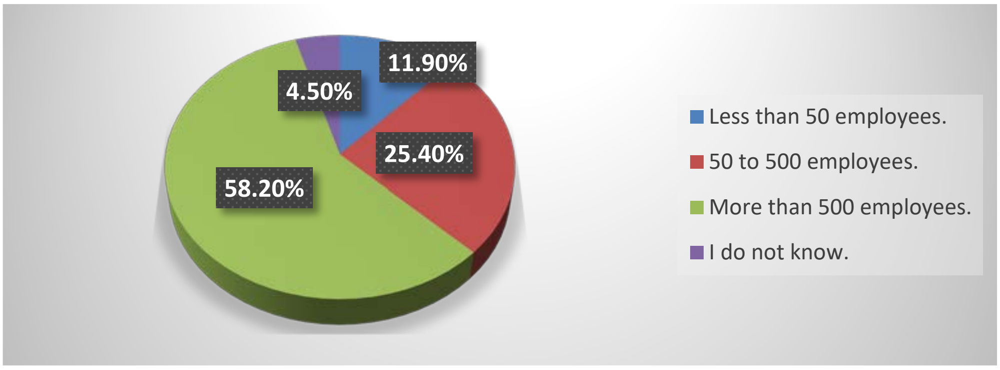


Figure 5.3 Participants based on organisation size

- **Organisation Location**

There are five provinces in Saudi Arabia and the geographical distribution for the participants was as follows: Central Province (56.7%), Western Province (29.4%), Eastern Province (4.5%), Western region (3.0%) and Northern region (6.5%). This indicates that most of the participants are working in Central and Western provinces, which is expected since most of the main offices of the healthcare organisations in Saudi Arabia are located in those two regions and they also contain the majority of the Saudi population (MoH, 2012). Figure 5.4 presents the participants' profile based on location of the healthcare organisations.

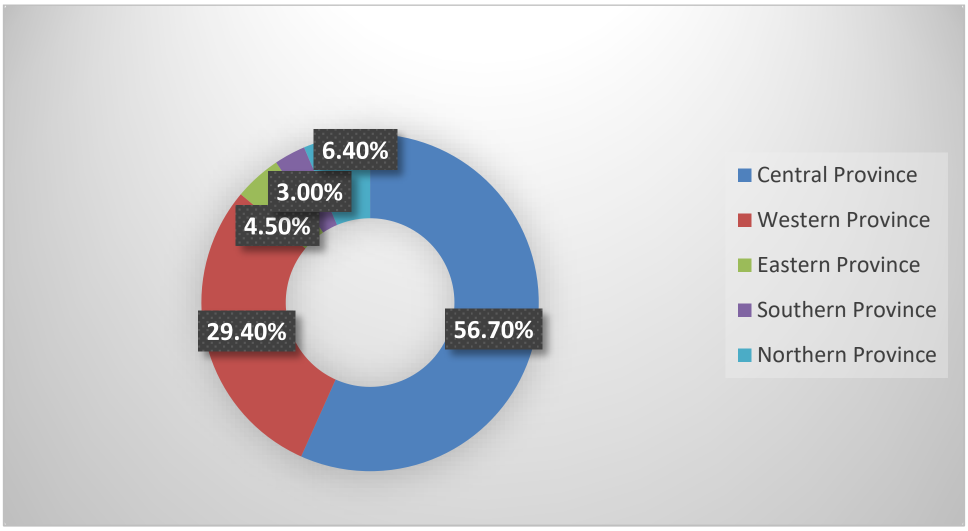


Figure 5.4 The participants' profile based on location of the healthcare organisations

- **Participants' Experience**

This item represents the participants' years of relevant work experience: 58.2% have more than five years' experience in the healthcare area and 41.8% have less than five years' experience. This indicates that the study presents different views from participants with a range of work experience and opinions. Figure 5.5 shows the participants' experience profile.

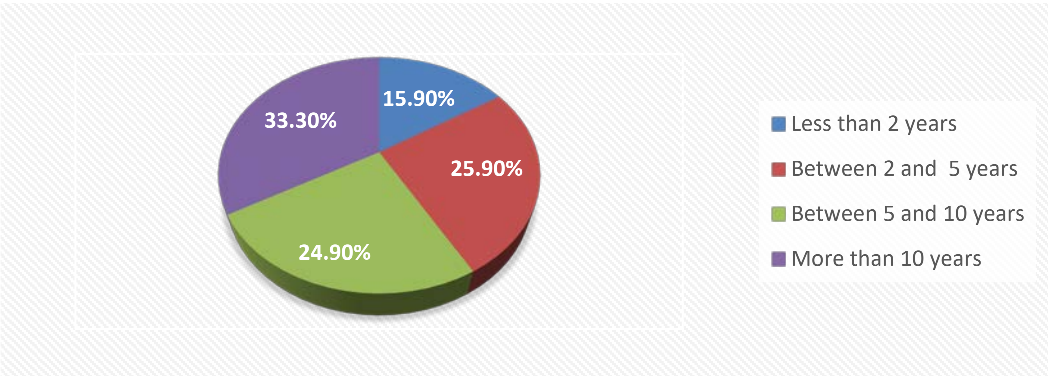


Figure 5.5 The participants' experience profile

5.4.2 Validity and Reliability of the Survey

Reliability of the questionnaire means measuring the degree of internal consistency between the variables of each construct (Hung et al., 2010). The Cronbach's alpha test was conducted on the items of each construct to test the validity of the questionnaire and its internal consistency (Saunders et al., 2009). While Cronbach's alpha value ranges between one (perfect reliable) and zero (unreliable), values greater than 0.5 are considered to be acceptable (Gliem & Gliem, 2003). The Cronbach's alpha values of the constructs of this research are greater than 0.5, except for the complexity construct. Therefore, the researcher decided to remove it from the research model since some of this component will be covered by other constructors. The variables are labelled and abbreviated to show the construct reliability of all items and the factor labels are as outlined in Table 5.4.

Table 5.4 Construct Reliability of all Items

Construct	Abbreviation	Number of items	Cronbach's alpha
Relative Advantage	RA	3	0.800
Technology readiness	TR	3	0.741
Compatibility	CO	3	0.720
Complexity	CX	2	0.246
Decision-makers' innovativeness	CI	2	0.907
Internal expertise	IE	2	0.692
Prior technology experience	PE	2	0.713
Top management support	TS	2	0.838
Attitude towards Change	CR	2	0.847
Regulation Compliance	RC	3	0.678
Business Ecosystem Partners Pressure	TP	3	0.600
External expertise	EE	2	0.593
Hard Financial Analysis	HA	3	0.608
Soft Financial Analysis	SA	3	0.773

Factor analysis is implemented to determine the instrument construct validity. Factor analysis is a powerful statistical approach that has many uses and purposes (Suhr, 2006; Williams et al., 2012). Table 5.5 shows the 13 factors that have been extracted from the five contexts (i.e. Business, Technology, Organisation, Environment and Human). Factor analysis is used, for example, to reduce a large number of variables or factors into a manageable number of variables (Suhr, 2006). It also has been utilised as a tool to examine the structure or relationship between factors (Williams et al., 2012). There are two major types of factor analysis: Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA) (Williams et al., 2012).

Table 5.5 Validity of instrument items

Items	Business K/B/TVE 0.79/0.00/50.35%		Technology K/B/TVE 0.82/0.00/57.20%			Organisation K/B/TVE 0.72/0.00/69.77%		Environment K/B/TVE 0.77/0.000/58.00%			Human K/B/TVE 0.76/0.000/58.93%		
	HA	SA	RA	TR	CO	TS	CR	RC	TP	EE	CI	IE	PE
HA1	0.534												
HA2	0.643												
HA3	0.738												
SA1		0.710											
SA2		0.793											
SA3		0.803											
RA1			0.589										
RA2			0.548										
RA3			0.529										
TR1				0.591									
TR2				0.672									
TR3				0.612									
CO1					0.675								
CO2					0.730								
CO3					0.668								
TS1						0.798							
TS2						0.865							
CR1							0.858						
CR2							0.819						
RC1								0.682					
RC2								0.711					
RC3								0.554					
TP1									0.637				
TP2									0.590				
TP3									0.661				
EE1										0.671			
EE2										0.721			
CI1											0.825		
CI2											0.818		
IE1												0.780	
IE2												0.695	
PE1													0.750
PE2													0.729

K: KMO test; B: Bartlett’s test; TVE: Total Variance Explained

EFA is used for exploratory purposes since the researcher has no expectations regarding the number of variables (Suhr, 2006). Thus, EFA is performed to recognise the underlying factor structure or the common factors. In CFA, the researcher implements this approach to test a proposed theoretical framework or model (Williams et al., 2012). Generally, CFA is completed prior to knowledge of theory, empirical research, or both to decide the number of factors, and which factor theories or models best fit (Suhr, 2006). CFA is a type of structural equation modelling (SEM) that allows the researcher to test the hypothesis that a relationship exists between observed measures or indicators and latent constructs. In the study analysis, CFA is applied firstly to test the fit between the constructs and their items. It will be also implemented to measure a 'good model fit' for the developed framework. All items in the instrument have to meet the following criteria: the threshold of factor loading is 0.5 and eigenvalue is larger than 1. The table also includes the KMO test and Bartlett's test for each dimension, which test sampling adequacy (Escanciano & Santos-Vijande, 2014). The KMO value ranges from 0 to 1 and must be above 0.5 for the data to be adequate for the factor analysis (Williams et al., 2012). Bartlett's test represents the p value, which should be significant ($p<0.05$) to conduct factor analysis (Williams et al., 2012). All KMO values of the dimensions are above 0.5 and the Bartlett's test indexes are significant ($p=0.000$), which confirms that the data was adequate for the use of factor analysis. The table also presents the Total Variance Explained (TVE) for each dimension, which represents the total variance in the factor analysis model and should explain at least 50% of the variance (Prasad et al., 2014). The result indicates that the TVE of all dimensions accounted for more than 50% of the variance.

5.5 Cloud Computing Adoption

Among the participants, only 36.8% reported that their organisations have adopted some Cloud Computing services (as a contrast, 84% of American healthcare organisations have adopted some Cloud Computing services (HIMSS, 2016)). While 28.90% of the healthcare organisations in Saudi Arabia are planning to adopt Cloud Computing, 11.90% will not adopt Cloud Computing solutions; 22.40% of the respondents do not know about their organisation's intention towards or use of Cloud Computing. Figure 5.6 presents the percentage responses to this question.

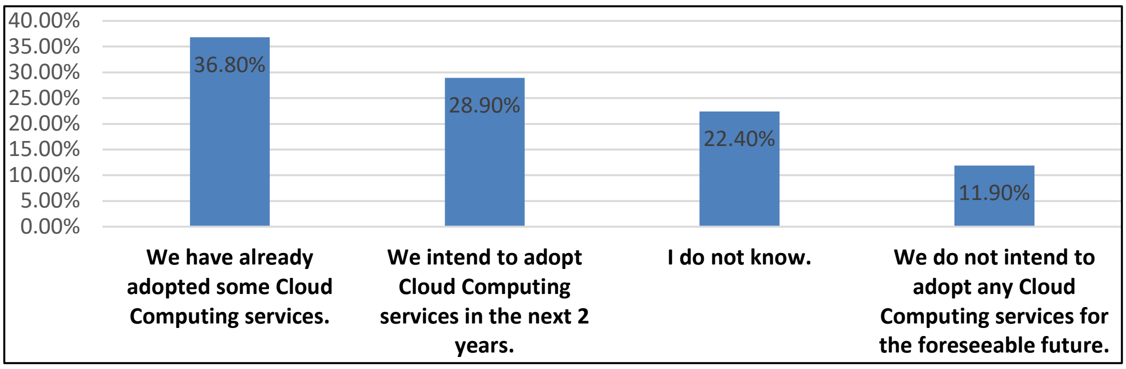


Figure 5.6 Plan for Cloud Computing Adoption among Saudi Healthcare Organisations

The participants considered some services and systems of Saudi healthcare organisations to be moving to Cloud Computing. The business processes that respondents most recommended should be moved to the cloud were Electronic Health Record (EHR) (62% of participants), followed by human resources processes (50.7%) and Pharmacy Management System (46.3%). Other HIS systems that respondents suggested should be Cloud-based systems were Laboratory Information System (39.8%), Radiology Information System (36.3%), Computerised Physician Order Entry System (CPOE) (36.3%), and Picture Archiving and Communication System (PACS) (30.3%). The participants also considered other administrative systems could to move the cloud, such as Payroll (41.8%), Accounting and Finance (36.8%) and Procurements (28.9%); 32.8% of the respondents also indicated the possibilities of using Cloud Computing services when developing healthcare applications and services. Other applications including email were also mentioned by 4.5% of the respondents. Figure 5.7 shows the participants' views of the possible IT services and systems that healthcare organisations could move to the cloud.

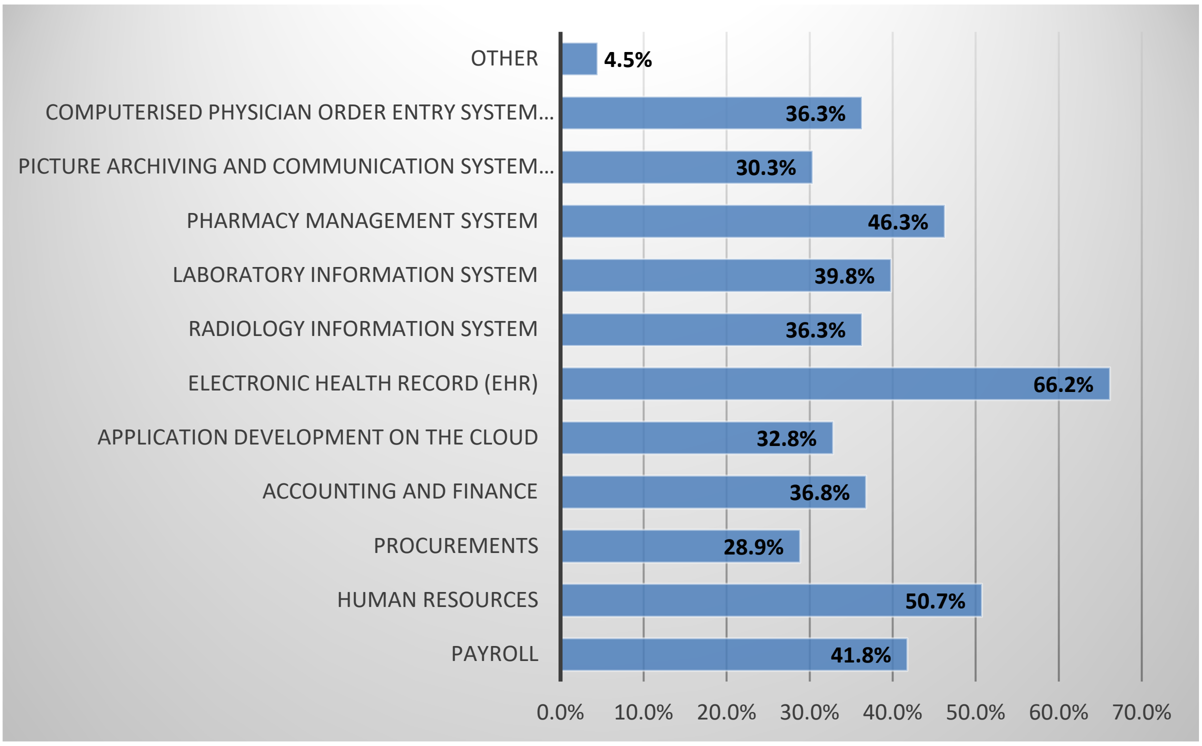


Figure 5.7 Possible IT services and systems to move to Cloud Computing

5.5.1 Overall Findings

The goal of this research is to identify factors that influence the adoption of Cloud Computing in Saudi Arabia's healthcare organisations. The author has accomplished this by analysing the data collected from the survey. Among the five dimensions, the most important one is Business (mean= 3.90), then Technology (mean= 3.62), followed by Organisation (mean= 3.49), Environment (mean= 3.47) and finally Human (mean= 3.36). Table 5.6 shows the analysis of factors affecting Cloud Computing adoption in Saudi healthcare organisations.

Table 5.6 Analysis of factors affecting Cloud Computing adoption in Saudi healthcare organisations

Context	Variables	Mean	Standard Division S.D.	Rank
Business 3.90/1	Soft financial analysis	3.99	0.907	1
	Hard financial analysis	3.81	0.918	3
Technology 3.62/2	Relative advantage	3.93	0.958	2
	Compatibility	3.47	1.016	7
	Technology readiness	3.46	1.154	8
Organisation 3.49/3	Attitude towards Change	3.65	1.057	4
	Top management support	3.32	1.284	12
Environment 3.43/4	Business ecosystem partners' pressure	3.52	0.952	5
	External expertise	3.49	0.969	6
	Regulation compliance	3.29	1.139	13
Human 3.36/5	Internal expertise	3.40	1.064	9
	Decision-makers' innovativeness	3.36	1.294	10
	Prior technology experience	3.33	1.035	11

The results show that the five most critical factors affecting the decision of Cloud Computing adoption in Saudi healthcare organisations are: soft financial analysis, relative advantage, hard financial analysis, attitude towards change and business ecosystem partners' pressure. Figure 5.8 also represents a graphical view of the overall results.

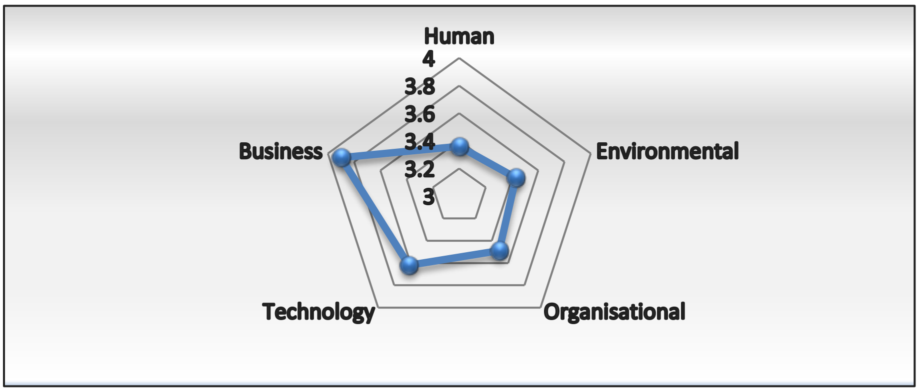


Figure 5.8 Ranking the overall contexts affecting Cloud Computing Adoption in Saudi Healthcare Organisations

5.5.2 Comparison between Different Groups

The questionnaire results showed that Saudi healthcare organisations are divided into three categories. The first category is the organisations that have already adopted some Cloud Computing solutions (36.8%). The second category is the organisations that are planning to adopt Cloud Computing (28.90). The third category is the organisations that do not intend to adopt any Cloud Computing services for the foreseeable future (11.90%). The researcher used an Analysis of Variance (ANOVA) test to determine any useful information that explained the difference between the three categories. ANOVA is a statistical test that assesses the means between the groups in which the authors are interested and examines whether any of those means are significantly different from each other (Saunders et al., 2009). Table 5.7 shows the means for the different categories based on organisations' adoption status for all constructors. Table 5.8 presents the mean of the contexts for the three categories of the Saudi healthcare organisations based on their Cloud Computing adoption status.

Table 5.7 Factors across different groups

Context	Constructor	Adopter			Planning to adopt			Rejecter		P value
		Mean	S.D.		Mean	S.D.		Mean	S.D.	
Business	SA	4.02	0.732		4.07	0.809		3.79	0.850	0.923
	HA	3.83	0.681		3.89	0.732		3.69	0.673	0.930
Technology	RA	3.91	0.749		4.16	0.901		3.69	0.804	0.017**
	CO	3.73	0.700		3.49	0.937		3.18	0.997	0.002**
	TR	3.75	0.764		3.44	0.982		3.14	0.529	0.103
Organisation	CR	3.95	0.918		3.64	1.029		2.98	0.972	0.011**
	TS	3.83	1.120		3.09	1.218		2.48	1.078	0.007**
Environment	TP	3.64	0.627		3.54	0.702		3.08	0.800	0.130
	EE	3.53	0.927		3.49	0.814		3.13	0.912	0.929
	RC	3.44	0.903		3.33	0.899		2.83	0.927	0.213
Human	IE	3.64	0.909		3.40	0.912		3.23	0.821	0.003**
	CI	3.78	1.107		3.21	1.246		2.92	1.283	0.038**
	PE	3.66	0.836		3.14	0.821		3.02	1.118	0.015**

** $p < 0.05$.

Table 5.8 Contexts across different groups

Context	Adopter			Planning to adopt			Rejecter		P value
	Mean	S.D.		Mean	S.D.		Mean	S.D.	
Business	3.93	0.645		3.98	0.684		3.74	0.654	0.822
Technology	3.80	0.523		3.70	0.772		3.34	0.491	0.025**
Organisation	3.89	0.905		3.36	1.021		2.73	0.853	0.023**
Environment	3.56	0.626		3.49	0.630		3.10	0.660	0.807
Human	3.69	0.789		3.25	0.814		3.06	0.953	0.089

** $p < 0.05$.

The results show that there are significance differences in seven factors, which are: RA: Relative advantage (p=0.017); CO: Compatibility (p=0.002); CR: Attitude towards Change (p=0.011); TS: Top management support (p=0.007); Decision-makers' innovativeness (p=0.038); IE: Internal expertise (p=0.003); and PE: Prior technology experience (p=0.015). Figure 5.9 presents a graphical view of the factors affecting Cloud Computing adoption in Saudi healthcare organisations based on the three groups (i.e. Adopter, Planning to adopt and Rejecter groups). Among the five contexts, there was a significant difference in Technology (p=0.021) and organisation (p=0.023), as shown in Figure 5.8 (see Appendix B for further details of the ANOVA test).

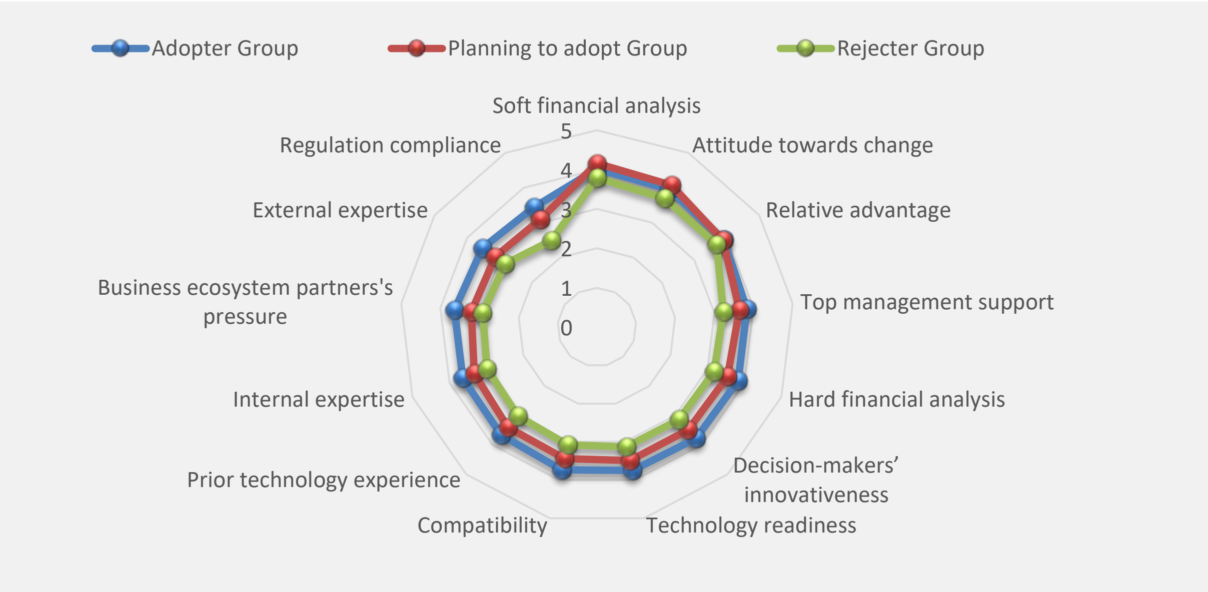


Figure 5.9 Factors affecting Cloud Computing adoption in Saudi healthcare organisations among different groups

- **Adopter Group**

This category represents Saudi healthcare organisations that have adopted some Cloud Computing services. For this category, the most important perspective is Business (mean= 3.93), then Organisation (mean= 3.89), followed by Technology (mean= 3.80), Human (mean= 3.69) and finally Environment (mean= 3.56); see Table 5.8. As shown in Figure 5.9, Soft financial analysis (mean = 4.02), Attitude towards change (mean= 3.95), Relative advantage (mean= 3.91), Top management support and hard financial analysis with the same mean value (3.83), and Decision-makers' innovativeness are the most important factors for the adopter group. The results also show that the less important factors for the adopter group are External expertise (mean= 3.53) and Regulation compliance (mean= 3.44).

- **Planning to Adopt Group**

This category comprises Saudi healthcare organisations that are planning to adopt Cloud Computing in the future. For this group, the business dimension (mean=3.98) and technology dimension (mean=3.70) came first and second respectively, followed by the environment dimension (mean= 3.49) and Organisation (mean= 3.36), and finally human dimension (mean= 3.25); see Table 5.8. Regarding the factors, Figure 5.9 shows that relative advantage (mean= 4.16) followed by soft financial analysis (mean= 4.07), hard financial analysis (mean= 3.89), Attitude towards change (mean= 3.64) and Business Ecosystem Partners Pressure (3.54) are the most important factors among Saudi healthcare organisations that are intending to adopt Cloud Computing. For this group, Prior technology experience (mean= 3.14) and Top management support (mean= 3.09) are found to have less impact among other factors.

- **Rejecter Group**

This group contains Saudi healthcare organisations that have decided not to adopt Cloud Computing. For this group, business (mean= 3.74) and technology (mean= 3.34) contexts were considered as the first and second dimensions respectively. The environment context (mean= 3.10) was ranked as the third important dimension for the rejecter group followed by the human context (mean= 3.06) and finally the organisation context (mean= 2.73); see Table 5.8. For this group, Soft Financial Analysis (mean= 3.79), Hard Financial Analysis (mean= 3.69) and Relative advantage (mean= 3.69) were considered as the factors that have a high impact when making the decision whether or not to adopt Cloud Computing. However, Decision-makers' innovativeness (mean= 2.92), Regulation Compliance (mean=2.83) and top management support (mean= 2.48) were ranked as factors with lower mean values, as shown in Figure 5.9.

5.6 Discussion

The results of the study cover many aspects regarding Cloud Computing adoption in Saudi healthcare organisations. This section discusses the finding of the study as follows:

5.6.1 Cloud Computing Adoption

The questionnaire findings indicated that 36.8% of Saudi healthcare organisations have adopted some type of Cloud Computing. This Cloud Computing adoption rate is similar to the percentage in Taiwan, where 35% of hospitals were found to be using Cloud Computing solutions (Lian et al., 2014b). However, it is still low when it is compared with the adoption of Cloud Computing services among American healthcare organisations with 84% (HIMSS, 2016). The finding also indicates that the participants considered some HIS systems to be appropriate for a move to Cloud Computing. For example, 66.2% of the participants reported that the Electronic Health Record (EHR) application had the potential to be Cloud based. This result shows that IT healthcare systems built based on the Cloud Computing model can be accepted by different stakeholders in Saudi healthcare organisations.

5.6.2 Business Context

The business context represents the consideration of business issues related to the adoption decision. The results show that the business context is the most important context among the five contexts. Both factors (i.e. Soft Financial Analysis and Hard Financial Analysis) in this context have high values, which demonstrates the importance of business concerns for the adoption decision. Since Cloud Computing is a new way of delivering and dealing with computing services rather than a new technology (Oredo & Njihia, 2014), many healthcare organisations evaluate its use of Cloud Computing from a strategic viewpoint. This viewpoint is highlighted in the results of the current study by the fact that soft financial analysis is the most important of the factors. This can be supported by the finding of Hsu (2013), where the researcher found that the perceived benefits factor has a positive impact on the cloud adoption decision. Alsanea and Barth (2014) also indicated that indirect benefits of Cloud Computing have a positive impact on the decision about Cloud Computing adoption for the Saudi government sector. The perceived benefits of Cloud Computing may go beyond cost savings, such as providing new services that could not be provided previously (Oredo & Njihia, 2014). Awosan (2014) found that an increased focus on core business is a major reason for adopting the cloud. However, other researchers found that critical business processes are negatively affected by cloud adoption (Güner & Sneiders, 2014). Another important variable in this context is the hard financial analysis, where the cost of Cloud Computing solutions is considered. Cost effectiveness has been found by many studies to have a positive and significant effect on the decision to adopt Cloud Computing (Lian et al., 2014b; Oliveira et al., 2014; Jones et al., 2017). This result is expected since cost saving is one of the main drivers of Cloud Computing adoption. However, organisations should be careful of the hidden costs of Cloud Computing (Runeson & Höst, 2009; Güner & Sneiders, 2014). Another finding of this study is that no significant differences exist between the different categories for all factors in the business context. This may indicate that healthcare organisations in Saudi Arabia believe in the importance of considering intangible and tangible effects when making the decision concerning Cloud Computing adoption.

5.6.3 Technology Context

The technology context refers to the technical issues that will affect the decision regarding Cloud Computing adoption. This is the second most important dimension. The relative advantage of Cloud Computing over traditional IT has been seen as an important factor for healthcare organisations. Thus, relative advantage was identified as the second most important factor in this study. This finding is supported by other researchers who indicated that the greater the relative advantage to the organisation, the more willingness there will be to adopt Cloud Computing (Lin & Chen, 2012; Low et al., 2011; Tashkandi & Al-Jabri, 2015; Al-Mascati & Al-Badi, 2016). Relative advantages of Cloud Computing will contribute to cost savings such as faster implementation time (Morgan & Kieran, 2013). Compatibility and technology readiness lag behind other factors (i.e. 7th and 8th) respectively. However, their alignment was towards the generally agreed category where the mean of compatibility is 3.47 and the mean of technology readiness is 3.46. With regard to compatibility, it has been suggested that some organisations may have concerns about Cloud Computing's compatibility with their information systems (Lin & Chen, 2012; Wu et al., 2013). However, compatibility has not been found to have a significant effect on Cloud Computing adoption in Saudi academic organisations (Tashkandi & Al-Jabri, 2015). Other researchers have found that compatibility has a positive impact on the Cloud Computing adoption decision in the services sector in Portugal (Oliveira et al., 2014). One reason for this may relate to the organisation's decision priorities (i.e. cost or business processes) (Lin & Chen, 2012). Variations in organisations' cultures and policies could be another reason (Wu et al., 2013). Technology readiness was found to not necessarily influence Cloud Computing adoption or have a negative impact on the adoption decision in some studies (Lumsden & Anabel, 2013; Wu et al., 2013; Low et al., 2011). However, some studies indicated that technology readiness is a facilitator of Cloud Computing adoption (Oliveira et al., 2014; Al-Mascati & Al-Badi, 2016). One reason for this again refers to the variations in organisations' IT infrastructure. Also, organisations that intend to or have adopted Cloud Computing solutions have already made or will make some amendments relating to their infrastructure (Low et al., 2011). Changing security mechanisms could be an example of such a required amendment (Rosenthal et al., 2010). This study shows that the relative advantage factor is more important for planning to adopt group than for adopting group. However, the adopter group could be faster in implementing Cloud Computing solutions because of other factors such as the availability of IS human resources and Decision-makers' innovativeness. The compatibility variable is also assessed as more important by adopters. This is expected since they are considered as innovators who are dealing with immature technologies such as Cloud Computing (Low et al., 2011; Tashkandi & Al-Jabri, 2015).

5.6.4 Organisation Context

Organisational factors are the internal factors of an organisation that are controlled by the organisation itself (Lin & Chen, 2012). While the organisational dimension is the second most important dimension for the adopter group, it is the least important dimension for the rejecter group. Both factors in this context present significant differences across different adopting groups. One factor of this dimension, Attitude towards Change, is ranked fourth out of all the factors. The attitude towards Cloud Computing in Saudi Arabia in the current study is positive, which is consistent with other research which indicated that employees in managerial positions in Saudi organisations had positive attitudes towards Cloud Computing adoption (Alharbi, 2012). However, other studies have shown that Cloud Computing may face some resistance among employees in institutions in different countries (Yeboah-boateng & Essandoh, 2014; Morgan & Kieran, 2013). Thus, it is important for healthcare organisations to observe various consumers' behaviours (i.e. IT staff, healthcare professionals and patients) and how this attitude can affect a Cloud Computing adoption decision. One source of resistance to change could be from IT managers who are afraid of losing control of their IT sources (Morgan & Kieran, 2013). Top management support plays a significant role in Cloud Computing adoption. Some empirical research has shown that there is a positive relationship between top management support and adoption of Cloud Computing (Lian et al., 2014b; Low et al., 2011; Alshamaila et al., 2013; Alhammadi et al., 2015). However, the result of this study indicated that, in healthcare, top managers have a neutral view about Cloud Computing adoption. This result is consistent with another study about Cloud Computing in Saudi academic organisations (Tashkandi & Al-Jabri, 2015). Two reasons could be given to explain this result. The first reason is the immaturity of Cloud Computing services in Saudi Arabia (Yamin, 2013; Tashkandi & Al-Jabri, 2015). Secondly, some healthcare organisations’ mangers may still have some concerns about the hidden costs of Cloud Computing or about data security and privacy. This study also shows that attitude towards change and top management support are more important for adopter organisations than hard financial analysis. For example, the adopter group ranked the top management support factor as the fourth most important factor but the planning to adopt and rejecter groups ranked this factor as the least important factor. Thus, this study also offers empirical evidence that top management support and attitude towards change will play important roles in the decision about the adoption of Cloud Computing.

5.6.5 Environment Context

Environmental factors are related to the external world in which the organisation conducts its business. In this study, three factors were considered: regulation compliance, business ecosystem partners' pressure and external expertise. Only one of these factors has been identified as one of the five most critical factors affecting the decision about Cloud Computing adoption in Saudi healthcare organisations, which is business ecosystem partners' pressure (mean= 3.58). Healthcare organisations have many partners such as suppliers, vendors and government agencies that affect and are affected by each other. External pressure has been found to be positively related to Cloud Computing adoption by many researchers (Tashkandi & Al-Jabri, 2015; Alshamaila et al., 2013). External pressure from, e.g. IT vendors, could be influential or, in the case of governmental regulation, could be compulsory (Low et al., 2011). Government support has been found to significantly affect Cloud Computing adoption in Saudi Arabia (Alhammadi et al., 2015).

Another factor is the availability of external expertise that would support the healthcare institutes in adopting Cloud Computing solutions. This factor ranked sixth among the factors. IT providers with a good reputation and the ability to provide a high level of support could influence an organisation's innovation adoption decision. The importance of the availability of external expertise is supported by other studies (Güner & Sneiders, 2014; Alshamaila et al., 2013). It was also found that the lack of trust in cloud service providers has a negative impact on Cloud Computing adoption in other countries (Awosan, 2014). In this study, government legislation and policies have not been found to have a high influence on Cloud Computing adoption in Saudi healthcare organisations. Other researchers (Borgman et al., 2013; Oliveira et al., 2014; Tashkandi & Al-Jabri, 2015) have indicated that regulation compliance is not a determinant of Cloud Computing adoption. It has been suggested that sector-specific regulations may have a negative influence on the decision about adopting Cloud Computing in the healthcare environment (Güner & Sneiders, 2014). There are two possible explanations for the finding of the study undertaken for this research. The first one is that it is mandatory for healthcare organisations to follow compliance requirements; thus, they do not need to consider it when making their decision about Cloud Computing (Borgman et al., 2013). The second reason may relate to the lack of regulations in Saudi Arabia regarding Cloud Computing services (Tashkandi & Al-Jabri, 2015). However, Saudi healthcare organisations considering Cloud Computing adoption must take into account the fact that they must comply with all IT regulations in Saudi Arabia, such as Computing and Networking Controls in the Government Agencies Act. Additionally, healthcare organisations in Saudi Arabia must ensure that providers will apply specific security measurements and standards such as ISO/IEC 27002 and ISO/IEC 27001 (Rezaeibagha et al., 2015). Healthcare organisations also should ensure there are security requirements in their Service Level Agreements (SLA) or any other legal agreements (Schweitzer, 2011).

The study undertaken for this research shows that there is no significant difference between the different groups for all factors in the environmental context. A possible explanation is that the Cloud Computing adoption decision in Saudi healthcare organisations relies more on the internal needs and capabilities of the organisation rather than external pressure (Hsu et al., 2014). However, two factors of this context ranked among the most important factors: business ecosystem partners' pressure and external expertise. This result indicates that Cloud Computing adoption in Saudi healthcare organisations still requires some external support, either from government bodies or IT vendors (Alkraiji et al., 2013).

5.6.6 Human Context

The human context was found to be a less important dimension than the other dimensions. This finding is not consistent with another study (Lian et al., 2014b), where the human dimension was found to be the second most important dimension among four different dimensions. All the factors in the human context in the present study are ranked behind the other factors, as following: Internal expertise (mean= 3.40), Decision-makers' innovativeness (mean= 3.36) and Prior technology experience (mean= 3.33). Although the availability of internal IS expertise was found to be one of the most important factors that affect the decision concerning the adoption of cloud solutions in Taiwanese hospitals (Lian et al., 2014b), this is not the case in Saudi healthcare institutions. The dependence of Saudi healthcare organisations on trading partners for their IT solutions could offer an explanation for this result. Another explanation may relate to the fear of downsizing of IT department staff (Awosan, 2014). The decision-makers' innovativeness factor has not had much influence on the Cloud Computing adoption decision in Saudi healthcare organisations. This finding is consistent with another study, about Taiwanese hospitals (Lian et al., 2014b). This result is expected since hospitals are usually slow in adopting new information technologies due to the decision-makers' characteristics (Haddad et al., 2014). In this study, prior technology experience with Cloud Computing has not been found to have a high influence on Cloud Computing adoption in Saudi healthcare institutions. This may relate to the fact that the use of Cloud Computing is still developing in the healthcare field. Some researchers have indicated that a lack of knowledge about Cloud Computing negatively affects Cloud Computing adoption (Güner & Sneiders, 2014). Although all the factors in this context have low mean scores compared with other factors, the differences have been found to be statistically significant for all factors. This finding shows that healthcare organisations that are more open to new ideas are more likely to adopt Cloud Computing faster than the others. For example, while the adopter group ranked decision-makers' innovativeness among the most important factors, the rejecter group ranked this factor among the least important factors. It also indicates that healthcare organisations in Saudi Arabia should complete an assessment of their internal capabilities before taking the decision about Cloud Computing adoption.

5.7 Framework Refinement

Based on the findings of the questionnaire and the discussion of the results, the HAF-CCS framework is refined. The refinement procedure for the framework is based on the decision that the included factors must have a composite mean score above the middle point of the scale (i.e. 3), as suggested by Euwema et al. (2014), Escanciano and Santos-Vijande (2014) and El-Gazzar et al. (2016). Figure 5.10 presents the comparison of composite mean score for all the factors against the middle point of the scale.

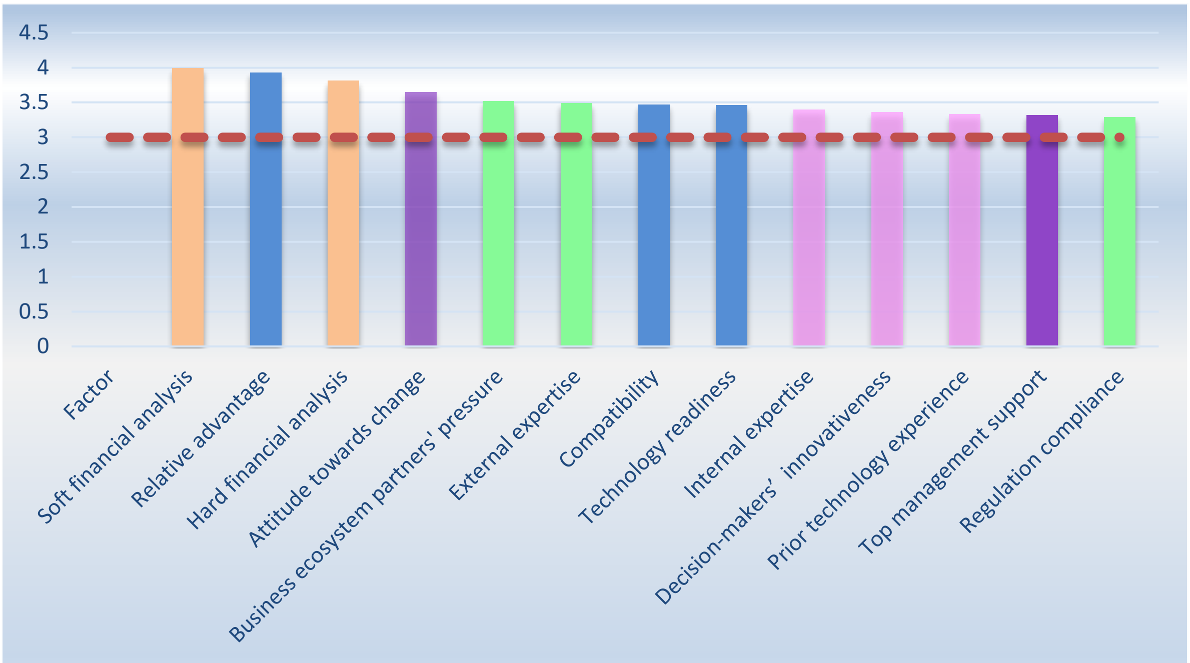
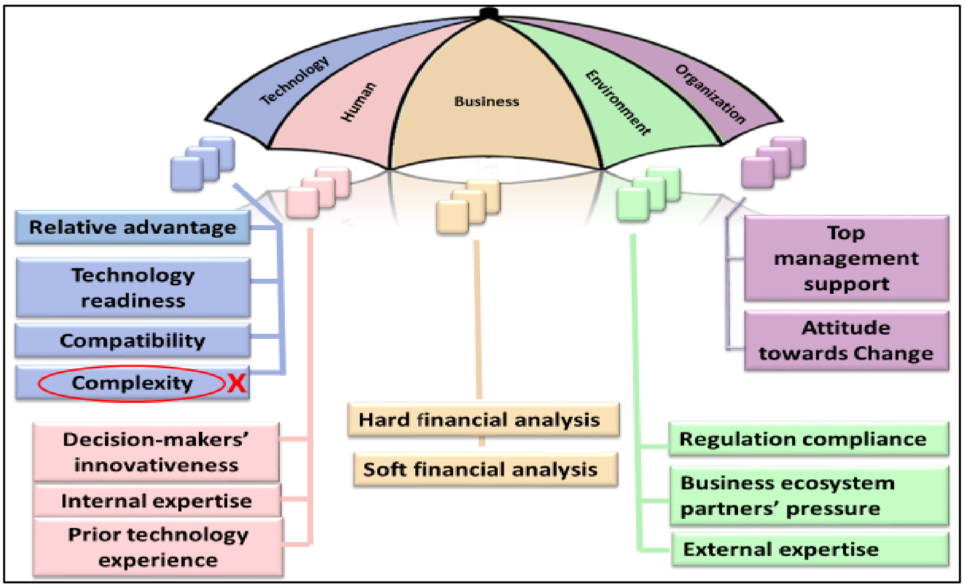


Figure 5.10 Composite mean score for all the factors of HAF-CCS

Figure 5.11 shows the modified framework based on the result of the questionnaire and statistical analysis, which is outlined as follows:

- The first version of the framework is developed from the literature review, where the critical factors affecting the decision regarding Cloud Computing adoption are gathered from multiple perspectives.
- The second version of the framework is enhanced from the first version and one factor has been removed based on the questionnaire and statistical analysis of the results of the Cronbach's alpha (reliability) test, i.e. Complexity.

Version 1: HAF-CCS based on the literature



Version 2: HAF-CCS After The questionnaire and statistical analysis

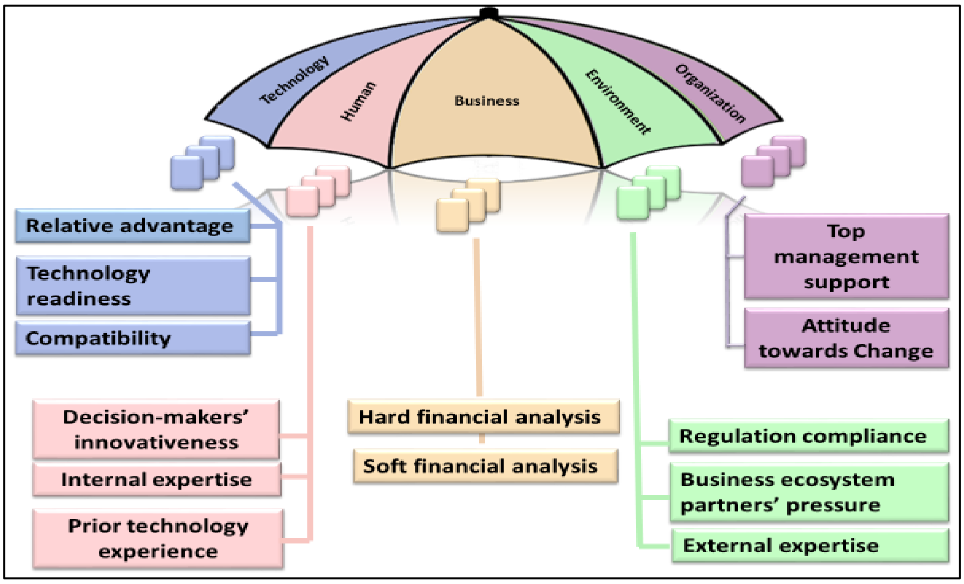


Figure 5.11 Framework Development

5.8 Conclusion

This chapter has discussed the determinants of Cloud Computing adoption in Saudi healthcare organisations. A questionnaire was designed and implemented to conduct the study, and the development process for the questionnaire was also described by explaining the three stages of questionnaire development: item construction, questionnaire reviewing process and questionnaire testing stage. Then, the different parts of the questionnaire were outlined along with the administration and distribution process. The population of the questionnaire was staff members in Saudi healthcare organisations; there were 206 respondents, which represents the sample of the population that completed the questionnaire. However, only 201 responses were included in the analysis. The chapter has offered detailed information about the statistical tests that were performed to ensure the validity and reliability of the questionnaire. The tests included Cronbach's alpha, Confirmatory Factor Analysis and KMO test. The results of the questionnaire were then presented and it was shown that only 36.8% of the participants reported that their organisations have adopted some Cloud Computing services. They also indicated that the most important context for Saudi healthcare organisations is the business context, followed by the technology, organisation, environment and finally human context. The data from the survey also clarified that the most important factors for Saudi healthcare organisations are: Soft financial analysis, Relative advantage, Hard financial analysis, Attitude towards change and Business ecosystem partners' pressure. The results also indicated that Saudi healthcare can be categorised into three categories based on their Cloud Computing adoption status: adopter, planning to adopt and rejecter. The ANOVA test was also applied to examine the difference between the three types. Then, intensive analysis was conducted to explain the findings of the study. Finally, the HAF-CCS framework was modified based on the findings and the analysis of the study, which eliminated one factor (i.e. Complexity). The next chapter will describe the focus group approach used to gain an in-depth understanding of the decision-makers' views of factors affecting Cloud Computing Adoption in Saudi Healthcare Organisations.

6 Decision-Makers' views of factors affecting Cloud Computing Adoption in Saudi Healthcare Organisations

6.1 Introduction

This chapter presents an investigation that provides an in-depth understanding of the Cloud Computing adoption decision-making process in healthcare organisations in Saudi Arabia. It starts by describing the purpose of the investigation and the design of the interviews. The chapter discusses the data analysis process that is applied to identify useful information for the decision-makers in Saudi healthcare organisations regarding Cloud Computing adoption. This chapter also identifies some of the key drivers and challenges of Cloud Computing adoption in Saudi healthcare organisations. This is followed by a discussion of the factors influencing Cloud Computing adoption in Saudi healthcare organisations. Finally, the chapter updates and modifies the HAF-CCS framework discussed in chapters 4 and 5 based on the results and discussion of the study.

6.2 Purpose of the Investigation

The aim of the investigation was to develop an in-depth understanding of the factors that influence Cloud Computing adoption in Saudi healthcare organisations to support the development of the HAF-CCS framework. The findings from this investigation enrich the HAF-CCS framework and present aspects related to the adoption of Cloud Computing from the decision-makers' point of view. This investigation provides details about the information required by the people making decisions concerning Saudi healthcare organisations in relation to Cloud Computing adoption and this supports the development of the framework. It also presents information about the decision-making process regarding the adoption of IT systems in Saudi healthcare organisations in order to provide information about the current practices of the organisations when adopting IT systems, as this is relevant to an understanding of Cloud Computing adoption. Due to the exploratory nature of this research, a case study approach was considered appropriate. Case studies are useful for exploring phenomena where existing knowledge is limited and support the in-depth examination of a complex phenomenon in its natural setting (Alkraiji et al., 2013). A multiple-case study methodology was selected to carry out this study by choosing two hospitals in two different cities in Saudi Arabia. One hospital is based in Riyadh, the capital of Saudi Arabia, and the other in another major city in Saudi

Arabia. The hospitals were at different stages of the Cloud Computing adoption process. Due to confidentiality requirements, data has been anonymised. The primary data collection method was semi-structured qualitative interviews. Interviews were used because this allows the researchers to interact directly with the participants, which enables more clarity between them (Alkraiji et al., 2013). The interview method also supports understanding by meeting the respondents in their social context (Lin & Chen, 2012).

6.3 Investigation Design

The researcher used interview techniques to accomplish the research aim and to recognise the factors affecting Cloud Computing adoption in Saudi Arabian healthcare organisations from the decision-makers' point of view. This section describes the process of conducting this investigation, which is outlined as follows:

6.3.1 Interview Design

A semi-structured interview was developed to enrich the existing data obtained from the questionnaire and from the literature and to refine the HAF-CCS framework. The interview questions were divided into four parts partly adopted from Alshamaileh (2013), as shown in Appendix C. The first part of the interview document collects information about the interview, such as the date and time of the interview, interviewee position in the healthcare organisation, and unique code for the interviewee to allow anonymity. The second part of the interview document includes general questions about the current situation of the healthcare organisations regarding their IT system (Alkraiji et al., 2013). The third section identifies the challenges and advantages of adopting Cloud Computing based on the interviewees' point of view (Alshamaileh, 2013). The fourth part contains questions about factors affecting Cloud Computing adoption and allows the interviewees to make suggestions about overcoming any barriers that may affect Cloud Computing (Alshamaileh, 2013; Alkraiji et al., 2013). To ensure confidentiality, the questions do not include any identifying details about the organisation or the participant. The interview document was reviewed by an expert who has worked at a Saudi healthcare organisation and was approved by the Regional Research Ethics Committee at the Ministry of Health in Saudi Arabia, to ensure the reliability and validity of the interview content (Alkraiji et al., 2013). The researcher also conducted a pilot interview with one PhD student to determine the duration of the interview and to discover any issues with the interview questions.

All of the interview procedures are in compliance with the ethical regulations of Staffordshire University.

6.3.2 Participant Selection

The focus of this investigation was on the Cloud Computing decision-making process and the people who could affect the decision. Although this investigation considered IT department managers as the main decision-makers for the implementation of Cloud Computing, other decision-makers such as Hospital Directors and Medical Directors were also included to obtain the views of other stakeholders (Alkraiji et al., 2013). This allows for different stakeholder viewpoints from a diversity of professional backgrounds to be considered (Runeson & Höst, 2009). The selected participants were in charge of the adoption and selection of information systems solutions in the selected hospitals. Seven senior decision-makers drawn from the two hospitals agreed to participate in the study, as listed in Table 6.1.

Table 6.1 Participants' Profiles

Participant Code	Participant position	Healthcare organisation
P1	Hospital Director	A
P2	Medical Director	A
P3	Chief Information Officer (CIO)	A
P4	Head of Network Department	A
P5	Chief Information Officer (CIO)	B
P6	Head of Security and Network Department	B
P7	Head of Patient Administration System Department	B

6.3.3 The Interview Procedure

The researcher gained official approval from the two hospitals, and arrangements were made by phone to schedule the interviews. An interview protocol based on Runeson and Höst (2009) was followed during all the interviews, as follows:

- At the beginning of each interview, the researcher introduces himself and shows the support letter which was prepared by the researcher's supervisor.
- The research objectives are explained and discussed with the interviewee.
- Both researcher and interviewee sign a consent from to ensure the participant is aware of aspects including: the participants have the opportunity to consider the

information, ask questions and have these answered satisfactorily; the participants understand that their participation is voluntary and that they are free to withdraw at any time, without giving any reason; and the Staffordshire University code of ethics will be followed during all the phases of this research. The researcher made clear to all participants that the information will be anonymised in any reports, publications or presentations.

- The participants are informed of the likely duration of the interview based on the pilot study.
- The researcher asks for the interviewee's permission to record the interview.
- The interview takes place and the researcher takes notes for all of the questions.
- At the end of the interview, the researcher thanks the participant for their time and their information.

All of the interviews were conducted in person by the researcher to ensure that an actual interviewee has participated in the interview and to discuss any issues. The majority of the interviews were conducted in the interviewee's office or in meeting rooms to be more convenient for the participants. After the interviews were completed, the transcripts were sent to the participants to allow them to make any changes or corrections (Runeson & Höst, 2009).

6.4 Data Analysis

A thematic analysis approach was applied to allow the researcher to report the findings of the study. This approach is used in qualitative research to identify, analyse and report patterns (themes) within data (Gale et al., 2013). Each theme represents something important about the data in relation to the research activities (Braun & Clarke, 2006). By classifying the data into categories through comparison between and within cases, the themes are developed and realised (Gale et al., 2013). A framework analysis method, which is one method of thematic analysis, was applied in the analysis of the data in this study. In framework analysis, the data is summarised by using a matrix output where rows represent cases and columns represent codes (Gale et al., 2013). The researcher conducted the framework analysis by applying the steps mentioned in Braun and Clarke (2006) as follows:

- **Familiarisation with the data**: This was achieved through the process of transcribing the interviews and reading the transcripts many times, and the participants checked the accuracy of the information.

- **Generating codes**: In this step, the transcripts are read to generate an initial list of ideas about elements that appear interesting. This step is helpful to ensure important aspects of the data are not missed (Gale et al., 2013).
- **Allocating themes**: Data was re-analysed to group the codes together into categories or themes. Iteration may be required at this stage to review, define and name the themes (Gale et al., 2013). In this step, the researcher identified that factors affecting Cloud Computing adoption in Saudi Healthcare organisations could be divided into five main themes: Technology, Organisation, Environment, Human and Business.
- **Producing the report**: The researcher produced the final report showing the findings and the full thematic analysis.

Figure 6.1 shows an example of the interview analysis that was implemented in this study. This figure shows that the data is coded by using colours to indicate potential patterns and then the data assigned to specific theme (e.g. blue colour indicates technological factors and green colour indicates environmental factors). This also matches the primarily design of the framework as shown in Figure 4.1.

Interview Thematic Template

Participants	Running IT services with traditional way	The hospital policy with regard to the purchasing, adoption and implementation of IT applications	Cloud Computing benefits	Cloud Computing concerns	Technology factors	Organisation factors	Environment factors	Human factors	Business factors
P1	There are many challenges that actually affect running IT services at the hospital. The first challenge was the availability of qualified IT staff. The hospital does not have enough budgets to bring professional IT people. Another challenge is the cost. There is an ongoing project to update the hospital's infrastructure. For example,	The IT budget of the hospital is issued by the ministry of health. IT managers prepare a request each year for their IT projects. This request could be rejected by the ministry. We outsource IT activities of the hospital based on contractor relationship. Choosing IT vendor is not easy procedure.	There are many possible advantages for using Cloud Computing at the hospital. It could reduce our need for qualified IT staff. Cloud Computing could also allow us to introduce new services such as: Mobile application. The use of Cloud Computing could allow	My concerns about Cloud Computing will be around security and if it is applicable for health environment. The fees of using such technology are not clear to me yet.	I am not sure about internet connection that available at the hospital. We need to test the compatibility of our current health information system and the cloud. As a hospital, there is a need to have high level of availability of IT services. Many solutions could be provided here. For example, improving out internet connection by	We face some resistance to use our HIS, so this could be the factor that will affect Cloud Computing adoption. Regarding to top management support, I was careful to support such technology because I need extra information from Health affairs – XXX region. Providing workshop for healthcare professional and	Cloud Computing could be accepted by our organisation but with ministry of health support. We always look for pioneer hospital in Saudi Arabia to copy their practises. We could look for other hospital such as King Fiasal Hospital. Choosing the appropriate vendor will not be easy job for us. However, we were working with good vendors in the	Our IT director is very innovative. We try many IT solutions that actually work very well. For example, We have very good implementation of EMR at the hospital with about 40%. My big concern about our IT staff is that Cloud Computing is new technology for them. Thus, they need more training to deal with it. Provide extra training for IT staff	As I said before, we do not have high control on our budget. Although Cloud Computing will provide new services for us, we need to consider the cost and the fees for such technology. I believe in our IT leader and I think they will be able to deal with the financial issues such as billing and fees. We should have good contract with Cloud provider to

Figure 6.1 Partial interview example of the thematic analysis process

6.5 The Interview Results

The following sections presents the interview results as follows:

6.5.1 Current IT Practices

The interviews examined the hospitals' current IT practices to identify any issues or challenges that face the implementation of IT projects in Saudi healthcare organisations. The participants outlined some challenges regarding current implementation of IT services in their organisations as follows:

- **Budget constraints:** For both hospitals, the IT budget is controlled partially by the Ministry of Health in Saudi Arabia because they are governmental hospitals. However, IT departments in the hospitals have the opportunity to prepare their requirements without any involvement from the Ministry. One participant stated that "*sometimes we do not have decision control for procurement procedure*" (P7). Although this approach may improve monitoring and controlling of the budget from the Ministry's side and ensure best practice in IT budgeting, it can lead to a delay in IT procurement procedures in cases where extra needs are identified by the hospital staff.
- **The lack of clear strategic planning:** Some participants indicated that their IT departments lack a long-term planning strategy regarding their IT services and applications. One participant stated that "*We have a problem in our IT operations, which is the absence of clear strategic planning*" (P4). However, others indicated that their strategic plans were under the process of being implemented.
- **Less effective IT management:** The study found that the main focus of the IT department is on operational IT activities such as troubleshooting application issues. One hospital has buildings at a distance from each other and so IT staff need additional time to go between the buildings (P3). One participant also reported that fixing some system failures may take a long time (P2).
- **Shadow IT:** Some participants indicated that "*some departments at the hospital use applications without the permission of the IT department*" (P6), referred to here as Shadow IT. This can lead to some difficulties in managing IT services such as security issues and increases the cost of implementing IT services.

6.5.2 Cloud Computing Drivers

The interviewees identified a number of motivations for the adoption of Cloud Computing in Saudi healthcare organisations. The key benefits of adopting Cloud Computing in Saudi healthcare organisations, determined in this investigation, are as follows:

- **Reducing IT cost:** Cost saving is considered to be one of the major motivations for using Cloud Computing services. This driver is important for many participants (P2, P5, P6). One participant stated that "*Cost saving is the number one factor that affected our decision when adopting Cloud Computing.*" (P5). The impact of cost savings will be either direct or indirect. Direct cost savings can be caused by decreasing the need for capital investment for IT resources (P5). Indirect cost savings include decreasing the cost of power consumption (P7) and decreasing maintenance costs (P3, P6). The use of Cloud Computing solutions will reduce the need for new IT resources for development and testing of new software (P3).

- **Collaboration between healthcare organisations:** Cloud Computing will enable better integration and exchange of medical information across multiple organisations (P1, P4). One participant stated that they had a proposal to connect all the hospitals in the region via Community Cloud Computing (P4).

- **Increase resource sharing:** Some healthcare organisations have shortages issues in terms of advanced medical devices. Some participants see Cloud Computing as an enabling technology that allows them to share their resources (P1, P4, P5). One participant stated that "*The use of Cloud Computing could allow us to share some medical devices with other organisations such as: PACS.*" (P1).

- **Better management of IT resources:** Maintenance and operational activities are time consuming for IT employees. Cloud Computing will allow for better management of these activities by controlling the activities required to manage resources, thereby reducing demands on staff. IT resources can be acquired and deployed more quickly and easily due to the self-service characteristic of Cloud Computing. For example, one participant explained that "*The hospital has many buildings which require several minutes for IT staff to go between buildings. Thus, Cloud Computing will reduce maintenance time since some maintenance jobs will be done by using virtualisation technologies.*" (P3).

- **Address the issue of scarcity of professionals:** Some Saudi healthcare organisations face a shortage of professionals, either IT professionals or health informatics professionals (Alkraiji et al., 2013). Some participants pointed out that Cloud Computing could help to reduce this problem since the use of cloud technology means that fewer technicians will be required by the healthcare organisations (P1, P2).

- **New business opportunities:** The use of Cloud Computing in healthcare organisations will also allow the introduction of new classes of applications and delivery of services that were not possible before (Marston et al., 2011). Comments made in the interviews suggest that Cloud Computing can help healthcare organisations with the introduction of new applications that were not previously available because of cost or technical difficulties (P1). Another advantage of implementing Cloud Computing solutions is that Cloud Computing will give IT professionals more time to think about innovative ideas because it will reduce daily operations and maintenance time (P7).

- **Enhance business agility:** Cloud Computing can allow healthcare organisations to add to or change IT resources quickly and easily without the need to wait a long time for replacements (P3, P5). One participant clarified that by saying "*We will not need to wait a long time for someone to accept our request to add new hardware or software.*" (P3).

- **Improve the availability of IT resources:** Cloud Computing will allow healthcare organisations to improve the availability of their IT resources (P3, P4, P6). For example, one participant stated that "*Another benefit of using Cloud Computing is that we will not need to have application down time when we conduct planned maintenance.*" (P6). Cloud Computing will also support development and testing of new components of the system with limited need for extra IT resources (P3).

- **Scalability:** This driver refers to the ability of IT resources to scale up and down based on the needs of the users' demands and usage (AbuKhousa et al., 2012). Only one participant mentioned scalability as a driver of Cloud Computing (P7). However, scalability may not be an issue for Saudi healthcare organisations, which usually have unchanging usage of IT resources (Alkraiji et al., 2013).

Table 6.2 summarises the key drivers for Cloud Computing adoption in Saudi healthcare organisations based on the participants' views.

Table 6.2 Key Drivers for Cloud Computing adoption in Saudi Healthcare Organisations

Key Driver	Participant Code
Cost reduction	P2, P3, P5, P6
Collaboration with other organisations	P1, P4
Resource sharing	P1, P4, P5
Better management of IT resources	P3
Reduce the need for qualified IT staff	P1, P2
New business opportunities	P1, P6, P7
Enhance business agility	P3, P5
Improve the availability of IT resources	P3, P4, P6
Decrease power consumption	P7
Scalability	P7

6.6 Cloud Computing Challenges

The participants of this study also discussed the challenges that may hinder the adoption of Cloud Computing in Saudi Healthcare organisations as follows:

- **Hidden costs:** Although the cost of the Cloud Computing model is considered to be more transparent than traditional outsourcing (Dhar, 2012), some participants have concerns about the hidden cost of implementing this model (P1, P3). One possible reason for that is the lack of experience in dealing with such a model (P1). A solution suggested during the interviews was to conduct a complete financial analysis before adopting Cloud Computing.

- **Security concerns:** Healthcare organisations usually have concerns regarding IT security because of the sensitive personal data with which they deal (AbuKhousa et al., 2012). Security issues have been identified as a challenge for adopting Cloud Computing solutions by some participants (P1, P5). However, one participant stated that "*I am not concerned that much about security issues because I hope that we at the hospital can deal with such concerns. We can deal with security concerns through technological means such as use of a firewall.*" (P2). One possible explanation for the security concerns is the shortage of professionals in Saudi Arabia who can deal with such concerns (Alkraiji et al., 2013). The implementation of private cloud solutions could minimise these concerns.

- **Data privacy concerns:** The privacy and confidentiality of hospital information is a real concern for some participants (P3, P6). The concerns are about who has access to the data and the fear of losing control over the data. However, one participant indicated that the concerns could be reduced if national regulation of Cloud Computing was available (P5). Patient information privacy is a concern for Saudi hospitals since the country does not have national health privacy legislation (Alkraiji et al., 2013).

- **Integration and compatibility concerns:** One participant clarified that some software at the hospital is found to be incompatible with Cloud Computing services (P5). This will lead to difficulties in the integration processes between some IT resources and the Cloud Computing environment (P4). One possible reason for this obstacle is the shortage of qualified IT professionals at the hospital who are able to make any required modifications for the software or the hardware to be compatible with Cloud Computing.

- **Managing the relationship with the Cloud Vendor:** healthcare organisations will need to manage the relationship with their cloud provider very carefully (P7). Some healthcare organisations have concerns about Vendor-lock in (P4). However, participants identified possible solutions for such concerns. One participant stated that "*The hospital must have a database migration strategy to avoid [the] vendor lock-in issue.*" (P4). Another participant mentioned that standardisation of Cloud Computing could solve this issue.

Table 6.3 summarises the challenges for Cloud Computing adoption in Saudi healthcare organisations from the decision-makers' viewpoints.

Table 6.3 Challenges for Cloud Computing adoption in Saudi Healthcare Organisations

Challenge	Participant code
Hidden cost	P1, P3
Security concerns	P1, P2, P5
Data privacy concerns	P3, P5, P6
Integration and compatibility concerns	P4, P5
Managing relationship with the vendor	P4, P7

6.6.1 Factors Affecting Decision-makers' Adoption of Cloud Computing in Healthcare Organisations

The factors that affect the decision-making process concerning the adoption of Cloud Computing in Saudi healthcare organisations, based on the participants' views, are classified as follows:

- **Technological Factors**

  The awareness among healthcare organisations about the potential benefits of adopting Cloud Computing is seen as a positive factor supporting its adoption. Relative advantage was considered by all respondents since they stated that their organisations are aware of the values of implementing Cloud Computing solutions. Another factor mentioned by all participants is the IT infrastructure readiness of the healthcare organisation to implement Cloud Computing. Some participants were concerned about Internet connectivity in their organisation (P1, P5, P6), while other participants were concerned about integrating Cloud Computing with legacy architectures (P2, P4, P6). Compatibility was cited by many respondents as an important factor that will affect the decision about Cloud Computing adoption. This factor was discussed from two perspectives: IT infrastructure's compatibility with the cloud (P3, P5) and healthcare organisation values compatibility (P1). Security concerns are also considered to have an impact on Cloud Computing implementation in healthcare organisations (P1, P4, P5). However, the implementation of private cloud solutions could ease some security concerns. One participant mentioned that providing trialability (i.e. the degree to which an innovation can be experimented prior to actual adoption (Atkinson, 2007)) for Cloud Computing solutions will positively affect the Cloud Computing adoption decision (P7). However, this trialability factor will be dependent on the innovativeness of IT leaders in the organisations.

- **Organisational Factors**

  Top management support was identified by almost all the respondents as an important factor for Cloud Computing adoption. However, two of them indicated that this factor has affected the adoption decision positively (P1, P5) whilst the others stated that top management had negatively affected the decision (P2, P3, P6, P7). One participant suggested that lack of knowledge about Cloud Computing may be the reason for the lack of top management support. Another factor mentioned by some of the participants was the attitude towards change, mostly from IT personnel, in the healthcare organisations. The data indicated that there is a possibility for resistance to change especially from IT staff in the organisations (P1, P2, P3, P6, P7). One possible reason for this resistance is the IT staff's fear that they may lose their jobs if the organisation adopts Cloud Computing. One participant stated that it would be important to explain Cloud Computing concepts for all the hospital's stakeholders (P2). However, some interviewees did not believe that Cloud Computing adoption would affect end users or IT staff (P4, P5).

- **Environmental Factors**

The data revealed that national regulation about the implementation of Cloud Computing can play an important role in supporting or slowing its adoption (P3, P4, P5, P6). Currently, there is no national regulation about Cloud Computing in Saudi Arabia. However, some participants indicated that there are general IT regulations that will apply to the adoption of Cloud Computing in healthcare organisations, such as: the resolution of Computing and Networking Controls in Government Agencies in Saudi Arabia (P4). Pressures from peers in the same industry will also affect Cloud Computing adoption. Almost all of the respondents agreed that, if pioneering hospitals in Saudi Arabia adopted Cloud Computing, this would influence other hospitals to adopt Cloud Computing quickly. Some participants clarified that visiting hospitals that had already implemented Cloud Computing solutions would allow them to learn from their experience and would make the implementation process easier. The availability of external support for implementation and use of Cloud Computing will also be a positive factor supporting adoption. Healthcare organisations in Saudi Arabia will need to work with IT providers that have a good reputation in the area and have multiple-disciplinary experience (i.e. both health informatics and IT) (P5). Another participant stated that "*attending seminars organised by cloud providers affected our decision about adopting Cloud Computing*" (P7).

- **Human Factors**

The innovativeness of the decision-makers had a great impact on the willingness to adopt Cloud Computing in Saudi healthcare organisations (P1, P3, P4, P6, P7). Chief Information Officer (CIO) innovativeness allowed the hospital to try the latest technologies and to find innovative ways of implementing IT services (P4, P6, P7). CIOs can use their capabilities to convince top management to adopt new technologies (P1). The availability of internal experts is another important factor that should be considered when making the decision about Cloud Computing adoption in healthcare organisations (P2, P3, P5, P6, P7). However, some participants indicated that the implementation of Cloud Computing will change IT staff roles to focus more on managerial activities instead of operational activities (P2), which could be related to the IT staff's possible resistance to change. Another respondent mentioned that the hospital may need to recruit IT staff that are able to deal with and manage Cloud Computing solutions effectively, and it could be expensive to recruit them. Additionally, previous experience of implementing and managing this kind of project is considered another important factor by many participants (P1, P3, P4, P5, P6). Some participants advised the organisations to have a training plan for their IT staff to develop knowledge and experience (P2, P6, P7). One participant mentioned that "*attracting new IT professionals with creative minds and providing them with enough training about Cloud Computing*" could be a solution (P2).

- **Business Factors**

There was agreement among all participants in this study that healthcare organisations must consider the financial aspects before adopting Cloud Computing. Healthcare organisations must be aware of the direct costs (e.g. new hardware) and non-direct costs (e.g. training) of implementing Cloud Computing. One participant clarified that it is important for an organisation to establish detailed Service Level Agreements (SLAs) before Cloud Computing is adopted (P5). The participants also highlighted that an important factor to be considered when adopting Cloud Computing is the strategic benefits of the adoption. Some participants indicated that Cloud Computing will increase collaboration between the hospital and other organisations (P1, P4). One participant stated that "*we are implementing new technologies but with old processes so I think that the business model of our department needs to be changed*" (P7).

Table 6.4 summarises the factors that affect the Cloud Computing adoption decision in Saudi healthcare organisations.

Table 6.4 Factors that affect the Cloud Computing adoption decision in Saudi Healthcare Organisations

Perspective	Sub-Factor	Participant Code
Technology	Internet connection	P1, P5, P6
	Compatibility	P1, P3, P5
	Relative advantages	P1, P2, P3, P4, P5, P6,P7
	Integration	P2, P6, P4
	Infrastructure readiness	P2, P3, P4, P6, P7
	Security	P1, P4, P5
	Trialability	P6
Organisation	Top management support	P1, P2, P3, P5, P6, P7
	Change resistance	P1, P2, P3, P6, P7
	Lack of knowledge of Cloud Computing	P3
Environment	Regulation compliance	P1, P3, P4, P5
	Business ecosystem pressure	P1, , P2, P3, P5, P6, P7
	External expertise	P1, P3, P4, P7
	Lack of standardisation	P2, P4
	Accreditation organisation	P5
Human	Decision-makers ’innovativeness	P1, P3, P4, P6, P7
	Internal expertise	P2, P3, P5, P6, P7
	Previous experience	P1, P3, P4, P5, P6
Business	Cost and hard financial analysis	P1, P2, P3, P4, P5, P6
	Strategy and soft financial analysis	P1, P2, P3, P4, P5, P6, P7

6.7 Discussion

The goal of this investigation is to assess the determinants of Cloud Computing adoption in Saudi healthcare organisations by means of interviews with decision-makers in Saudi healthcare organisations in order to support the development of the HAF-CCS. The findings of this investigation divided the factors that will influence Cloud Computing adoption in Saudi healthcare organisations into five themes: Technology, Human, Organisation, Environment and Business.

6.7.1 Technology

Technological factors describe the technologies available to an organisation and how they will influence the Cloud Computing adoption process (Low et al., 2011). Four technical factors are identified in the current study: relative advantage, technology readiness, compatibility and security. Before making any decision about the adoption of an innovation, decision-makers usually start by discovering the relative advantages of such innovation (Low et al., 2011). The relative advantage of Cloud Computing is the degree to which Cloud Computing solutions have clear benefits over others in meeting an organisation's needs (Lian et al., 2014b). Respondents in this study agreed that Cloud Computing will provide many benefits for healthcare organisations. These benefits include improving business agility, improving the availability of IT resources, cost savings and improving collaboration between healthcare organisations. Thus, relative advantage will be a positive factor in the decision to adopt Cloud Computing in Saudi healthcare organisations. This finding is consistent with other studies that found Cloud Computing can provide many benefits for an organisation (Oliveira et al., 2014; Lin & Chen, 2012). However, some studies either found relative advantage to have a negative impact on Cloud Computing adoption in the high-tech industry (Low et al., 2011) or to be unimportant, as in Taiwan hospitals (Lian et al., 2014b). The finding in the current study is consistent with other studies that found perceived benefits have a positive impact on the cloud adoption decision (Hsu, 2013). A factor mentioned by all the participants in the current study is technology readiness, which refers to technological infrastructure in the healthcare organisations such as network technologies and IT systems (Low et al., 2011). Participants have concerns about the ability of their IT infrastructure to cope with some of the technical characteristics of Cloud Computing. This finding is similar to the findings by the HIMSS Analytics Cloud Survey which indicated that, in order to use Cloud Computing services, healthcare organisations have to upgrade their network infrastructure (HIMSS, 2014). Our finding implies that healthcare organisations in Saudi Arabia will need to upgrade some of their IT infrastructure in order to implement cloud solutions. Examples of the required upgrades mentioned by the participants are network bandwidth and Internet connection. Other studies have shown that technology readiness is a facilitator of Cloud Computing adoption (Oliveira et al., 2014). Healthcare organisations in Saudi Arabia also have some concerns about the compatibility of Cloud Computing either with current IT infrastructure or healthcare values. One possible explanation for these concerns is the shortage of qualified IT professionals at the hospital able to deal with the integration processes. Although compatibility has been found not to have a significant effect on Cloud Computing adoption in Saudi academic organisations (Tashkandi & Al-Jabri, 2015), the situation in healthcare organisations is different. The findings of our study are consistent with the findings of Wu et al. (2013), who indicated that issues with compatibility had a negative impact on Cloud Computing adoption in US manufacturing and retail industries. Other researchers found that compatibility was a facilitator for the Cloud Computing adoption decision in the service sector in Portugal (Oliveira et al., 2014). Security and privacy are also concerns for Saudi healthcare organisations when adopting Cloud Computing, given the sensitive nature of health information. Regarding privacy, some respondents referred to regulatory compliance. This finding is consistent with another study where data security was found to be the most critical factor affecting the decision to adopt Cloud Computing in Taiwanese hospitals (Lian et al., 2014b). However, security concerns were not identified as hindering the adoption of Cloud Computing in Portuguese firms (Oliveira et al., 2014). Privacy and data security may be more significant issues in a health context.

6.7.2 Human

Human factors refer to the internal capabilities of the organisation's workforce and the necessary skills and technical competence (Oliveira et al., 2014). Although some participants indicated that Cloud Computing could address issues relating to the scarcity of IT professionals, others mentioned the shortage of qualified IT staff able to deal with cloud technology and that recruitment would be expensive. The dependence of Saudi healthcare organisations on trading partners for their IT solutions could offer an explanation for this result (Alkraiji et al., 2013). The availability of internal Information Systems (IS) expertise was found to affect the decision on adoption of Cloud Computing in Taiwanese hospitals (Lian et al., 2014b). This investigation also indicated that the roles of hospital IT staff may require some modifications. As Cloud Computing is an emerging technology, prior experience of related technologies is important for Saudi healthcare organisations. However, since the use of Cloud Computing is still developing in the healthcare field, the respondents identified that more training will be required for IT staff in Saudi healthcare organisations. Lack of knowledge of Cloud Computing was found to have a negative impact on Cloud Computing adoption (Güner & Sneiders, 2014). Decision-makers' innovativeness and capabilities are found to have a positive impact on the decision whether to implement Cloud Computing in healthcare in Saudi Arabia. The participants indicated that CIOs could use their networks to influence top management to support Cloud Computing adoption. Hospitals are usually slow in adopting new information technologies and hospital decision-makers prefer to use mature technologies for reasons of patient safety (Haddad et al., 2014). The result also showed the importance of IT leaders encouraging and supporting a culture of innovation in their organisations in relation to successful Cloud Computing implementation (Marston et al., 2011).

6.7.3 Organisation

A healthcare organisation's organisational characterisations will play an important role in the decision-making about the implementation of Cloud Computing (Oliveira et al., 2014). These characteristics are the organisational conditions that enable or limit the adoption and implementation of Cloud Computing (Lian et al., 2014b). The participants in this study identified that two factors from the organisation perspective that affect Cloud Computing adoption in Saudi healthcare are top management support and attitude towards change. With regard to top management support, the participants in this study did not agree whether the impact was positive or negative. This confusion may relate to the fact that decisions about Cloud Computing will require approval from different levels of management (i.e. hospital directors and Ministry of Health directors). One possible reason for the perceived negative impact of top management may be lack of knowledge about Cloud Computing, as mentioned by some participants. Another possible reason is that some managers may still have some concerns about the implementation of Cloud Computing in healthcare organisations (Tashkandi & Al-Jabri, 2015). However, some participants indicated that top management support was a positive factor in the adoption of Cloud Computing. One possible explanation is that hospital mangers have identified the benefits of adopting Cloud Computing in their organisations (Lian et al., 2014b). The other important factor in the organisational perspective is attitude towards change. This factor is important because the adoption of Cloud Computing will affect the whole organisation, not only specific units or departments (Low et al., 2011). This factor was found to have a negative impact on Cloud Computing adoption (HIMSS, 2014), which is consistent with the finding of our study. One possible explanation for this is the fear of IT staff that they may lose their jobs due to the adoption of Cloud Computing. Participants advised healthcare organisations to organise workshops that explained the Cloud Computing concept to all the organisation's stakeholders.

6.7.4 Environment

Environmental factors refer to the healthcare environment and interactions with the government (Oliveira et al., 2014). Regarding regulatory compliance, there is currently no national regulation for Cloud Computing in Saudi Arabia. However, the participants clarified that the implementation of Cloud Computing must comply with all IT regulations in Saudi Arabia. Other researchers (Tashkandi & Al-Jabri, 2015; Alshamaila et al., 2013) found that regulatory compliance is not a determinant of Cloud Computing adoption. That could be because compliance is mandatory for healthcare organisations so is a taken-for-granted element when making the decision about Cloud Computing (Borgman et al., 2013). Another environmental factor is peer pressures in the healthcare environment. This factor was found to have a positive impact on the adoption of Cloud Computing since almost all the respondents indicated that the implementation of Cloud Computing at other hospitals will affect their decision positively. This finding is similar to the findings of other studies that found external pressure to be positively related with Cloud Computing adoption (Alshamaila et al., 2013; Tashkandi & Al-Jabri, 2015; Tan et al., 2012). Another related factor is the availability of IT vendors that can provide successful implementation of Cloud Computing for healthcare organisations. This factor was found to affect Cloud Computing adoption in Saudi healthcare organisations positively. This finding is consistent with other studies that found the availability of IT providers that could provide high levels of support and that had a good reputation' to be important (Güner & Sneiders, 2014; Alshamaila et al., 2013). However, some participants indicated that healthcare organisations must be able to manage the relationship with IT vendors effectively.

6.7.5 Business

Healthcare organisations are also required to analyse the implementation of Cloud Computing from the business side. This should take into consideration quantitative metrics (i.e. cost analysis) and qualitative metrics (i.e. intangible aspects of the Cloud Computing adoption decision) (Ho & Atkins, 2006b). Our study found that cost saving is one of the main drivers of Cloud Computing adoption. This finding is supported by other studies that found cost saving to be an important factor when deciding to adopt Cloud Computing (Lian et al., 2014b; Oliveira et al., 2014). However, there are still some concerns about the hidden cost of implementing this technology. Participants advised healthcare organisations to pay great attention to defining their requirements to avoid unnecessary costs. Another positive factor influencing the adoption of Cloud Computing in Saudi healthcare organisations is soft financial analysis, which considers the business opportunities and benefits that Cloud Computing provides for the organisations. Participants listed some benefits such as new business opportunities and improving collaboration between healthcare organisations. Thus, organisations must also consider the intangible aspects of adopting Cloud Computing solutions. However, some participants emphasised the possible need to change the business model of IT departments in the organisations when implementing Cloud Computing solutions.

6.8 Framework Refinement

The factors identified for HAF-CCS were crosschecked against the discussion and the findings of the investigation, as shown in Table 6.5.

Table 6.5 HAF-CCS factors against the interview findings

Perspective	Sub-Factor	Confirmation of the Factor
Technology	Compatibility	confirmed
	Relative advantages	confirmed
	Infrastructure readiness	confirmed
	Security	New Factor
Organisation	Top management support	confirmed
	Attitude towards change	confirmed
Environment	Regulation compliance	confirmed
	Business ecosystem pressure	confirmed
	External expertise	confirmed
Human	Decision-makers' innovativeness	confirmed
	Internal expertise	confirmed
	Previous experience	confirmed
Business	Hard financial analysis	confirmed
	Soft financial analysis	confirmed

The analysis of the interviews showed the importance of the security factor for Cloud Computing adoption in Saudi healthcare organisations. The significance of adding the security factor to the framework is to support healthcare organisations in evaluating their current IT security practises and the implications for the Cloud Computing adoption decision-making process (Granados Moreno et al., 2017).

Figure 6.2 shows the development of the HAF-CCS framework based on the three stages of development; that is, developed from the secondary literature, from the questionnaire results and the final version, which also includes the results from the qualitative investigation.

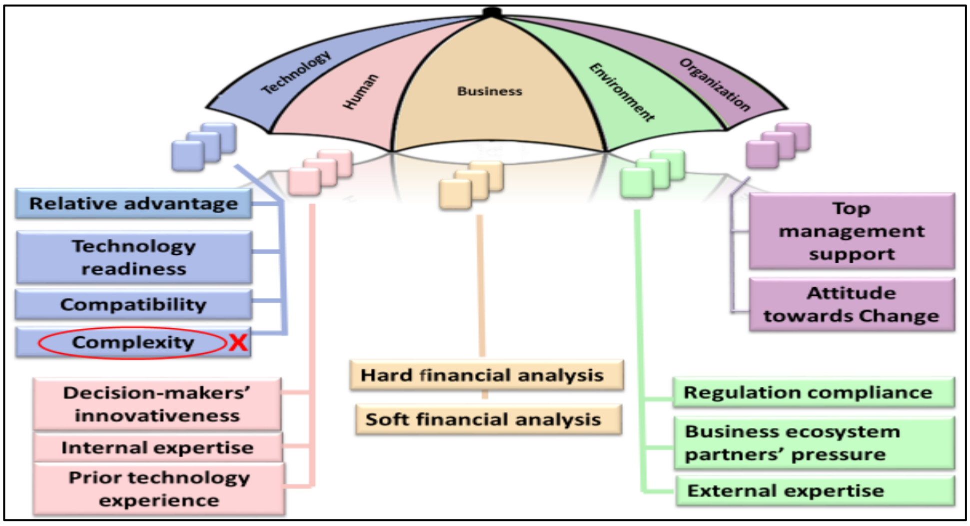
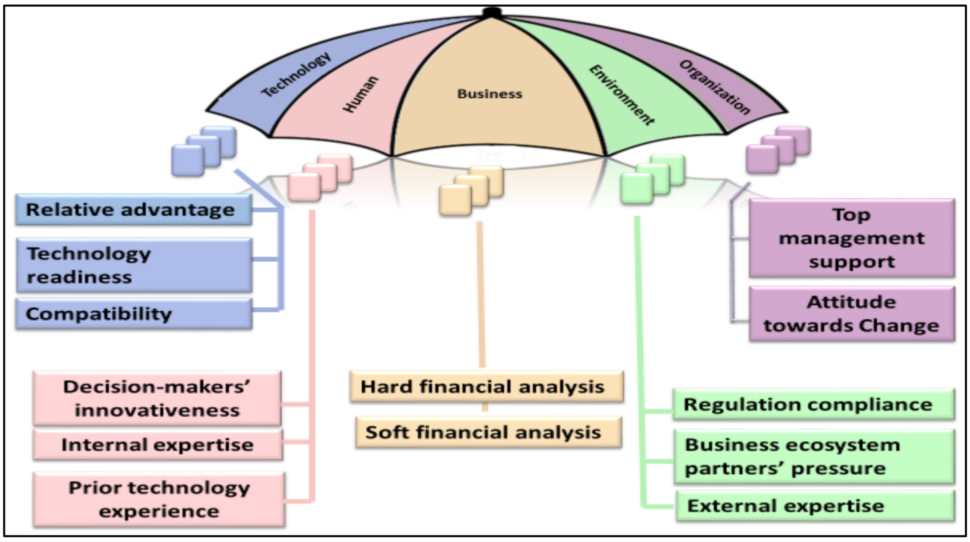
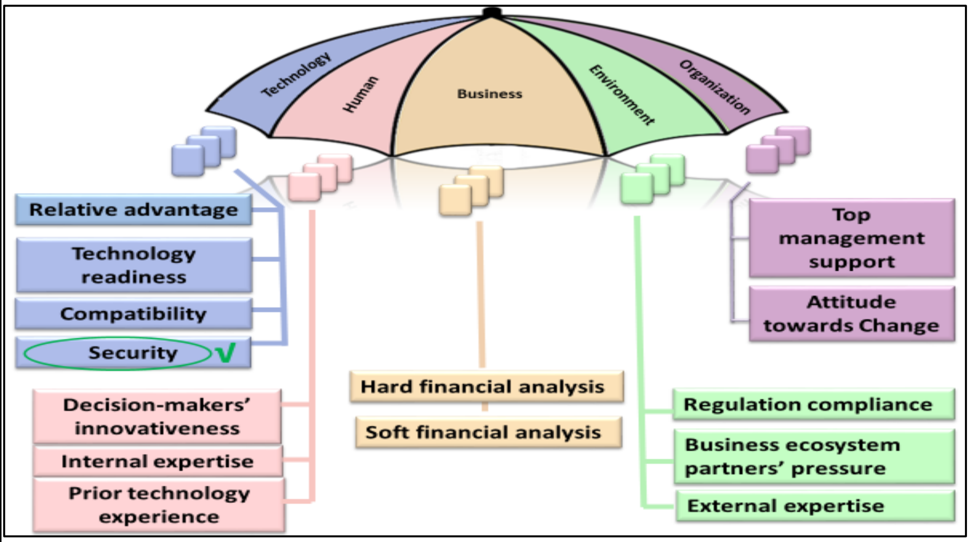
Version 1: HAF-CCS based on the literature	
Version 2: HAF-CCS based on the questionnaire and statistical analysis	
Version 3: HAF-CCS based on qualitative study results	

Figure 6.2 HAF-CCS Development

6.9 Conclusion

This chapter aimed to provide an understanding of Cloud Computing adoption decision-making in healthcare organisations in Saudi Arabia. Interviews with senior decision-makers in Saudi healthcare organisations were conducted in order to gain an in-depth understanding of the factors influencing the decision about adopting Cloud Computing in their organisations based on two case studies at major hospitals in Saudi Arabia. The chapter provided information about the interview procedures and the analysis of these interviews. It also discussed the findings of the study where the current IT practises are recognised along with the drivers and the challenges of Cloud Computing in Saudi healthcare organisations. The factors affecting Cloud Computing adoption in Saudi healthcare organisations are also identified. This chapter indicated that five perspectives, Business, Technology, Organisation, Environment and Human, should be considered when deciding whether to adopt Cloud Computing, which confirmed the findings of the previous chapter. The results of the interviews carried out with health sector decision-makers at two major hospitals showed that the factors that determine Cloud Computing adoption in Saudi healthcare organisations are relative advantage, technology readiness, compatibility, security, decision-makers' innovativeness, internal expertise, previous experience, hard financial analysis, soft financial analysis, regulation compliance, business ecosystem partner pressure, external expertise, top management support and attitude towards change. Finally, the HAF-CCS framework was modified based on the findings and the analysis of the study, which added one factor (i.e. Security). The findings of the investigation supported the findings from the literature, which indicated that the HAF-CCS covers the key factors affecting Cloud Computing adoption in Saudi healthcare organisations. The next chapter will describe the validation of the framework at two Saudi healthcare organisations.

7 Validating the Framework using two Healthcare Case Studies

7.1 Introduction

This chapter describes the validation of the HAF-CCS framework using two case studies based on healthcare scenario workshops. The aim of the validation is to test whether the framework is appropriate for its purpose and to assess whether it could be used in practice. The chapter starts by explaining how the framework is applied, discussing the weighting and scoring method and the implementation steps. Then, the two case studies are presented and evaluated against the HAF-CCS where the scores and the readiness of the five contexts and the sub-factors of each context are analysed. The chapter also explains the application of the Balanced Scorecard (BSC) to measure the implementation of Cloud Computing for healthcare organisation in one of the case studies. The chapter discusses the results of applying the framework in both case studies and how these results validate the framework.

7.2 Framework Application

HAF-CCS can be applied by the healthcare organisation's decision-makers to assess their organisation's suitability and readiness for Cloud Computing before adopting a Cloud Computing solution. This section provides descriptions of HAF-CCS implementation and shows how the framework can be used by healthcare organisations in the Cloud Computing adoption decision-making process.

7.2.1 The Benefits of HAF-CCS

HAF-CCS provides many benefits for healthcare organisations considering adopting Cloud Computing solutions. For example, it can measure how prepared the organisation is for the move to Cloud Computing implementation (Loebbecke et al., 2011). The framework can support decision-makers in understanding the organisation's position regarding Cloud Computing and identifying any gaps that may hinder Cloud Computing adoption. It also provides a tool by which to measure the progress of Cloud Computing over time in healthcare organisations. Additionally, the assessment can increase the awareness of Cloud Computing among healthcare organisations (Oliveira et al., 2014). The framework can also help identify organisational strengths that can be used to support Cloud Computing initiatives and measure the healthcare organisation's abilities to achieve the desired objectives of implementing Cloud Computing.

7.2.2 Weight and Score Method

Based on the result of the questionnaire (Chapter 5), all the dimensions of the framework were given the same weight: 20% each. However, organisations working with HAF-CCS can amend the weightings to meet their requirements, as shown in Figure 7.1, which presents the weighting utilised in the framework as discussed in this chapter.

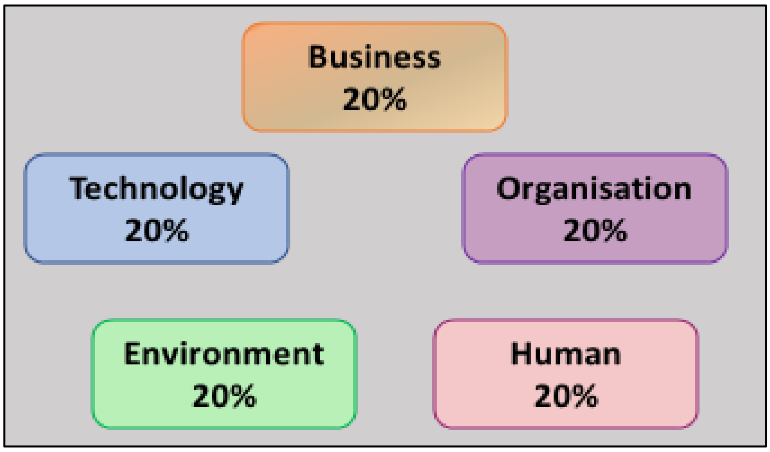


Figure 7.1 Weight of all the contexts of the HAF-CCS

The measurement technique of the proposed framework is based on the Likert scale approach. In the Likert scale technique, each item should be ranked based on specific values. The whole context assessment will be based on a five-point scale, as shown in Figure 7.2 overleaf, where a score of 5 indicates high readiness and 1 indicates low readiness. A five-point Likert scale is utilised to measure all factors in the framework. The use of a Likert scale will allow the transformation from qualitative data into a quantitative measure in some aspects of the framework (Boone & Boone, 2012). The Likert scale also has been used in many different readiness tools in the healthcare context (Van Dyk, 2014).

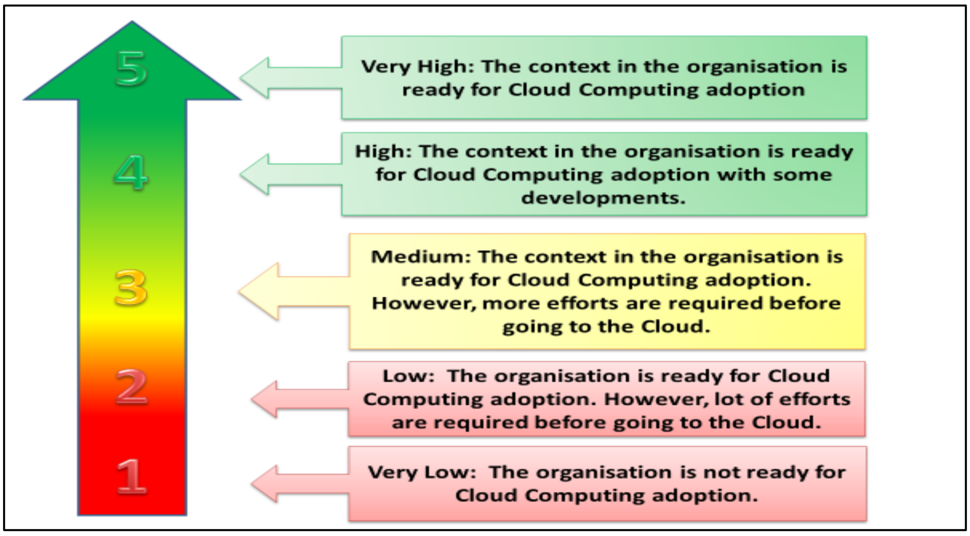


Figure 7.2 Likert Scaled Approach of context assessment in HAF-CCS

7.2.3 Framework Implementation Steps

The application of the framework is explained using the following steps:

1. The framework represents factors as 'cards' which can be added or removed within the 'context or 'sector' (i.e. Business, Technology, Organisation, Environment and Human) for various reasons, as shown in Figure 6.2.
2. Each factor in the context will be evaluated against criteria set out in the supporting questions and assigned a score (1 to 5).
3. For each context or 'sector', the scores of its sub-factors will be calculated based on a specific formula (i.e. each sub-factor scored 1 to 5 and totalled and divided by the number of sub-factors, giving a maximum of 5 for each context).
4. The overall score for each context will be represented in the Likert scale approach, as is shown in Figure 7.2. This assesses the readiness of the context using a range between 1 and 5. The results are also presented as a percentage to assist the decision-makers.
5. Finally, the calculated organisational final score is an aggregation of the five contexts (divided by the number of contexts (5)) with a maximum score of 5, which is similar to formats used in other radar-type diagrams.

A Microsoft Excel tool was developed to conduct the assessment and validation, to provide an outline of results and to allow the results to be shared among different stakeholders.

Figure 7.3 shows an explanation of the calculation process for the business context of the framework.

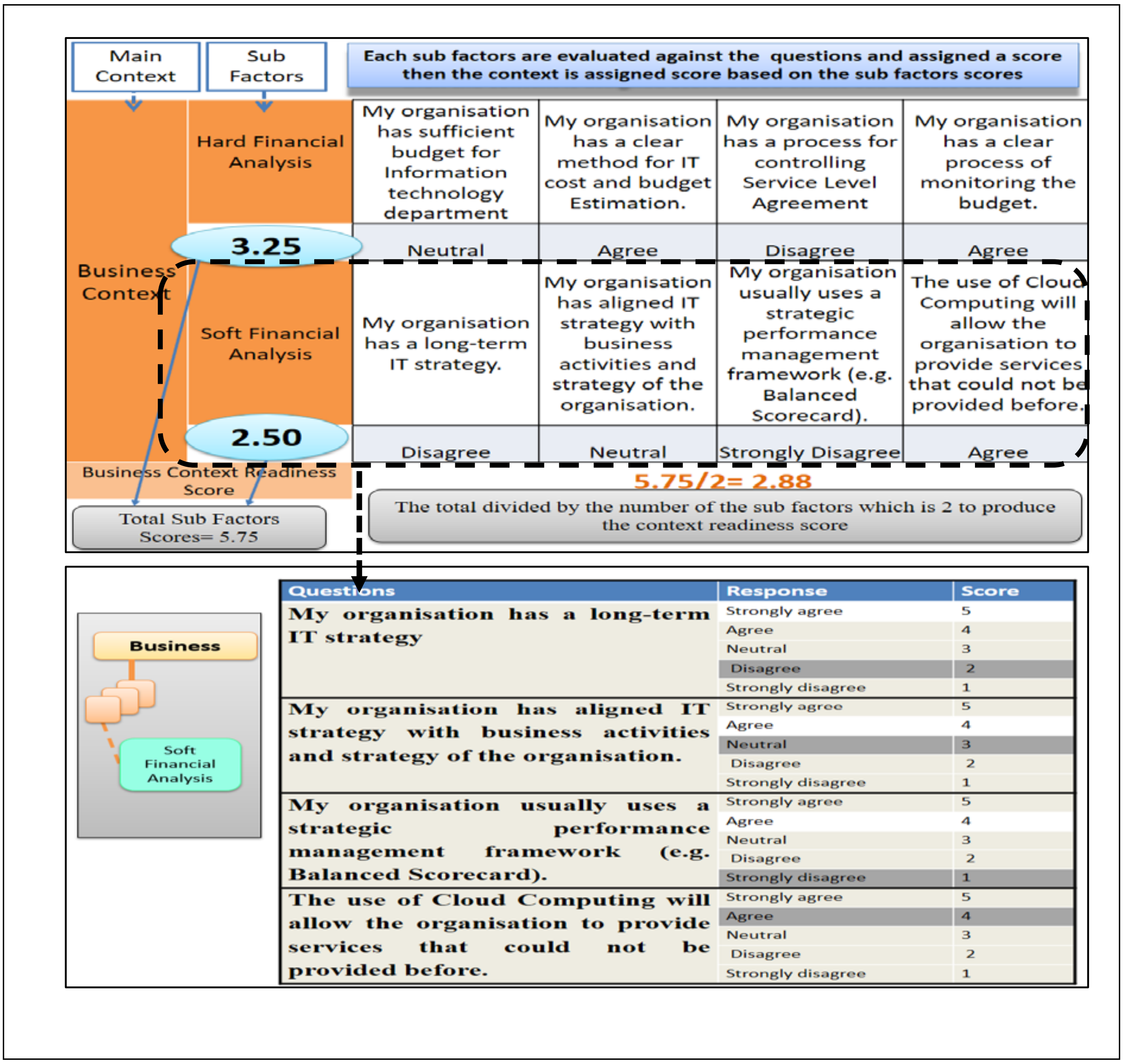


Figure 7.3 An explanation of the calculation process for the business context of the framework

7.3 Case Studies

Validation of the HAF-CCS was achieved by conducting workshops at two healthcare organisations that had agreed to implement the framework. Workshops are a widely used approach in validating e-health solutions and related frameworks (Yusof et al., 2008; Van Dyk, 2014). The institutions and individuals who took part in the case studies are anonymised for reasons of confidentiality.

The purpose of the validation is to show the applicability and the practical use of the framework in a real-world context (Rand & Wilensky, 2006; Marwedel, 2010). The workshops were held at the two participating hospitals and in each case involved decision-makers who have input into the Cloud Computing adoption decision-making process. The workshops were between two to three hours in duration and were organised as follows:

- The first 20 minutes was a presentation to explain the research and its objectives, the framework, the benefits, the implementation steps for the framework and the developed tool.
- The workshop included an example of the implementation of the HAF-CCS to show how to utilise the tool.
- Then, the participants were assisted in applying and validating the framework based on scenarios and real information from their healthcare organisations. This phase lasted for about one and a half hours, depending on the case study, and included also a discussion about organisational documents such as the Request for Proposal (RFP) document.
- The results of the validation were discussed with the participants to ensure that they reflect the situation in their healthcare organisation and to finalise the workshops.

Figure 7.4 illustrates the case study report process followed in this research based on Runeson and Höst (2009).

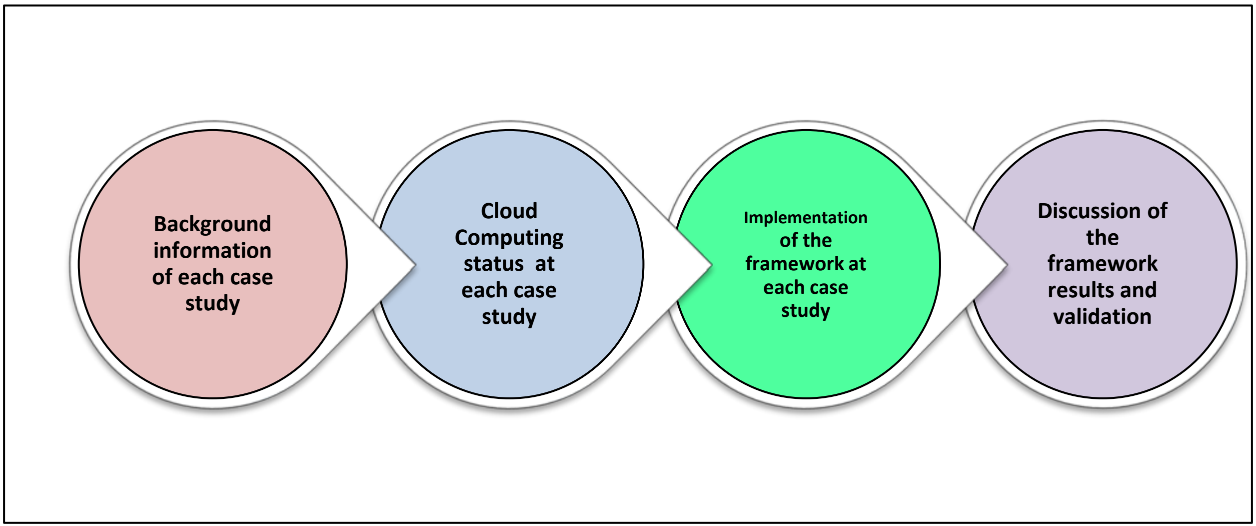


Figure 7.4 Case Study Report Sections

7.3.1 Case Study 1

The following section provides information about the first healthcare case study, which was carried out with a new hospital in Riyadh, the capital city of Saudi Arabia. The hospital is referred to as Hospital A.

7.3.1.1 Background

Hospital A has 500 beds and is one of the largest hospitals accepting referrals in the country. The hospital provides secondary and tertiary healthcare services for all age groups over 12 years of age and it is based at one central location. The department responsible for ICT and e-health services at the hospital is the IT department.

7.3.1.2 Cloud Computing solution

Hospital A has already adopted a private Cloud Computing solution, which allowed the HAF-CSS to be evaluated in the context of a recent exploration of Cloud Computing options. The IT Directorate at Hospital A decided to adopt some of the capabilities of private Cloud Computing solutions for a number of reasons, with security concerns a key factor. Private cloud solutions enable IT managers to have full control over the IT systems, making it easier for them to manage the overall IT resources. A private cloud will also allow the IT department to customise hardware performance, network performance and storage performance. The hospital's Virtualised Data Centre is operated by the IT department at the hospital; Infrastructure as a Service (IaaS) is the deployment model selected. Virtualisation technology is a key element of the Cloud Computing environment. Virtualisation is understood as converting one IT physical resource to multiple logical IT resources (Sultan & van de Bunt-Kokhuis, 2012). This technology provides many benefits such as: cost effectiveness, elasticity and scalability, hardware independency and customisation (Sajid & Raza, 2013). In addition, many physical types of IT resources can be virtualised such as: servers, storage and network (Erl et al., 2013). By applying the virtualisation concept, the IT department at Hospital A can allow other departments at the hospital to share computing resources. Cloud Computing also decreases the cost of IT resource acquisition for the hospital, whilst centralised maintenance is decreasing the time and effort required for hardware maintenance. To manage the cloud environment at the hospital, the IT management decided to outsource the operations to a third-party cloud provider.

7.3.1.3 Applying and validating the framework

This section outlines the application of the HAF-CCS in the Hospital A scenario with the focus on five contexts: Organisation, Technology, Environment, Human and Business. Each of the five contexts is assessed as follows:

- **Business Context**

➢ Hard Financial Analysis

Hospital A follows the Saudi Arabian government budget structure where there are no clear IT-related elements in the budget categories (Saudi-e-Government Program, 2007). As a result, the hospital does not have a specific budget for Information Technology. The hospital uses a Request for Proposal (RFP) document. This document is used in hospital departments for all IT procurement procedures at the hospital. The RFP usually includes information such as: price, technical requirements, vendor financial information and vendor qualifications. It also provides information about the Service Level Agreement (SLA), which includes maintenance, support and training. The RFP can also support the procurement team in the shaping of the project's contract. Although there is a central IT department at the hospital, any department can issue an IT procurement request for their projects. The role of the IT department is to review and control the procurement procedure and to check if IT department can provide the requested materials or services internally. Hospital A implements the Total Cost of Ownership (TCO) costing method. In this method, the cost of owning IT resources is not determined by purchasing cost only. Other costs have to be included such as: integration with current systems, software licences, training, warrantee, maintenance and support. IT management recognises the importance of this method because it helps them when reporting the real cost of IT to the Directorate at the hospital and other associated organisations such as the Ministry of Health (MoH). A financial penalty approach has been selected by the hospital to be applied when a provider fails to achieve the SLA targets previously contractually agreed.

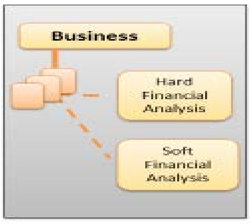
➢ Soft Financial Analysis

Hospital A currently does not have a long-term IT strategy. However, the organisation plans to have a written strategy by the end of 2017. As a result, there is a need for extra efforts to align IT strategy and business strategy and activities at the hospital. The organisation does not currently have a strategic performance management framework for its IT department. The organisation is still identifying the services that are going to be delivered by implementing Cloud Computing solutions.

➢ Business Context Readiness Score

The decision-makers at Hospital A scored all the factors in the business context and Table 7.1 presents the final scores for the context.

Table 7.1 Business Context Readiness Scores – Hospital A

<table>
<tr><td>Business Context</td><td>Factor</td><td>Score out of 5</td><td>Score out of 100%</td></tr>
<tr><td rowspan="3">
</td><td>Hard Financial Analysis</td><td>3.25</td><td>65.00%</td></tr>
<tr><td>Soft Financial Analysis</td><td>2.50</td><td>50.00%</td></tr>
<tr><td>Readiness Score</td><td>2.88</td><td>57.50%</td></tr>
</table>

- **Organisation Context**

➢ Top Management Support

The senior management team at Hospital A recognises the importance of IT so they have established a Chief Information Officer (CIO) position at the hospital. The CIO has taken leadership and responsibility for IT projects at the hospital. The CIO also helps the top management team to have an understanding of the hospital's IT needs and how to improve its IT performance. However, the organisation currently does not have an alignment between IT strategy and business strategy. The CIO at the hospital has a comprehensive understanding of Cloud Computing concepts and supports the use of Cloud Computing services. However, some top management team members still have some concerns about the security of Cloud Computing.

➢ Attitude towards Change

Hospital A currently has not established any change management processes. The IT department has not currently provided detailed workshops about Cloud Computing concepts and services for end users because they believe that employees in the healthcare organisation have sufficient information about and generally accept the use of Cloud Computing. IT staff in the organisation are prepared for the change in terms of how work will be performed either by training or by having prior experience.

➢ Organisation Context Readiness Score

The decision-makers at Hospital A scored all the factors in the organisation context and Table 7.2 represents the final scores for the context.

Table 7.2 Organisation Context Readiness Scores – Hospital A

Organisation Context	Factor	Score out of 5	Score out of 100%
	Top Management Support	3.00	60.00%
	Attitude towards Change	2.75	55.00%
	Readiness Score	2.88	57.50%

- **Technology Context**

➢ Relative Advantage

The IT departmental managers at Hospital A are aware of the benefits that are perceived from the result of adopting Cloud Computing over traditional IT systems. Cloud Computing allows IT staff to accomplish specific tasks more quickly. Decreasing the effort expended on maintenance is a clear advantage of using Cloud Computing in the hospital. Using virtualisation features can reduce the pressure on IT staff, which makes them more productive in their job roles. However, some Cloud Computing technologies are still emerging, which will require more training and initiatives from the IT management to enable the staff to update their knowledge in this domain. Cloud Computing also gives the organisation greater control over the IT budget by allowing several departments to share the IT resources, which also decreases capital expenditure. Cloud Computing also helps the organisation in managing its IT operations effectively.

➢ Technology Readiness

Hospital A does not currently have a written IT plan and strategy. However, the IT department managers were planning to complete an IT strategy by the end of 2017. The hospital has an enterprise database system, IT architecture and migration strategy, but currently has not completed an application inventory. The current bandwidth at the hospital is sufficient because it has implemented high-speed Fibre Optic lines giving all staff members unlimited access to the internet. The IT infrastructure at the hospital is maintained via centralised PC management software. Although the IT department has a partial Cloud Computing solution, IT as a Service (ITaaS) is not currently provided across the hospital.

- Compatibility

The attitude towards Cloud Computing solutions in the IT department at Hospital A was positive. Cloud Computing technologies were found to be compatible with the healthcare organisation's IT culture. However, the IT staff's views on the compatibility of Cloud Computing use with healthcare values and goals were found to be neutral because of the privacy and security concerns expressed by some staff members.

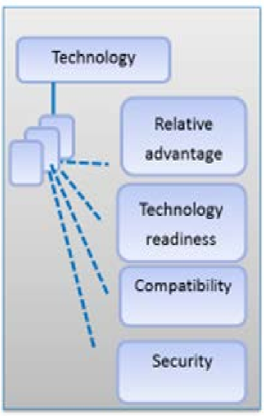
- Security

The IT department at Hospital A applies standard and traditional security technology solutions such as: firewall technology and backup facilities. The hospital uses a single sign-in as an access management approach. However, the IT department has not fully formalised its IT policies regarding the computer/network resources used at the hospital. The current disaster recovery plan needs additional controls to complete a comprehensive system.

- Technology Context Readiness Score

The decision-makers at Hospital A scored all the factors in the technology context and Table 7.3 represents the final scores for the context.

Table 7.3 Technology Context Readiness Scores - Hospital A

<table>
<tr><th>Technology Context</th><th>Factor</th><th>Score out of 5</th><th>Score out of 100%</th></tr>
<tr><td rowspan="5">
</td><td>Relative Advantage</td><td>4.50</td><td>90.00%</td></tr>
<tr><td>Technology Readiness</td><td>3.25</td><td>65.00%</td></tr>
<tr><td>Compatibility</td><td>3.75</td><td>75.00%</td></tr>
<tr><td>Security</td><td>3.50</td><td>70.00%</td></tr>
<tr><td>Readiness Score</td><td>3.75</td><td>75.00%</td></tr>
</table>

- **Human Context**

➢ Decision-makers' Innovativeness

Although the IT department at Hospital A does not usually launch innovative services, its IT initiatives are well aligned with the hospital's strategy. The hospital faces difficulties in attracting staff with the required qualifications and expertise. In some cases, the Hospital Directorate does not provide high-level encouragement to use the latest technologies because there is a preference for tried and tested traditional systems for reasons of patient safety.

➢ Internal Expertise

IT projects at Hospital A are not managed by dedicated personnel for each project, so the management of the IT infrastructure is based on the availability of IT staff in the department. The department also outsources its software development activities. IT managers have some concerns about the capabilities of their human resources to support Cloud Computing adoption at the hospital.

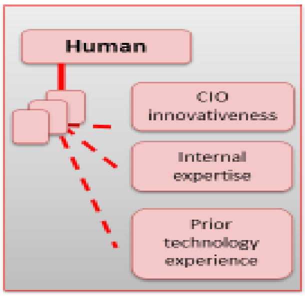
➢ Prior Technology Experience

IT staff at the hospital have limited previous experience in Cloud Computing project development since Cloud Computing is still a relatively new technology for Saudi healthcare organisations. The IT management team has not been able to conduct any Information Technology (IT) skills assessment for IT staff and healthcare professionals to determine and set-up an IT skills inventory system at the hospital. The IT department is planning to provide only partial Cloud Computing training for all hospital employees as some of them have previous knowledge of Cloud Computing.

➢ Human Context Readiness Score

The decision-makers at Hospital A scored all the factors in the human context and Table 7.4 represents the final scores for the context.

Table 7.4 Human Context Readiness Scores - Hospital A

Human Context	Factor	Score out of 5	Score out of 100%
	Decision-makers' innovativeness	3.00	60.00%
	Internal Expertise	2.25	45.00%
	Prior Technology Experience	1.25	25.00%
	Readiness Score	2.15	43.30%

- **Environment Context**

➢ Regulation Compliance

IT managers at Hospital A have limited information as to whether the use of Cloud Computing will violate the resolution of Computing and Networking Controls in Government Agencies in Saudi Arabia, as compliance regulations are under development. However, the current assumption is that the use of Cloud Computing will not violate Electronic Transactions Law in Saudi Arabia. Consequently, the IT management have applied some Regulation Compliance methods such as: maintaining data subject consent from their employees and customers, allowing them to transfer their data to a third party, etc. Additionally, the IT management have ensured that the Cloud Computing provider has agreed to a non-disclosure agreement relating to their subscribers and the data carried on the public telecommunications networks. The department management has also confirmed that no data will be transferred outside Saudi Arabia as a result of implementing Cloud Computing solutions.

➢ Business Ecosystem Partners' Pressure

The IT management are not aware of any preference for Cloud Computing adoption either from the Ministry of Health or from the General Directorate of Health Affairs for the region. However, some healthcare organisations in the region have implemented Cloud Computing solutions and Cloud Computing technology is also popular among the hospital's vendors.

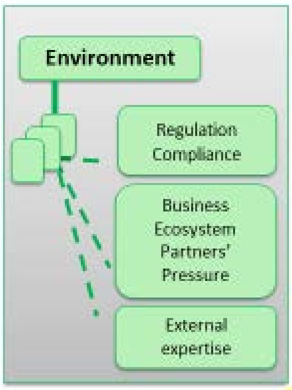
➢ External Expertise

The IT department at Hospital A has implemented appropriate Service Level Agreements for its IT services. Although the IT management have applied IT vendor analysis templates when selecting IT vendors, they are not able to check if the Cloud Computing providers are authorised by the Communications and Information Technology Commission in Saudi Arabia as the information is not published. The IT managers do not currently have an effective mechanism to require Cloud Computing vendors to provide appropriate data integrity and confidentiality at the host, network and application levels, to comply with the government regulations being developed regarding Cloud Computing in Saudi Arabia.

➢ Environment Context Readiness Score

The decision-makers at Hospital A scored all the factors in the environment context and Table 7.5 represents the final scores for the context.

Table 7.5 Environment Context Readiness Scores – Hospital A

Environment Context	Factor	Score out of 5	Score out of 100%
	Regulation Compliance	4.00	80.00%
	Business Ecosystem Partners' Pressure	3.00	60.00%
	External Expertise	2.33	46.60%
	Readiness Score	3.11	62.20%

- **Overall Hospital Readiness Score**

Based on the assessment and validation process, Hospital A showed an appropriate level of Cloud Computing readiness. Three of the five contexts scored 3 out of 5, one context scored 4 and one context scored 2, which indicates that, assessed against HAF-CCS criteria, Hospital A is ready for Cloud Computing adoption, as presented in Figure 7.5. However, the movement towards Cloud Computing still requires more efforts in all contexts, indicating that there is still work to be done.

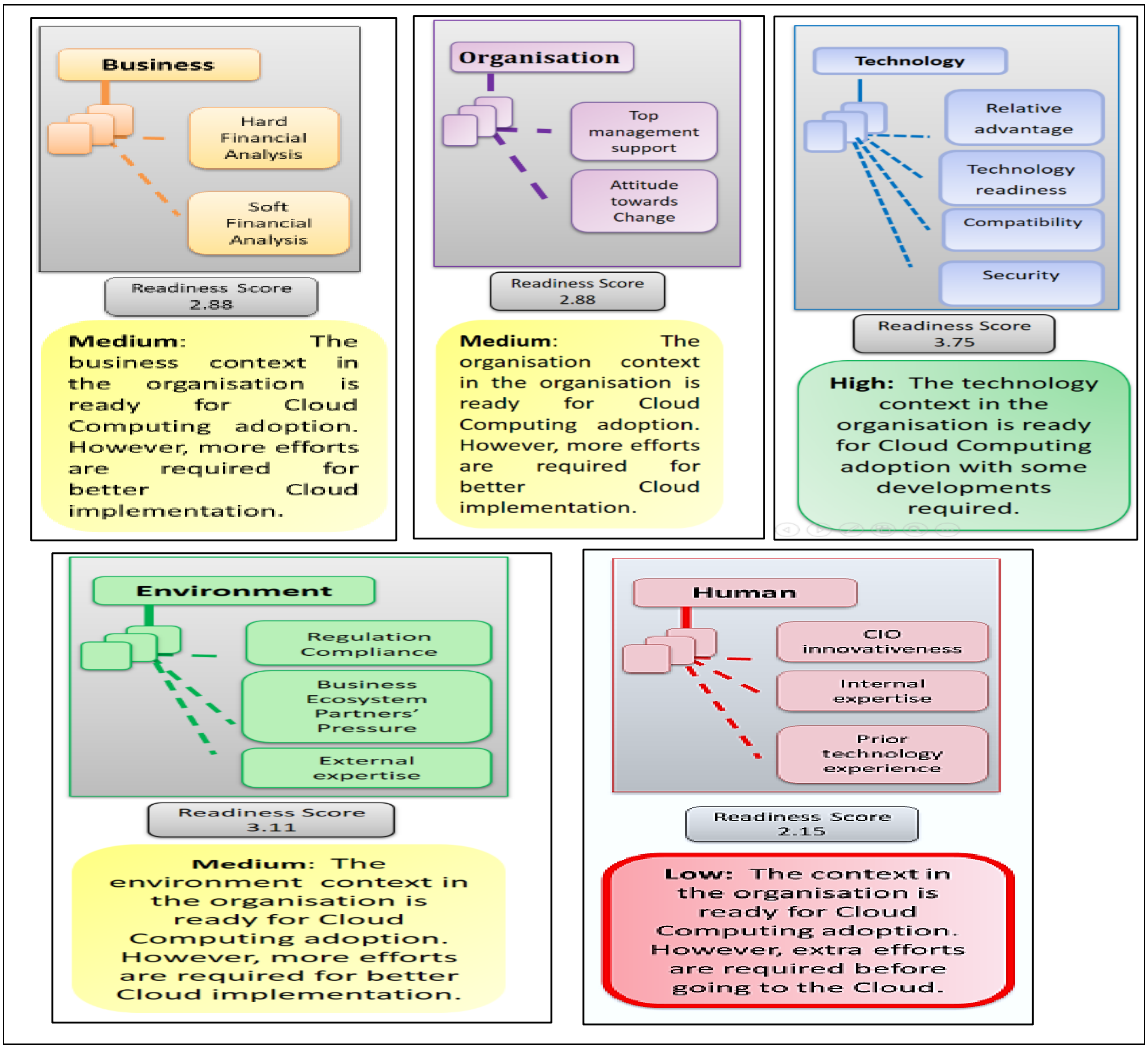


Figure 7.5 Cloud Readiness Score for all Contexts of Hospital A

Figure 7.6 presents the Cloud Computing Readiness Assessment summary for the five perspectives and the overall score for Hospital A, where a score of 5 indicates high readiness and a score of 1 indicates low readiness.

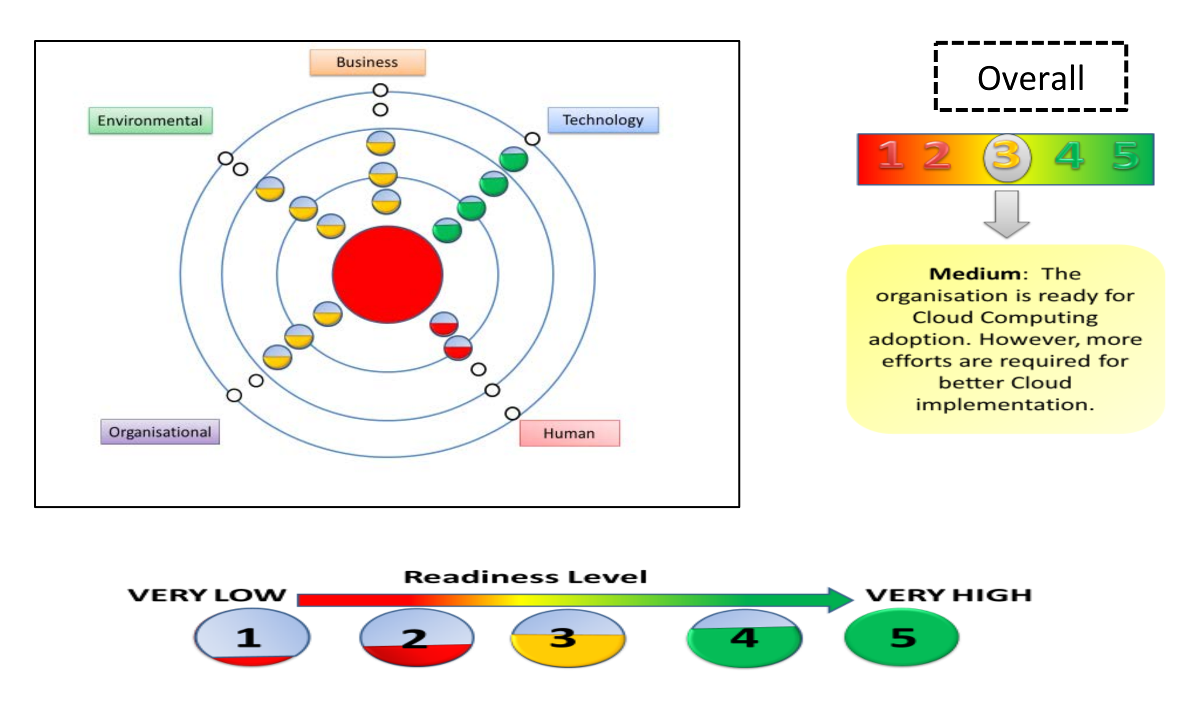


Figure 7.6 Cloud Computing Overall Readiness Assessment Score – Hospital A

7.3.2 Case Study 2

The following section provides information about the second case study, which is a governmental tertiary referral hospital in a major city in Saudi Arabia; like Hospital A, it also has a total of 500 beds. This hospital is referred to as Hospital B.

7.3.2.1 Background

The main aim of Hospital B is to provide the highest quality of patient care. The hospital aims also to be the regional training and educational centre for medical and paramedical staff and students. In addition to the hospital, there are five medical centres attached to it. The hospital is undertaking a critical infrastructure upgrade and has established an Electronic Health Department (EHD) to be responsible for developing an efficient and reliable IT environment to support medical services. Hospital B implemented a commercial Hospital Management Information System (HMIS) in 2013 to serve as the basis for HIT infrastructure with which other hospital systems should be integrated. However, Hospital B faced performance issues with the existing IT infrastructure in that some servers were outdated or were built on outdated architecture. Thus, the hospital included upgrading some of the IT infrastructure as part of the hospital upgrade project. The EHD also experienced some difficulties in managing its IT resources. For example, most of the IT staff at the hospital focus on maintenance or routine operations rather than developing new ideas or projects. EHD managers believe that IT systems should have the highest uptime possible. However, the maintenance approach in the department is currently reactive (i.e. fixing the problem after it has already happened). As a result, EHD managers have decided to implement IT solutions to achieve the following strategic objectives:

- Increase IT staff productivities and creativities which will lead to improvements in IT services.
- Increase IT resources utilisation.
- Improve information sharing inside and outside the hospital.
- Enhance IT resource availability.
- Improve customer satisfaction.
- Improve cost structure.

7.3.2.2 Cloud Computing solution

The IT team at Hospital B have decided on and are about to implement a private cloud solution to achieve their IT strategic goals. The hospital already has an IT infrastructure and hardware which can be used in building a private Cloud Computing environment. Thus, adopting a private Cloud Computing solution will not require unnecessary infrastructure investment. Hospital management and other authorities still have some concerns about the security of a public cloud and this was another reason for adopting a private cloud. Maintaining full control over the IT systems is also a reason for choosing a private cloud solution as this will support IT staff when managing IT services. A private cloud will also allow for customisation of hardware, network and storage performance. The decision was taken to outsource the private cloud operations to a third-party organisation. This was because Hospital B does not have enough qualified IT staff and also to gain access to the vendor’s specialised technical skills.

7.3.2.3 Applying and validating the framework

This section outlines the application of the HAF-CCS in Hospital B scenario with the focus on five contexts: Organisation, Technology, Environment, Human and Business. Each of the five contexts is assessed and validated as follows:

- **Business Context**

➢ Hard Financial Analysis

Since both Hospital A and Hospital B hospitals are governed by the same financial regulations, the findings of the hard financial analysis factor showed that both had the same score for this factor. Similar practices were found at both hospitals, such as the use of the Request for Proposal (RFP) document, Service Level Agreement (SLA), the role of the IT department and the implementation of the Total Cost of Ownership (TCO) as the costing method.

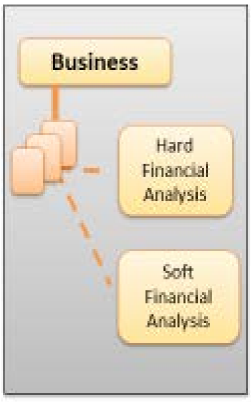
- Soft Financial Analysis

Similarly to the healthcare case study 1 which related to Hospital A, Hospital B currently does not have a long-term IT strategy. However, Hospital B plans to have a written strategy by the end of 2017. There is ongoing work to develop a Balanced Scorecard approach which can be incorporated to provide a measurement for Cloud Computing initiatives at the hospital, and it will be described in Section 7.3.2.4. The organisation tries to align its IT functions and business activities. IT department managers at Hospital B have identified some services that would be provided by implementing Cloud Computing solutions.

➢ Business Context Readiness Score

The decision-makers at Hospital B scored all the factors in the business context and Table 7.6 represents the final scores for the context.

Table 7.6 Business Context Readiness Scores – Hospital B

Business Context	Factor	Score out of 5	Score out of 100%
	Hard Financial Analysis	3.25	65.00%
	Soft Financial Analysis	3.25	65.00%
	Readiness Score	3.25	65.00%

- **Organisation Context**

➢ Top Management Support

As in case study 1, the senior management team at Hospital B established a Chief Information Officer (CIO) position at the hospital, called the E-health Director. The E-health Director has taken leadership and responsibility for IT projects at Hospital B and has sought to align these with e-health services. However, Hospital B currently does not have complete alignment between IT strategy and business strategy. Although the E-health director at Hospital B has a comprehensive understanding of Cloud Computing concepts and supports the use of Cloud Computing services, some top management team members still have some concerns about the security of Cloud Computing; these concerns were also mentioned in Hospital A.

➢ Attitude towards Change

The results indicated that Hospital B is in the same position as Hospital A, in that Hospital B has not established any change management processes and has not provided detailed workshops for end users about Cloud Computing concepts and services. However, at Hospital B there are some individual efforts to deliver a number of lectures to provide more information about Cloud Computing. IT staff at Hospital B also are prepared for the change in terms of how work will be performed, either by training or by having prior experience.

➢ Organisation Context Readiness Score

The decision-makers at Hospital B scored all the factors in the organisation context and Table 7.7 represents the final scores for the context.

Table 7.7 Organisation Context Readiness Scores – Hospital B

Organisation Context	Factor	Score out of 5	Score out of 100%
	Top Management Support	3.00	60.00%
	Attitude towards Change	3.00	60.00%
	Readiness Score	3.00	60.00%

- **Technology Context**

➢ Relative Advantage

The benefits of implementing a Cloud Computing solution at Hospital B were identified by the department managers, such as allowing IT staff to accomplish specific tasks more quickly and decreasing the effort expended on maintenance, which could lead to more effective management of IT operations at the hospital. IT managers at Hospital B are also aware that Cloud Computing could give the organisation greater control over its IT budget by allowing several departments to share the IT resources, which also decreases capital expenditure. They identified a possible cost saving from decreasing the costs of application testing and software licences.

➢ Technology Readiness

The result showed that, in terms of technology readiness, Hospital B is slightly behind Hospital A, which may be because Hospital A is newly established and most of its IT infrastructure uses the latest technology. However, Hospital B is undertaking new upgrading projects for its IT infrastructure, although it still does not have an updated IT plan and strategy. However, the IT department managers are planning to complete an updated IT strategy by the end of 2017. Hospital B has an enterprise database system, IT architecture and migration strategy, but currently has not completed an application inventory. The current bandwidth at Hospital B is sufficient because it has implemented high-speed Fibre Optic lines so most of staff members have unlimited access to the internet. However, the Fibre Optic lines do not cover all the hospital. The IT department is planning to apply IT as a Service (ITaaS) concepts across the hospital.

➢ Compatibility

Similarly to Hospital A, the attitude towards Cloud Computing solutions in the IT department in Hospital B was positive and is compatible with the healthcare organisation's IT culture. However, the IT staff's views on the compatibility of Cloud Computing use with healthcare values and goals were found to be neutral because of the privacy and security concerns expressed by some staff members and due to the use of outdated equipment which may not be compatible with Cloud Computing solutions.

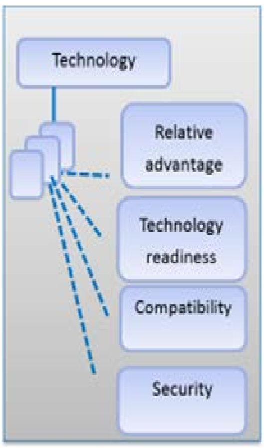
➢ Security

Although the IT department at Hospital B applies standard and traditional security technology solutions such as the firewall technology and backup facilities used by Hospital A, single sign-in as an access management approach has not been applied yet across the hospital. The IT department also has not fully formalised completed IT policies regarding the computer/network resources used at the hospital. The current disaster recovery plan requires additional components for comprehensive system coverage.

➢ Technology Context Readiness Score

The decision-makers at Hospital B scored all the factors in the technology context and Table 7.8 represents the final scores for the context.

Table 7.8 Technology Context Readiness Scores – Hospital B

<table>
<tr><th>Technology Context</th><th>Factor</th><th>Score out of 5</th><th>Score out of 100%</th></tr>
<tr><td rowspan="5">
</td><td>Relative Advantage</td><td>4.50</td><td>90.00%</td></tr>
<tr><td>Technology Readiness</td><td>3.13</td><td>62.50%</td></tr>
<tr><td>Compatibility</td><td>3.50</td><td>70.00%</td></tr>
<tr><td>Security</td><td>3.25</td><td>65.00%</td></tr>
<tr><td>Readiness Score</td><td>3.60</td><td>72.00%</td></tr>
</table>

- **Human Context**

➢ Decision makers' Innovativeness

The IT department at Hospital B usually launches innovative services and these initiatives are well aligned with the hospital's strategy. Hospital B faces difficulties in attracting staff with the required qualifications and expertise, as was the case with Hospital A. With regard to encouragement to use the latest technologies, the Hospital Directorate at Hospital B has adopted a similar position to management at Hospital A, by not providing a high level of encouragement due to patient safety concerns.

- Internal Expertise

Hospital B used a similar approach to Hospital A, by manging its IT projects based on the availability of IT staff in the department and outsourcing its software development activities. Regarding the capabilities of IT staff to support Cloud Computing adoption, IT managers at Hospital B still have some concerns due to the recent emergence of Cloud Computing technology in Saudi Arabia.

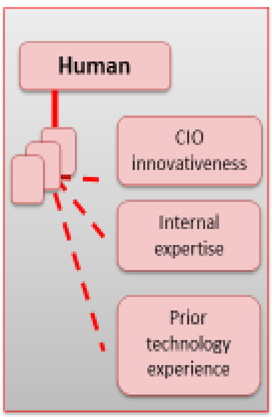
- Prior Technology Experience

IT staff in Hospital B have some experience in projects similar to Cloud Computing. Since Cloud Computing is still a relatively new technology for Saudi healthcare organisations, this means that Hospital B is in a better position than Hospital A. A skills assessment for IT staff and healthcare professionals has been partially completed, which means that Hospital B is in a similar position to Hospital A. However, there is ongoing work to complete the assessment and provide some training about Cloud Computing for IT staff based on their needs.

- Human Context Readiness Score

The decision-makers at Hospital B scored all the factors in the human context and Table 7.9 represents the final scores for the context.

Table 7.9 Human Context Readiness Scores – Hospital B

Human Context	Factor	Score out of 5	Score out of 100%
	Decision-makers' innovativeness	3.50	70.00%
	Internal Expertise	2.25	45.00%
	Prior Technology Experience	2.75	55.00%
	Readiness Score	2.83	56.67%

- **Environment Context**

➢ Regulation Compliance

Since both Hospital B and Hospital A are operating under Saudi Arabia legislation, the results showed that IT managers at Hospital B have the same limited information as those at Hospital A about whether the use of Cloud Computing will violate the resolution of Computing and Networking Controls in Government Agencies in Saudi Arabia, as compliance regulations are under development. However, they shared the same assumption that the use of Cloud Computing will not violate the Electronic Transactions Law in Saudi Arabia. Consequently, the IT management at Hospital B have applied some Regulation Compliance methods such as: maintaining data subject consent from their employees and customers, allowing them to transfer their data to a third party, etc. Additionally, the IT management at Hospital B will ensure that the Cloud Computing provider has agreed to a non-disclosure agreement relating to their subscribers and the data carried on the public telecommunications networks. As was the case in Hospital A, the department management at Hospital B has also confirmed that no data will be transferred outside Saudi Arabia as a result of implementing Cloud Computing solutions. However, IT managers at Hospital B still have some concerns about the compliance of Cloud Computing with Saudi regulations.

➢ Business Ecosystem Partners' Pressure

The IT management at Hospital B agreed with Hospital A in not being aware of any preference for Cloud Computing adoption either from the Ministry of Health or from the General Directorate of Health Affairs for its region. Management at Hospital B are also aware of other healthcare organisations that have implemented Cloud Computing solutions in the region. They also recognise the increased popularity of Cloud Computing among the hospital's vendors. The IT management at Hospital B mentioned that there are also other organisations in the region that have implemented some Cloud Computing solutions and they have been visited by some IT staff from the hospital.

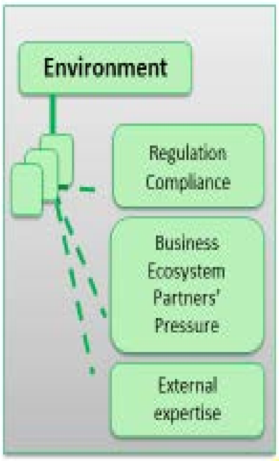
➢ External Expertise

As the IT management at Hospital B have more experience in dealing with many vendors, the IT department at the hospital has implemented better Service Level Agreements for its IT services than Hospital A. However, they are not able to check if the Cloud Computing providers are authorised by the Communications and Information Technology Commission in Saudi Arabia as the information is not published, which is similar to Hospital A's position. The IT department at Hospital B applies specific templates to ensure better selection of IT vendors. However, The IT managers still have some issues about ensuring an effective mechanism to require Cloud Computing vendors to provide appropriate data integrity and confidentiality at the host, network and application levels, to comply with the government regulations.

- Environment Context Readiness Score

The decision-makers at Hospital B scored all the factors in the environment context and Table 7.10 represents the final scores for the context.

Table 7.10 Environment context readiness scores – Hospital B

Environment Context	Factor	Score out of 5	Score out of 100%
	Regulation Compliance	3.50	70.00%
	Business Ecosystem Partners' Pressure	3.50	70.00%
	External Expertise	3.25	65.00%
	Readiness Score	3.42	68.33%

- **Overall Hospital Readiness Score**

Based on the assessment process, Hospital B showed an appropriate level of Cloud Computing readiness. Four of the five contexts scored 3 out of 5 and one context scored 4, which indicates that Hospital B is ready for Cloud Computing adoption and the hospital has passed the initial level of Cloud Computing implementation, as presented in Figure 7.7, Cloud Readiness Score for all Contexts of Hospital B. However, the movement towards Cloud Computing still requires more development in all contexts.

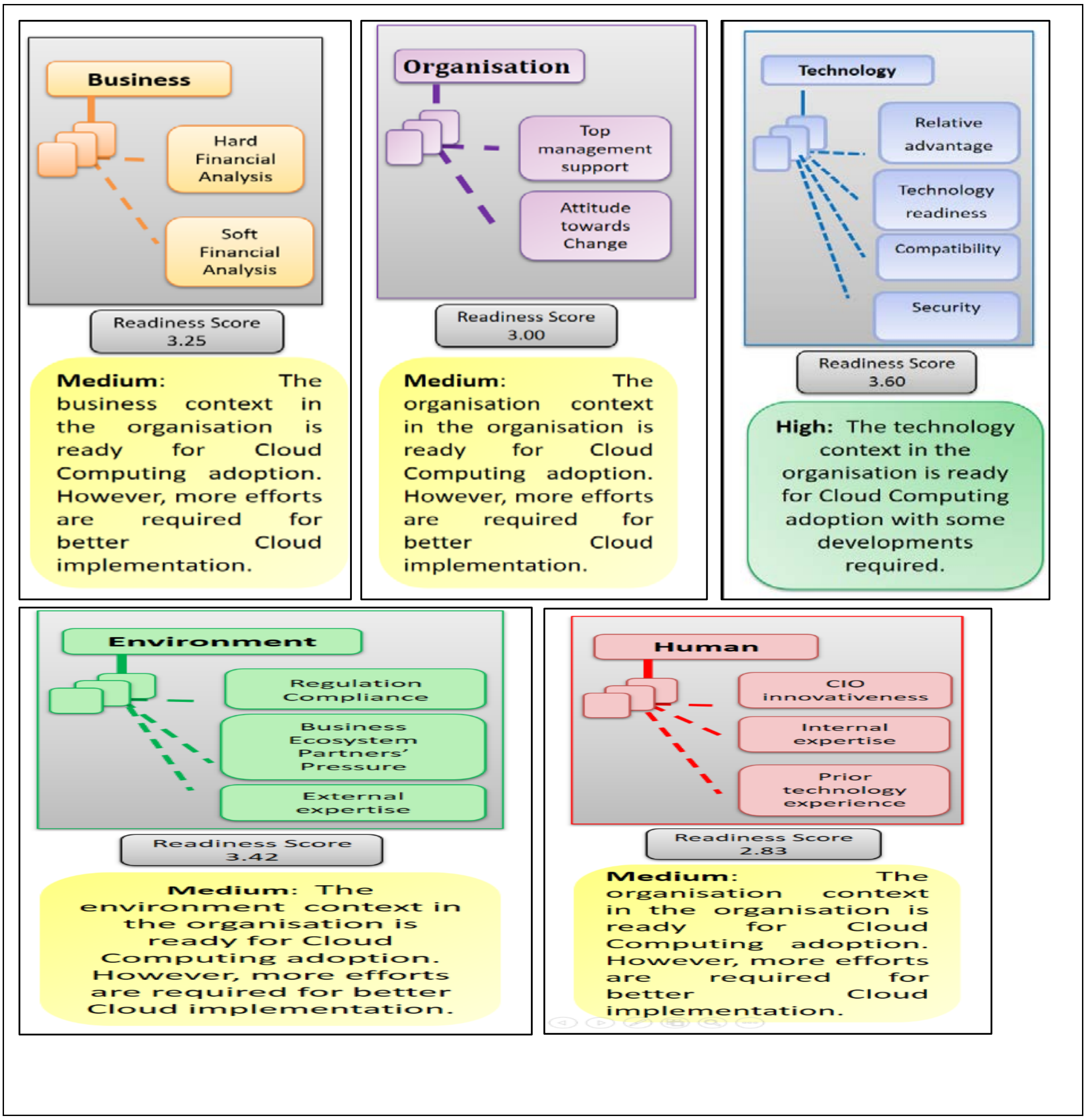


Figure 7.7 Cloud Readiness Score for all Contexts of Hospital B

Figure 7.8 presents the Cloud Computing Readiness Assessment summary for the five perspectives and the overall score for Hospital B, where a score of 5 indicates high readiness and a score of 1 indicates low readiness.

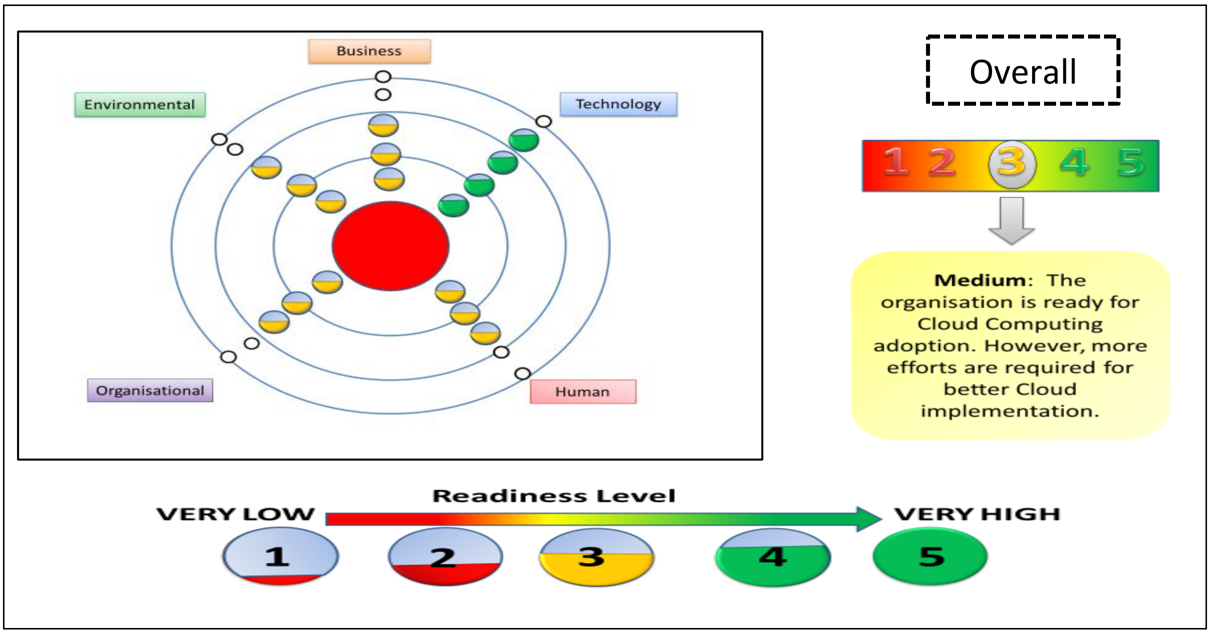


Figure 7.8 The Cloud Computing Overall Readiness Assessment Score- Hospital B

7.3.3 Measurement of Proposed Cloud Computing solution

The Balanced Scorecard (BSC) was implemented to measure the possible outcome of the proposed movement towards Cloud Computing solutions at Hospital B. The BSC was used as part of the HAF-CCS validation at Hospital B but not at Hospital A because Hospital B already applies the BSC approach in other departments, and also due to time constraints. BSC is a concept that was developed by Kaplan and Norton (1992) as a means to evaluate organisational performance. They argued that quantitative financial measures alone are not enough to provide a complete picture of business performance. The BSC combines traditional financial measures with other non-financial qualitative performance indicators. The BSC also emphasises multiple perspectives since it includes the Financial Perspective, the Customer Perspective, the Internal Perspective, and the Learning and Growth Perspective (Kaplan & Norton, 1992). The BSC is implemented by a wide range of healthcare providers and facilities at all levels of the health system and for different purposes. The BSC was chosen for this research because of its popularity among Saudi organisations (Althunaian, 2012) and for the flexibility it provides to make modifications to the perspectives.

IT managers of Hospital B agreed to work with the researcher to implement the BSC to measure the implementation of Cloud Computing solutions at the hospital and to set objectives, initiatives and targets. The BSC was chosen because this tool can be used as a performance measurement tool and/or a strategic management tool. It is also used to align the EHD department with the hospital strategy. IT managers hope that implementing the BSC could answer questions such as:

- Is the investment in Cloud Computing really worthwhile?
- Will Cloud Computing provide strategic value to the hospital?
- Will Cloud Computing provide operational benefits?

Together with the researcher, IT managers at Hospital B followed a 'Five-Stage' approach to build the Balanced Scorecard to measure the proposed cloud solution. The first stage was to map the EHD department's vision and strategy and align this with the hospital's vision and strategy. The second stage was to formulate the perspectives and the strategic objectives and decide on the weight of each perspective. Possible Key Performance Indicators (KPIs) were discussed at this stage. The third stage was to formulate the first drafts of the BSC and the strategy map. The fourth stage was a revision process to obtain feedback from different stakeholders at the hospital. Then the final stage was to obtain final agreement among the BSC, as shown in Figure 7.9.

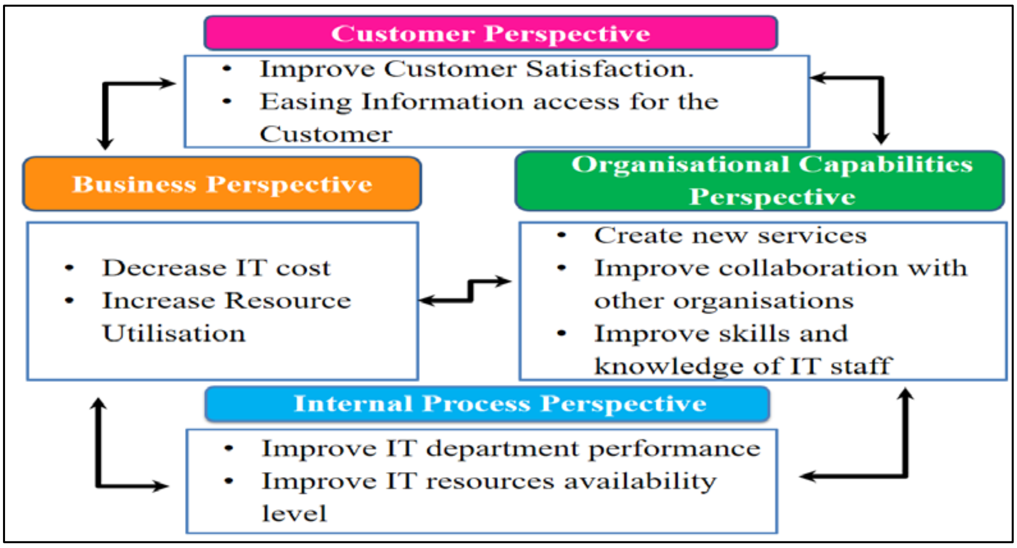


Figure 7.9 BSC approach to the Cloud Computing solution

Since Hospital B is a non-profit organisation which focuses more on operational excellence, no other strategies – such as product leadership strategy or customer intimacy strategy – were considered. IT managers adopted a mixed approach by combining an operational excellence strategy with a customer focus strategy. The BSC shown in Figure 7.9 was implemented by placing the Customer perspective at the top to highlight its importance. The Internal Process perspective has been placed at the bottom of BSC to show that this perspective is the basis of the operational excellence strategy. The learning and growth perspective has been renamed Organisational Capabilities to reflect how the use of Cloud Computing will deliver new capabilities, skills and services for EHD customers. For financial objectives, IT managers estimated that Cloud Computing will lead to improvements in cost structure and asset utilisation. A strategy map was developed to show the high-level objectives of the BSC and also to indicate the causal relationship between these objectives, as presented in Figure 7.10. For each perspective, the IT managers and the researcher developed strategic objectives. Eight main objectives were chosen with 14 performance indicators, as listed in Table 7.11.

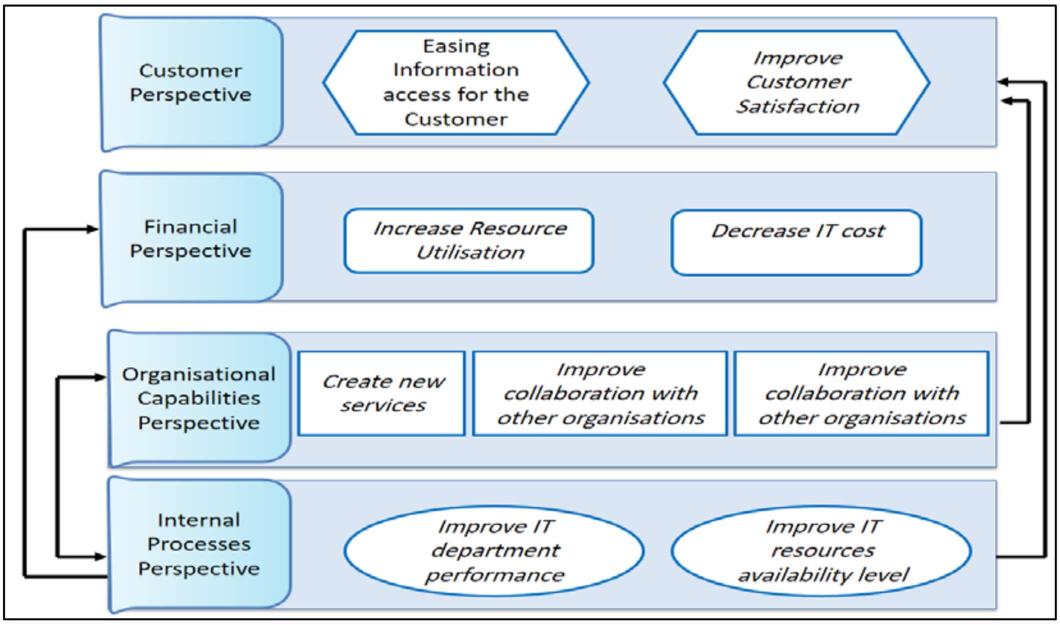


Figure 7.10 Cloud Computing Strategy Map

Table 7.11 shows the quantitative measurement and validation of the proposed cloud solution based on the BSC and indicates the potential improvements to the hospital from the different perspectives, as follows:

- **Customer Perspective:** The improvement in this perspective is observable against the two objectives of improving customer satisfaction and easing information access for the customer. Cloud Computing will enhance customer satisfaction by improving the IT department's performance by reducing both the percentage of system failures and the time taken to resolve problems.
- **Internal Process Perspective:** The first enhancement for the process perspective is improvement of department performance since Cloud Computing implementation will reduce maintenance time and improve help desk response time.

Table 7.11 Quantitative Measurement of the Proposed Cloud Solution using the BSC

Perspective	Strategic Objectives	Measurements	Current	Target	Initiatives
Financial	*Decrease IT cost*	*Decrease overall IT cost by 10%*	*30% of Hospital budget*	*20% of Hospital budget*	*Cloud Computing*
	Increase Resource Utilisation	*Increase Percentage of servers that are virtualised*	*20%*	*70%*	
		Decrease number of staff allocated to server maintenance	*3*	*1*	
Customer	*Improve Customer Satisfaction*	*Increase Customer Satisfaction by 20%*	*70%*	*90%*	*Patient portal* *Self-service stations* *Staff portal* *Mobile Application*
	Easing Information access for the Customer	*Increase number of visits to hospital websites*	*1000*	*5000*	
		Increase number of Self-service stations for Patients	*0*	*10*	
		Increase number of number of hospital mobile application downloads	*0*	*1000*	
Internal Processes	*Improve IT department performance*	*Decrease maintenance time by 30%*	*18 days per month*	*12.6 days per month*	*Proactive Care* *Load Balancer system* *Virtualisation*
		Decrease help desk response time by 10%	*72 hours*	*24 hours*	
	Improve IT resources availability level	*Increase network uptime during business hours*	*98%*	*99.99%*	
		Increase application uptime during business hours	*98%*	*99.99%*	
		Decreased unplanned downtime by 25%	*10 hours*	*1 hours*	
		Decrease application downtime during planned maintenance	*80%*	*1%*	
Organisational Capabilities	*Create new services*	*Increase number of mobile devices supported*	*0*	*100*	*Mobile Application* *Online Patient transfer request* *Training initiative*
		increase number of hours spent on innovation/projects	*2*	*5*	
	Improve skills and knowledge of IT staff	*Percentage of IT staff completed training on project management*	*10%*	*30%*	
		Percentage of IT staff completed training on Cloud Computing	*10%*	*80%*	
	Improve collaboration with other organisations	*Increase number of external interfaces with other organisations*	*2*	*20*	
		Increase number of centres that support IT department	*2*	*5*	

Cloud Computing solutions will improve the availability of IT resources by reducing system failure and planned and unplanned downtime.

- **Organisational Capabilities Perspective:** Cloud Computing will help the hospital provide new services such as mobile applications. Decreasing IT maintenance tasks will allow IT staff more time to develop their skills and work on innovative ideas. IT managers at the hospital identified that Cloud Computing will improve collaboration with other organisations by easing exchanges of information between the hospital and other organisations. However, the use of Cloud Computing will require improvements in IT staff skills and knowledge, especially with regard to Cloud Computing and project management.

- **Financial Perspective:** IT managers estimated that the use of Cloud Computing could help in reducing the Total Cost of Ownership (TCO) for IT services in the hospital from 30% to 20% of the IT budget. The potential cost saving will arise from reducing the costs of application testing and software licences and through better IT staff deployment. Cloud Computing could help increase resource utilisation through increasing the percentage of virtualised servers and decreasing the number of staff allocated to server maintenance.

7.3.4 Discussion of the Framework Validation Results

The implementation of the HAF-CCS revealed that the framework can be used in practice. This section discusses the results of the framework for both case studies and shows how this assists in the validation of the framework.

- **Business Context**

The HAF-CCS supports the healthcare organisations in evaluating financial aspects before adopting Cloud Computing. In this regard, the HAF-CCS implementation showed that the hospitals have implemented a Total Cost of Ownership (TCO) method which allows organisations to consider the purchasing cost of IT resources in addition to other variable costs such as training and integration. TCO is a method recommended for cost and budget estimation by the Saudi-e-Government Program (Saudi-e-Government Program, 2007) and by other researchers (Walterbusch et al., 2013). Its use will allow the hospital to have an holistic view of the hard financial analysis (Walterbusch et al., 2013). The HAF-CCS application also indicated that the hospitals will need to apply a robust process for controlling the Service Level

Agreement to maximise the potential advantages of implementing Cloud Computing and to reduce some of the concerns about the availability of such services. The use of the HAF-CCS allows the hospitals to identify limitations in the business context such as: the need to implement a tool to help them understand the potential strategic values of Cloud Computing for them and the need to have a stipulated long-term IT implementation strategy to support the movement towards Cloud Computing. These results validate the HAF-CCS because they show that the framework supports the identification of good practices at the hospitals regarding the business context, and that it has identified areas of improvement within the organisations in terms of improved alignment with Cloud Computing solutions.

- **Technology Context**

The HAF-CCS assesses the technological factors and the technologies available to the organisations and shows how they will influence the Cloud Computing adoption process. HAF-CCS implementation allows the IT management teams at the hospitals to recognise that there are several possible relative advantages to implementing Cloud Computing services; these include allowing specific IT tasks to be accomplished more quickly and increasing the productivity of IT staff. HAF-CCS application also identifies that the IT culture at both hospitals supports Cloud Computing adoption and it is the preferred solution. However, there are security and privacy concerns which negatively affect Cloud Computing's compatibility with healthcare values at the hospitals. The HAF-CCS allows the hospitals to discover areas for more improvement such as introducing other technologies and policies to improve the security aspects of IT services. For example, the IT department should add a clause in its IT project contracts confirming that the provider will follow specific security rules and processes (Schweitzer, 2011). The IT management team should also stipulate that the vendor must have an effective disaster recovery plan ready in case of any system failure issues. The analysis of the HAF-CCS results indicates that both hospitals have sufficient internet connection and bandwidth for the Cloud Computing implementation. HAF-CCS implementation also identifies that the IT departments at the case study hospitals need to focus on areas such as providing IT as Services and centralised PC management software. The IT management should also consider further application development to support Cloud Computing platforms. These results have validated the framework since the technology perspective has been identified at the hospitals as the perspective in the highest state of readiness to support Cloud Computing implementation. This is supported since one hospital (Hospital A) is a new establishment and consequently its IT infrastructures are considered to be modern and compatible with Cloud Computing solutions while Hospital B is conducting refinement of its IT infrastructure. HAF-CCS results also indicate that both hospitals still need to conduct further work to address issues of software compatibility with Cloud Computing solutions.

- **Organisation Context**

The HAF-CCS allows the healthcare organisations to evaluate their organisational factors and the internal variables that are under the control of the organisation itself. The implementation of the framework indicates that a more proactive approach is required from hospitals' top management to support the Cloud Computing adoption process and there is a need to develop a greater understanding of IT needs and the benefits and challenges of a Cloud Computing model. The HAF-CCS also shows that the decision regarding Cloud Computing will require approval from different levels of top management (i.e. Hospital Directorate and Ministry of Health Directorate). The framework identifies some positive attitude towards change in relation to Cloud Computing at the hospitals. However, a Change Management Team and the processes involved will help alleviate the negative concerns about the implementation of Cloud Computing in healthcare organisations. The results validated the framework because they show the need for further work at the Organisation perspective to support the adoption of Cloud Computing for both hospitals. One approach is for IT managers at the hospitals to use their personal relationships and contacts to inform top management about the benefits of implementing Cloud Computing solutions. Another approach for the IT management team is to identify successful case studies for the Hospital Directorate and/or arrange visits to other hospitals or organisations that have adopted successful Cloud Computing solutions. The IT department could consider organising and promoting workshops on Cloud Computing to explain Cloud Computing concepts to stakeholders.

- **Environment Context**

The HAF-CCS supports the healthcare organisations in considering the different attributes of the external world in which they conduct their business. The framework shows that, although there is an absence of specific Cloud Computing regulations in Saudi Arabia, the IT management still must comply with general IT regulations. It should be noted that specific Cloud Computing regulations are currently under discussion. The IT management will need to be prepared for any new regulations that are developed and to comply with all existing IT regulations in Saudi Arabia such as the Computing and Networking Controls in the Government Agencies Act. The implementation of the HAF-CCS allows the healthcare organisations to identify some limitations in the IT vendor analysis process. There are elements that should be considered such as ensuring that IT vendors will apply specific security measurements and standards such as ISO/IEC 27002 and ISO/IEC 27001. Both hospitals will also need to include security requirements in their Service Level Agreements (SLAs) together with any other legal agreements. The SLA should also deal with maintenance requirements to allow more proactive uptime procedures. The HAF-CCS results indicate that the hospital IT management teams are aware that Cloud Computing has been implemented by other hospitals, and their own vendors and partners. Consequently, the IT management team would find it helpful to visit these hospitals or other organisations to learn from their experience. The findings relating to the environmental factors validate the framework because they show that, although some of these factors are out of the organisation’s control, assessment of them can help organisations to discover alternatives and identify improvements for better Cloud Computing adoption.

- **Human Context**

The HAF-CCS framework helps the organisations in evaluating the capability of their staff to deal with the Cloud Computing solutions. HAF-CCS implementation shows that the IT departments at the hospitals will need to consider innovation initiatives such as mobile information services. HAF-CCS results also identify that the IT departments need to attract new IT staff with appropriate qualifications and experience, especially in the management of IT services. The IT departments may also need to review the department organisation structure and functions to introduce new roles for their staff such as: Business Analyst – Cloud Operator, Cloud Applications Developer, etc. HAF-CCS implementation indicates that the IT departments may also wish to change the way that IT projects are managed in the hospitals to allow greater alignment between their business objectives and IT. Additionally, the departments should consider updating IT staff skills and knowledge to provide for more effective management of IT human resources, and consider building a human resources skills inventory database. These results validate the HAF-CCS since the human perspective is identified as the perspective at the first case study hospital, Hospital A, that demonstrated the lowest level of readiness with regard to Cloud Computing adoption but it has a higher score in Hospital B, the second case study hospital. This is supported by identifying the previous experience of IT department staff at Hospital B which allows them to deal with various types of IT projects.

7.4 Conclusion

The chapter has presented the validation of the framework using two real healthcare case studies which applied the framework in a real-world context. It introduced the application of the framework and the implementation steps. There was a detailed discussion of the two case studies, explaining the background of the case studies, the Cloud Computing status of the healthcare organisations and the results of implementing the framework. For one healthcare organisation, Hospital B, the proposed Cloud Computing transformation was measured using the BSC to show the possible benefits of such a solution based on four different perspectives. The chapter also showed that, in applying the framework, it could be demonstrated that both hospitals are at an appropriate level of Cloud Computing readiness. However, they still require more development to reach a high level of readiness for Cloud Computing adoption. The results indicated that the HAF-CCS could be applied in a real-world context to support Cloud Computing adoption decision-making. The next chapter will discuss the evaluation process for the framework.

8 Evaluation of the HAF-CCS Framework

8.1 Introduction

The chapter presents the results of the evaluation of the HAF-CCS framework using a panel of experts. The purpose of the evaluation process is to assess the framework based on established criteria. The evaluation process discussed in this chapter includes the assessment of factors such as perceived ease of use, the clarity, usefulness, efficiency, support for decision-making process and comprehensiveness of the framework from the user's perspective. The chapter also includes the assessment of the framework's suitability to be utilised by decision-makers inside healthcare organisations. The individuals who comprise the panel of experts are from different backgrounds and roles and represent two healthcare organisations; this enables the framework to be evaluated based on a wide range of opinions and experiences. The results of the evaluation of the framework are presented and followed by recommendations to enhance the framework.

8.2 Evaluation of the Framework by a Panel of Experts

Evaluation in the context of this chapter refers to the assessment of the framework regarding its acceptance by the end users and its performance in the field (Begueria, 2006). The main aim of the evaluation process is to examine the concepts that underpinned the developed framework, primarily in terms of usefulness, clarity and intuitiveness. Expert feedback and judgement has been widely used in the evaluation of information system and e-health studies (Beecham et al., 2005; Van Dyk, 2014).

Panel participants were selected based on specific criteria:

- Working in a healthcare organisation.
- Have a minimum of five years' relevant experience.
- Involved in the Cloud Computing decision-making process.

The selected participants had a wide range of experience in health informatics projects in Saudi healthcare organisations and all of them had been involved in Cloud Computing decision-making processes. While most of the experts came from an IT background, two experts were healthcare professionals working with an IT department on a Cloud Computing project and another expert was an HIS project manager with experience in both IT and management. Table 8.1 presents a summary of the participants' profiles.

Table 8.1 Participants' Profiles

Case Study	Participant's Position	Participant's Background	Years of Experience
Hospital in Saudi Capital City Case 1 (Hospital A)	Project Manager of HIS	Management	14
	Head of ICT department	IT	7
Hospital in Major Saudi City Case 2 (Hospital B)	Head of e-health department	Health professional	15
	Head of network department	IT	10
	Head of IT maintenance department	IT	6
	LIS specialist and Lab supervisor	Health professional	10
	Technical IS specialist	IT	13

The evaluation and the assessment of the framework were conducted following the validation workshops which were discussed in Chapter 7 Section 7.3. The researcher gave a hard-copy, 15-page booklet which contained a detailed explanation about the developed framework to the experts to provide more information about the framework. Figure 8.1 presents a screenshot of the evaluation booklet.

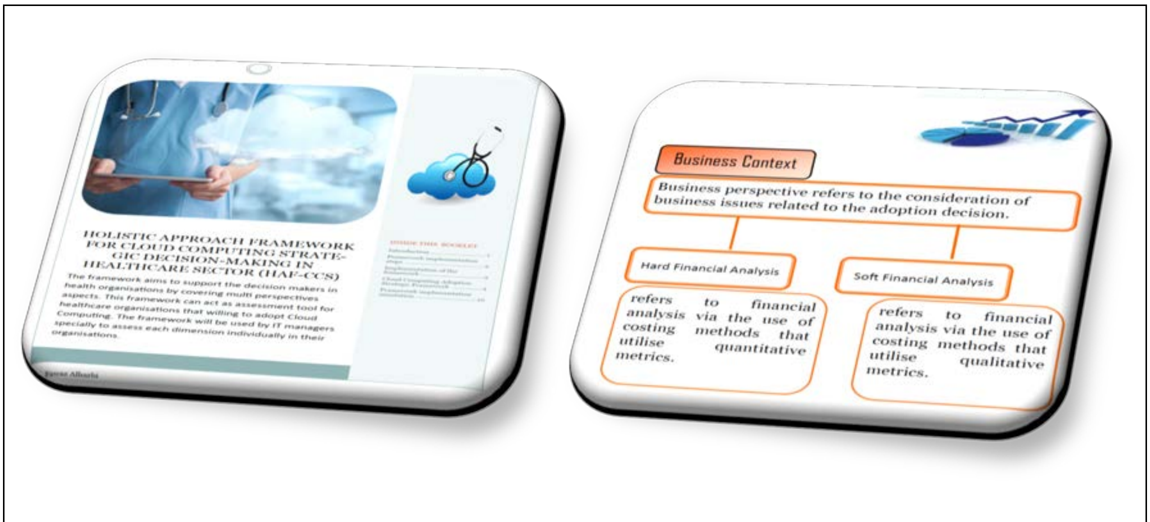


Figure 8.1 Screenshot of the evaluation booklet

8.3 Design of the Evaluation

A questionnaire was designed to gain feedback from the experts to ensure that the framework will be appropriate for its purpose and will work as expected. The questionnaire was built on a variant of the Technology Acceptance Model (TAM) (Bhatiasevi & Naglis, 2015) and other criteria to test the framework with regard to covering all or nearly all the important aspects of the Cloud Computing decision-making process. The TAM and its variants have been applied in different studies to evaluate IS solutions in healthcare organisations (Van Dyk, 2014). Table 8.2 shows the assessment criteria and the definition of each criterion.

Table 8.2 Framework Assessment Criteria

Assessment Criterion	Definition
Ease of Use	The degree to which an expert believes that using the framework is free of effort (Bhatiasevi & Naglis, 2015).
Usefulness	The degree to which an expert agrees that using the framework would enhance the Cloud Computing adoption decision-making process (Bhatiasevi & Naglis, 2015).
Cloud Computing Decision-Making Support	The measurement of how much the framework will provide support for the implementation of Cloud Computing (Alonso et al., 2013).
Comprehensiveness	The measurement of how comprehensive the framework is (Beecham et al., 2005).
Required Time	The measurement of the cost in terms of time required to complete the framework (Bhatiasevi & Naglis, 2015).
Intention to use	The measurement of how likely the decision-maker will be to use the framework (Bhatiasevi & Naglis, 2015).

The questionnaire consists of three parts. The first part was to gather information about the participants to make sure the right experts were selected. Information such as: name, number of years' experience, role in the organisation and involvement in the Cloud Computing decision-making process was collected. The second part includes closed questions with a five-point Likert scale to allow the participants to assess the framework based on specific criteria. The third part contains open questions to allow the experts to add extra comments regarding the developed framework. Figure 8.2 shows a screenshot of the HAF-CCS evaluation form.

Framework Assessment Please answer the following questions by choosing one answer only for each question					
1. With regard to the ease of use of the framework, the framework was	5 Very easy to use	4 Easy to use with little explanation needed	3 Easy to use but required explanation	2 Not easy to use but could be used with explanation	1 Not at all easy to use
2. With regard to the usefulness of the framework, the framework was	5 Very useful	4 Useful	3 Useful but may need some improvement	2 Not very useful but it could be considered for use	1 Not at all Useful
3. With regard to support for the implementation of Cloud Computing adoption decision-making provided by the framework, the framework	5 Provided a lot of support	4 Provided support	3 Provided some support but there would be a need for other tools	2 Did not provide enough support but it could be used as an extra tool	1 Did not provide support
4. With regard to the comprehensiveness of the framework, the framework was	5 Very comprehensive	4 comprehensive	3 Fairly comprehensive	2 Not sufficiently comprehensive	1 Not at all comprehensive
5. With regard to the time required to complete the framework, the framework was	5 Very efficient in terms of time required to complete the framework	4 Efficient in terms of time required to complete the framework	Efficient but with some difficulties in terms of time required to complete the framework	2 Not efficient in terms of time required to complete the framework but it could be used	1 Not at all efficient in terms of time required to complete the framework
6. If you were involved in Cloud Computing adoption decision-making, how likely would you be to apply this framework?	5 Very likely	4 Likely	3 Quite likely but would require some modifications to the framework	2 Not likely unless there were major modifications to the framework	1 Not at all likely

Figure 8.2 Screenshot of the HAF-CCS evaluation form

8.4 Analysis of the Results

The purpose of the questionnaire was to allow the experts to evaluate the developed framework based on specific criteria. In this section, the analysis of the questionnaire results will be introduced. Figure 8.3 shows the overall evaluation of the framework and each criterion is discussed as follows:

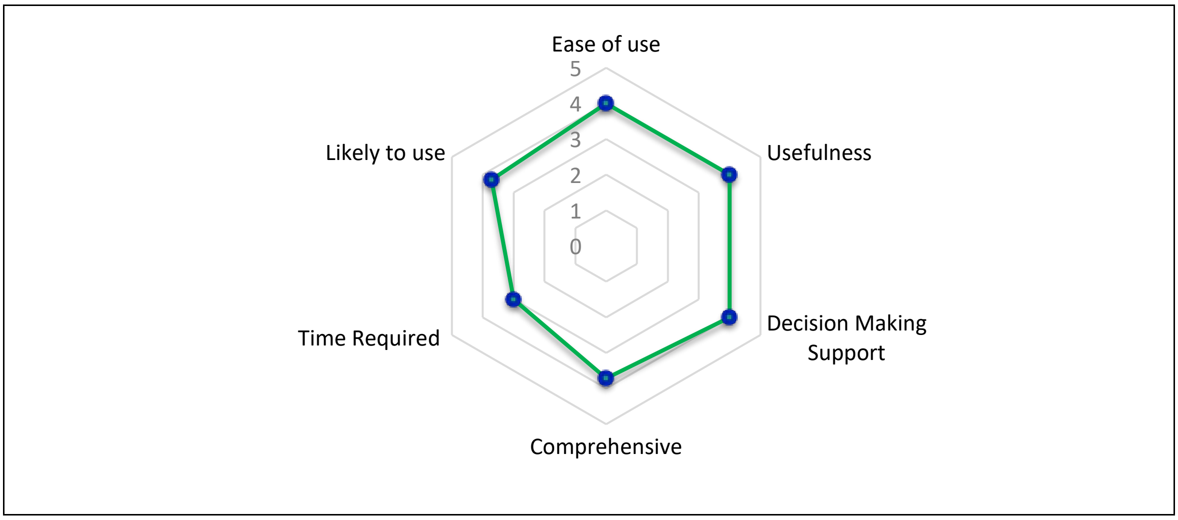


Figure 8.3 The Overall Evaluation of the framework

- **Ease of Use**

This feature is used to measure the degree to which a participant believes that using the framework is effortless. Most of the participants considered the framework to be easy to use with little explanation required. Figure 8.4 shows the results for the assessment of the framework's ease of use based on the experts' opinions. The result for this feature showed that the framework will be understood by the decision-makers but with only a small amount of effort being required.

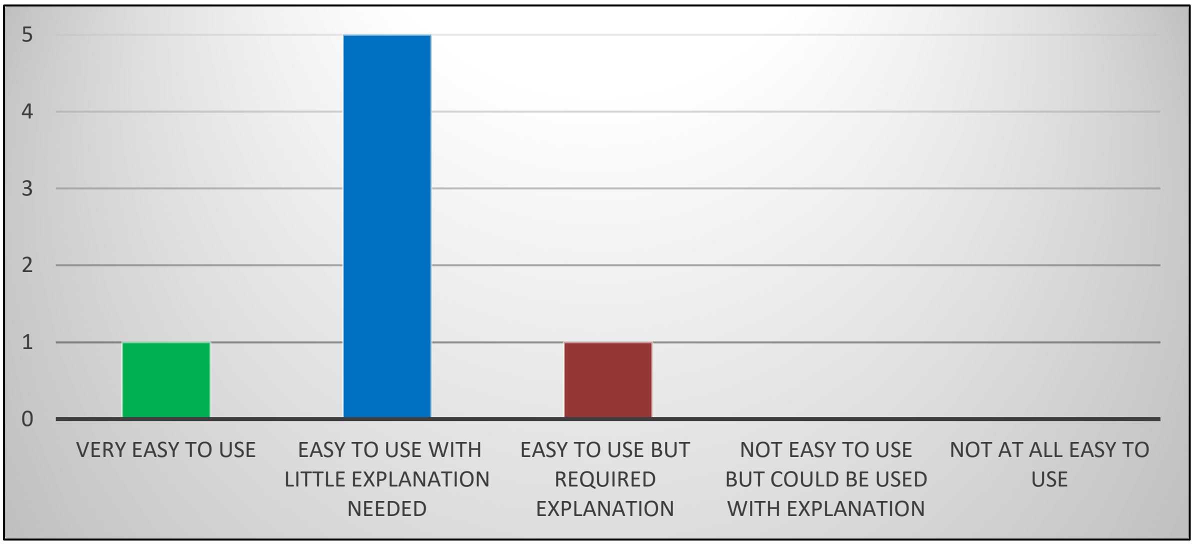


Figure 8.4 Framework Ease of Use Assessment

- **Usefulness**

This item was implemented to assess the degree to which an expert believes that using the framework would enhance job performance. Most of the experts agreed that the framework will be useful in the Cloud Computing decision-making process. Figure 8.5 presents the experts' views on the usefulness of the HAF-CCS framework. The results show that the framework will be useful to decision-makers in healthcare organisations.

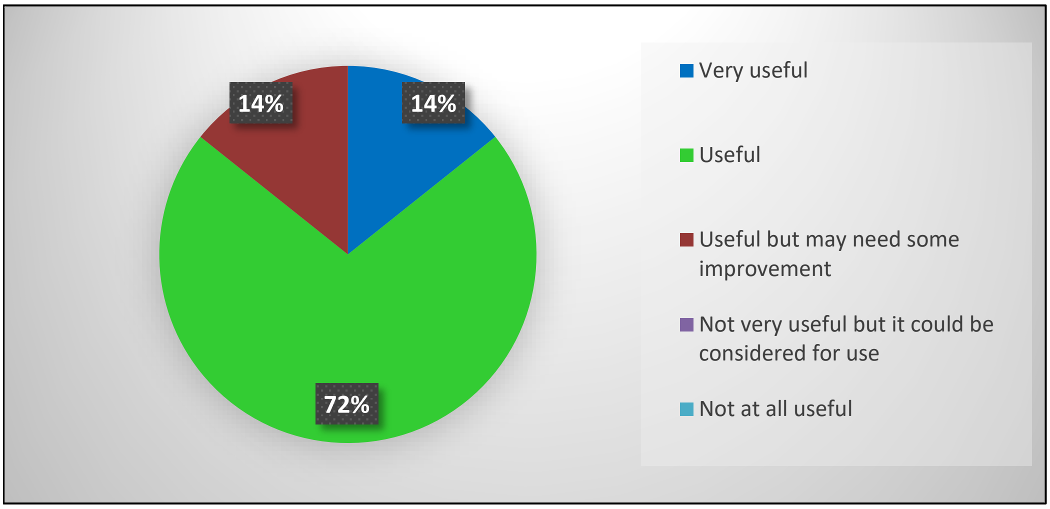


Figure 8.5 Framework Usefulness Assessment

- **Cloud Computing Decision-Making Support**

This feature measures the support that is provided by the framework for the Cloud Computing decision-making process. While three experts believed that the framework will provide a lot of support/support, the other three experts concluded that the framework will provide some support but other tools will be required. A possible explanation for this refers to fact that some healthcare organisations require their decision-makers to use specific tools such as budget estimation tools. Figure 8.6 shows the assessment of the framework's support for the Cloud Computing Decision-Making process.

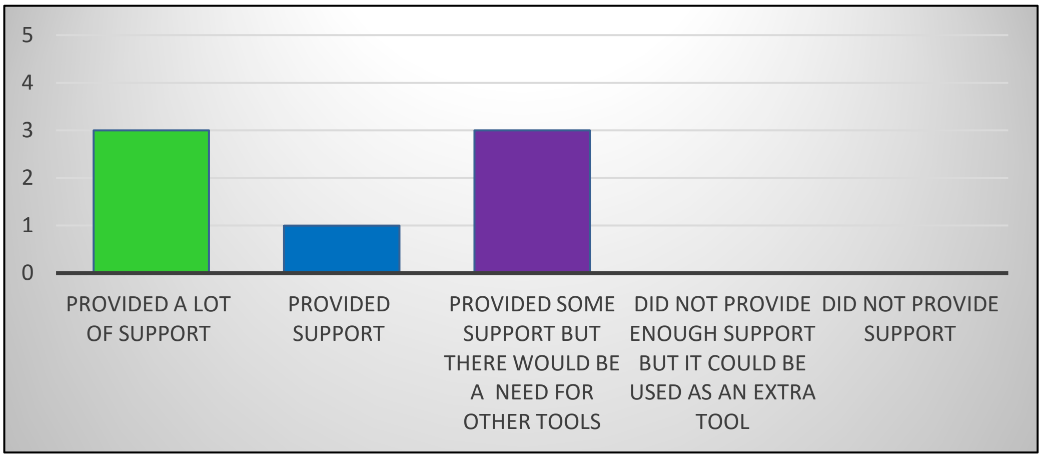


Figure 8.6 Framework Decision-Making process support

- **Comprehensiveness**

This criterion assesses if the framework covered all the factors that are crucial for the Cloud Computing Decision-Making process. The experts assessed the framework as comprehensive or fairly comprehensive. This result showed that the framework covered the most important factors that decision-makers should consider when making Cloud Computing decisions. In addition, the framework design allows healthcare organisations to add new factors or remove any factor based on their specific requirements. Figure 8.7 presents the experts' opinions regarding the comprehensiveness of the framework.

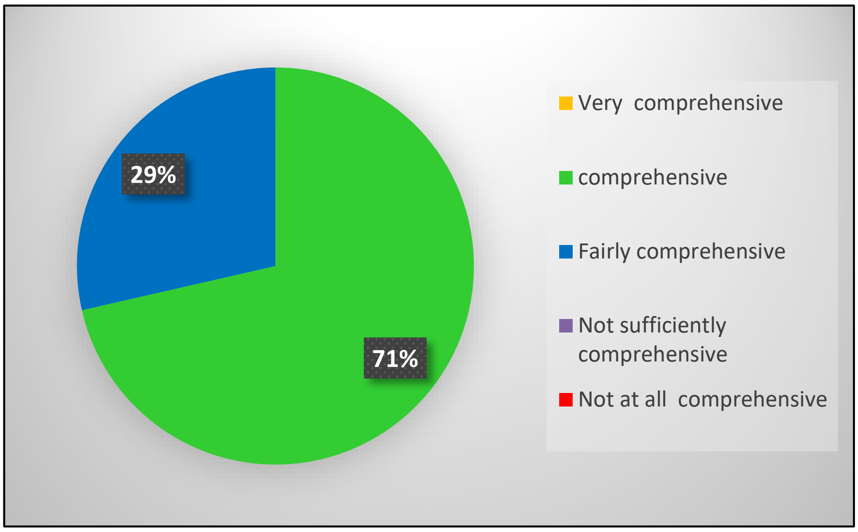


Figure 8.7 Comprehensiveness of the Framework

- **Required Time**

This item measures the cost in terms of time required to complete the framework. Most of the respondents concluded that, although the framework was efficient with regard to the time required to complete it, they faced some difficulties in terms of this aspect. A possible explanation may refer to the time needed to collect the required information from various sources. Figure 8.8 demonstrates the respondents' feedback about the time required to complete the framework.

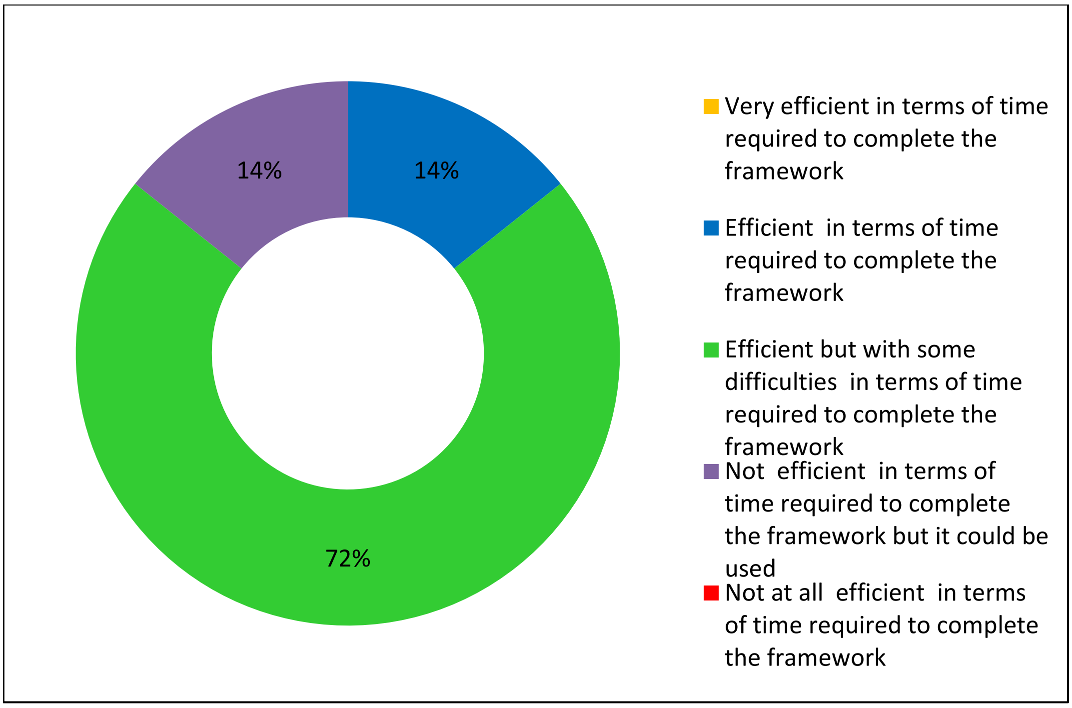


Figure 8.8 Time Required to complete the Framework

- **Intention to use**

This feature aims to measure how likely the experts would be to apply the HAF-CCS framework in their healthcare organisations. All the experts agreed that they do so. However, some asked for a few modifications to the framework so that it would be suitable for their needs. This finding shows the experts' level of acceptance of the framework and the possibility of applying the framework in healthcare organisations. Figure 8.9 shows the result for the experts' feedback on the intention to use the framework.

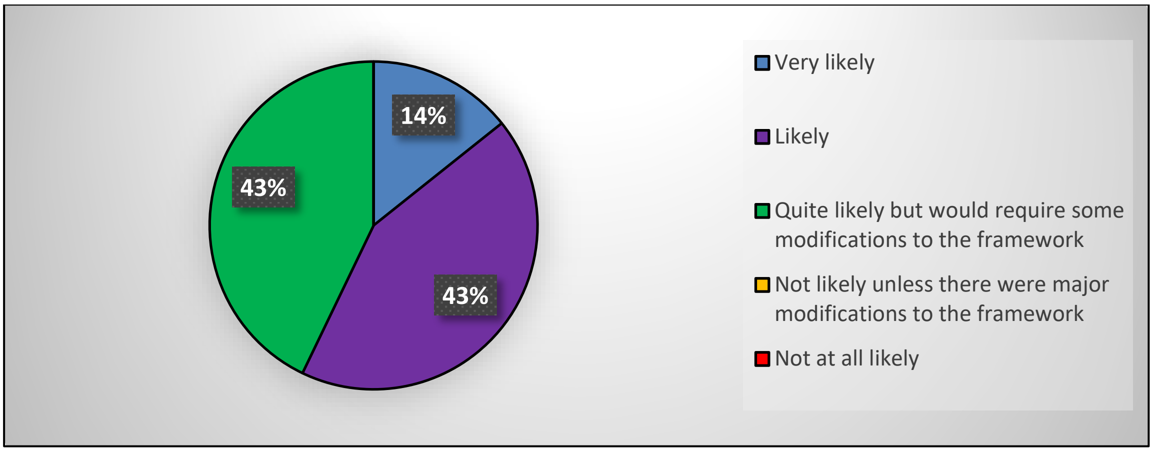


Figure 8.9 Intention to use the Framework

- **Overall results based on the case studies**

This section presents the analysis of the evaluation of the framework based on the individual case studies. Figure 8.10 shows the overall results based on the case studies. The results show that the experts in healthcare case 1 (Hospital A) considered the framework to be easy to use and comprehensive. However, they mentioned that it may take longer to complete than anticipated. At healthcare case 2 (Hospital B), the participants gave a better score for the usefulness and time required features. The experts at both healthcare organisations indicated that the HAF-CCS provides enough support for the Cloud Computing adoption process and that there is a high possibility that the framework would be adopted and used in their organisations. These results show that the framework is suitable for use in healthcare organisations.

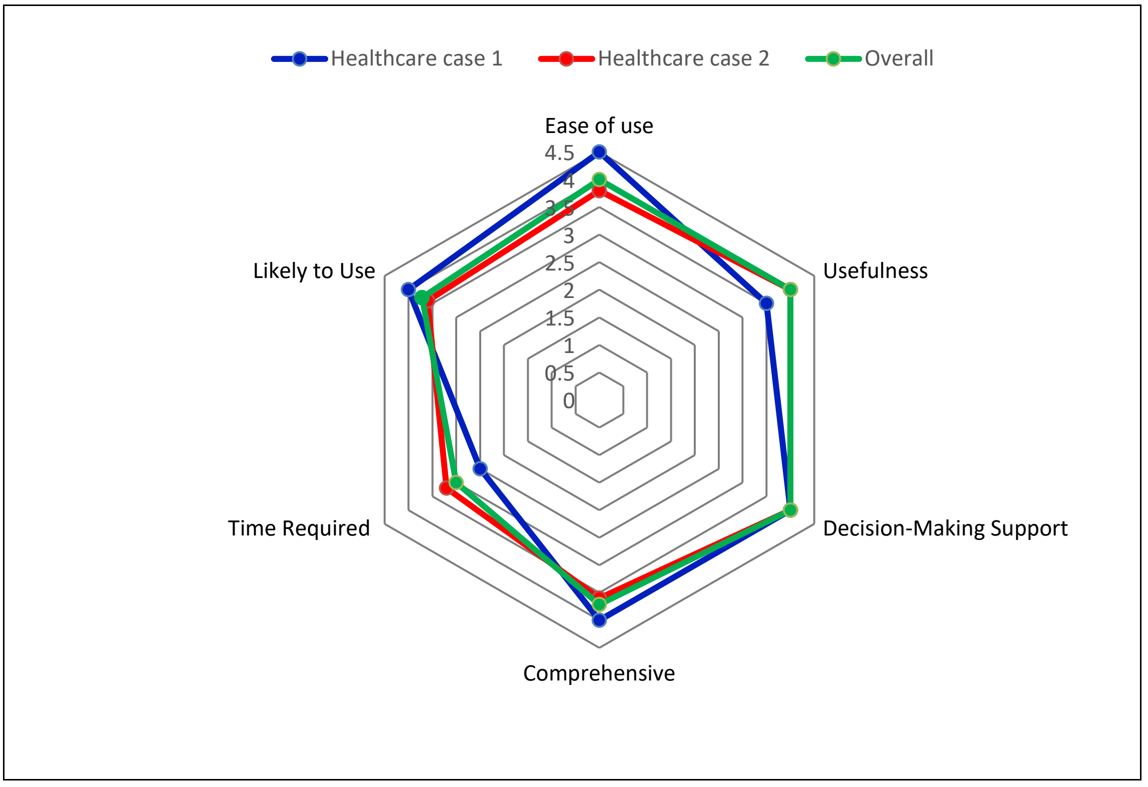


Figure 8.10 Overall results based on the Case Studies

- **Overall results based on the roles of the participants**

This section presents the analysis of the evaluation of the framework based on the roles of the participants. The results showed that healthcare professionals found some difficulties in using the framework, which may relate to the need to have some technical knowledge for some aspects of the framework. While both the healthcare professionals and the admin expert gave an average assessment for the usefulness of the framework, the IT professionals gave higher scores. Again, this result may demonstrate that more technical information is required to utilise the framework. The participants considered the framework to be comprehensive, which indicated that it covers most of the key factors for decision-makers. The project manager indicated that the framework can support the decision-making process required for Cloud Computing adoption, and the IT and healthcare professionals gave an average score for this feature. Time required to complete the framework received an average score from most of the experts, which indicated that sufficient time musts be allocated to collecting the required information in order to achieve more accurate results. Regarding the intention to use the framework, most of the participants showed an interest in utilising the framework in their healthcare organisations, with a high score from the project manager, which indicates that the framework is accepted by different roles within the healthcare organisations. Figure 8.11 demonstrates the evaluation results based on the roles of the participants inside the healthcare case studies.

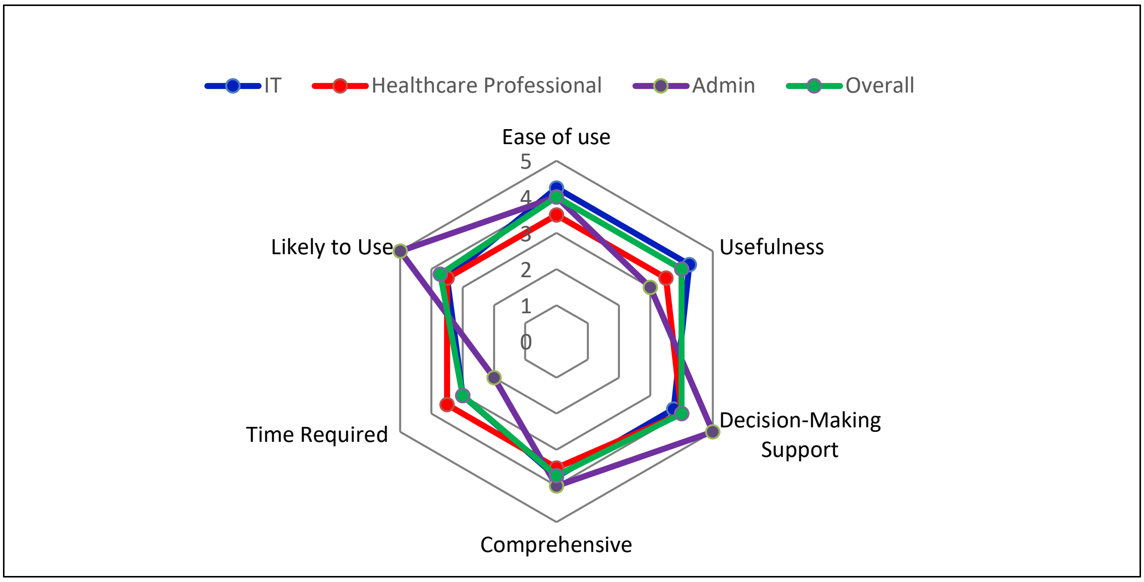


Figure 8.11 Overall results based on participants' roles

8.5 Recommendations

The evaluation process was implemented to allow a panel of experts to review whether the HAF-CCS framework is accurate and reliable when used by decision-makers. After considering the factors and the design of the framework, the experts made the following recommendations:

- One expert suggested that adding a Not Applicable (N/A) option will make the framework more flexible. The N/A option has been added in response to this comment.
- One expert suggested linking the framework to quality measurements of the healthcare organisation for the automated collation of quality and performance data for future Cloud Computing evaluation; this will be considered in future work.

8.6 Conclusion

The chapter has reviewed the HAF-CCS evaluation process based on specific criteria to test the acceptance of the framework. Seven experts working in healthcare organisations, with a minimum of at least five years' experience and who are involved in Cloud Computing adoption decision-making participated in the evaluation process. The researcher designed a booklet and form to be used in the evaluation process. The result of the evaluation was analysed from different perspectives (i.e. healthcare case study, the participants' roles, overall). The results showed that the framework is understood by the experts but requires some effort and that it is useful for implementation in healthcare organisations. The experts indicated that the framework is comprehensive and can support the process of decision-making for Cloud Computing adoption. They also suggested that, although the framework is efficient regarding the required time taken to complete it, it can be enhanced with regard to this feature. The outcome of the evaluation showed positive results regarding the experts' intention to use the framework in their healthcare organisations. The chapter ended by discussing the experts' recommendations. The following chapter will outline the conclusion of the thesis and future work.

9 Conclusions and Future Work

9.1 Introduction

This chapter provides an overview of the thesis by summarising the argument put forward in the thesis and presenting the findings of the empirical and literature studies. The research is evaluated against the aim and objectives described in Chapter one to demonstrate that the research has fulfilled them. The chapter highlights the contribution and implications of the research and links them to the research problem. It also discusses some limitations of the research and identifies areas for future work and further research.

9.2 Research Overview

Although Cloud Computing is an emerging technology, there is limited information in the literature concerning its application in the Saudi healthcare sector. This thesis studies Cloud Computing adoption in healthcare organisations, discusses the factors that can affect the adoption decision-making process and develops a framework to assist healthcare organisations in making decisions about Cloud Computing adoption. The next sections summarise the stages in the development of the thesis and show the mapping between the chapters and the outcomes of the research.

9.2.1 Research Summary

- **Chapter 1 (Introduction)**

This chapter offers an overview of the background and the motivation for the research and describes the context of the investigation. The chapter also includes a discussion of the research process; research methodologies are explained and the choice of research approach is justified. The contributions to knowledge are also explained and the ethical considerations of the thesis are discussed.

- **Chapter 2 (Cloud Computing)**

This chapter provides a comprehensive literature review of Cloud Computing. The chapter outlines various aspects of Cloud Computing such as the essential characteristics and the enabling technologies. It contains a critical review of the different deployment models of Cloud Computing (i.e. Public, Private, Hybrid and Community) and Cloud Computing service models (IaaS, SaaS and PaaS). The chapter also studies the main drivers and concerns in implementing

Cloud Computing and categorises them. The chapter also includes an analysis of the current frameworks and models of Cloud Computing adoption decision-making. The relationship between Cloud Computing and other topics such as SOA and outsourcing are also discussed. The findings of the chapter indicate that there is still a need for a comprehensive framework to assess the adoption of Cloud Computing particularly in economically developing countries such as Saudi Arabia. The literature indicates that Cloud Computing adoption needs to be tailored for different countries and industries based on their individual domains.

- **Chapter 3 (From E-health to E-health Cloud)**

This chapter discusses electronic health and examines the use of Cloud Computing in this domain, with a special focus on Saudi Arabia. The chapter demonstrates the need to implement e-health solutions by analysing the challenges that are faced by traditional healthcare systems such as the shortage of healthcare professionals, the increase in chronic diseases, the increased cost of delivering healthcare services, etc. Then, the chapter critically reviews the role of e-health in providing better healthcare services by outlining the benefits and the challenges of such solutions. The discussion confirms the need to implement the Cloud Computing model in healthcare organisations. The opportunities and challenges of Cloud Computing in the healthcare domain are presented. E-health projects are discussed in a Saudi context together with Cloud Computing solutions. The findings of the chapter are that Cloud Computing implementation in Saudi healthcare organisations requires further investigation. It also indicates that there is a need to develop a comprehensive strategic framework to assist healthcare organisations in Cloud Computing adoption.

- **Chapter 4 (The development of an Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS))**

This chapter discusses the development process of the Holistic Approach Framework for Cloud Computing Strategic Decision-Making in the Healthcare Sector (HAF-CCS). The theoretical frameworks underpinning the development of the HAF-CCS are discussed and three well-documented theoretical frameworks –TOE, IS strategy triangle and HOT-fit – are combined to provide an holistic view of the new framework. HAF-CCS was developed to cover five perspectives of healthcare organisations: Business, Technology, Organisation, Environment and Human. These perspectives and their sub-factors are discussed based on the literature for the domains of Cloud Computing and e-health in Saudi Arabia. The new HAF-CCS framework considers the different factors for Cloud Computing adoption decision-making and provides a comprehensive view. The chapter links the new framework with the Cloud Computing adoption life cycle to show the role of the framework in Cloud Computing adoption decision-making.

- **Chapter 5 (Understanding the Determinants of Cloud Computing Adoption in Saudi Healthcare Organisations)**

This chapter discusses the first phase of the primary research which was carried out to understand the factors affecting Cloud Computing adoption in healthcare organisations in Saudi Arabia by using a questionnaire. Two hundred and one respondents from various backgrounds and roles in Saudi healthcare organisations were included in the study. Several statistical tests were conducted such as Cronbach's alpha, Confirmatory Factor Analysis, KMO test and ANOVA test to ensure the validity and reliability of the questionnaire and to find useful information from the results. The analysis of the study shows that Saudi healthcare organisations considered the Business context of Cloud Computing adoption first, then the Technology factors, followed by the Organisation, Environment and Human contexts. All the factors except one (complexity) which have been included in the HAF-CCS were found to have some influence on the Cloud Computing adoption decision-making process in Saudi healthcare organisations.

- **Chapter 6 (Decision-Makers' views of factors affecting Cloud Computing Adoption in Saudi Healthcare Organisations)**

This chapter presents the second phase of the primary research by providing an in-depth understanding of the Cloud Computing adoption decision-making process in healthcare organisations in Saudi Arabia. The semi-structured interview method was selected to gain information about Cloud Computing decision-making from seven senior decision-makers in Saudi healthcare organisations. The findings from this investigation enrich the HAF-CCS framework and present aspects related to the adoption of Cloud Computing from the decision-makers' point of view. The findings of the interviews support the findings from the literature and the first phase of the primary research, and indicate that the HAF-CCS includes the main factors affecting Cloud Computing adoption in Saudi healthcare organisations. The results of the investigation show that the HAF-CCS factors that determine Cloud Computing adoption in Saudi healthcare organisations are relative advantage, technology readiness, compatibility, security, decision-makers' innovativeness, internal expertise, previous experience, hard financial analysis, soft financial analysis, regulation compliance, business ecosystem partner pressure, external expertise, top management support and attitude towards change.

- **Chapter 7 (Validating the Framework using two Healthcare Case Studies)**

This chapter describes the validation of the HAF-CCS at two Saudi healthcare organisations. The validation was achieved by conducting two workshops with experienced decision-makers from Saudi healthcare organisations. During the workshops, the HAF-CCS was used to evaluate and measure the readiness of the five contexts and the sub-factors of each context at the two healthcare organisations. The chapter also describes the implementation of the BSC to measure the proposed Cloud Computing solution in one of the case studies. The analysis and discussion of the validation process showed that the HAF-CCS can be applied in a real-world context and that the framework can be used to support Cloud Computing decision-making.

- **Chapter 8 (Evaluation of the HAF-CCS Framework)**

This chapter presents the HAF-CCS evaluation process to test the framework based on criteria developed from the TAM model and other criteria. Specific evaluation forms and a booklet were designed to be used in the evaluation process. Seven experts who are involved in Cloud Computing adoption and have relevant experience in healthcare organisations took part in the evaluation process. The results show that the framework is easy to use, useful and provides an holistic view for Cloud Computing decision-making support. The evaluation results indicate that the HAF-CCS supports Cloud Computing adoption and can be implemented by decision-makers in Saudi healthcare organisations.

9.2.2 Fulfilling the Aim and Objectives

The aim and the objectives of this research have been achieved through the different chapters and sections of the thesis. The research findings have contributed to six conference papers and two journal publications. Table 9.1 shows the correlation between the thesis chapters, publications and the objectives and the methods of investigation applied to accomplish them.

Table 9.1 Correlation between the thesis chapters and the objectives and the methods of investigation

Objective	Method of Investigation	Chapter	Included in Publications
To conduct a comprehensive literature review on current Cloud Computing technologies, trends and decision-making strategies and frameworks for Cloud Computing in different sectors.	Academic papers and industrial reports were reviewed to obtain a comprehensive understanding of current Cloud Computing trends and frameworks.	Ch. 2	√
To critically review the existing Cloud Computing applications and the use of Cloud Computing in the healthcare sector.	A literature review about the use of Cloud Computing in healthcare organisations was carried out.	Ch. 3	√
To identify factors that affect the adoption of Cloud Computing in the healthcare domain from multiple perspectives.	Academic papers and reports from various organisations were investigated to identify the factors.	Ch. 3, Ch. 4	√
To understand the determinants of Cloud Computing adoption in Saudi healthcare organisations using quantitative methods.	A survey with 201 participants was conducted to identify the factors affecting Cloud Computing adoption in Saudi healthcare organisations.	Ch. 5	√
To investigate Cloud Computing adoption decision-making in Saudi healthcare organisations using qualitative methods.	Interviews with decision-makers in Saudi healthcare organisations were carried out to understand the Cloud Computing adoption decision-making process in Saudi healthcare organisations.	Ch. 6	√
To develop a strategic framework for Cloud Computing decision-making particularly in health sector applications in Saudi Arabia.	The HAF-CCS was developed based on the three stages, which are: from secondary literature, from the questionnaire results and the final version, which also includes the results from the qualitative investigation.	Ch. 4, Ch. 5, Ch. 6	√
To validate the developed framework using healthcare case studies from Saudi Arabia.	Two workshops were conducted with informative decision-makers to validate the framework.	Ch. 7	√
To evaluate the developed framework from the user's perspective using a panel of experts.	Seven experts from Saudi healthcare organisations evaluated the framework based on specific criteria.	Ch. 8	
To evaluate the research and the research process as a whole.	The findings of the research are summarised and discussed and the future work is identified.	Ch. 9	√

9.3 Research Contribution and Implications

The thesis contributes to the body of knowledge on the adoption of Cloud Computing in many aspects, as follows:

- The initial literature review showed that there is limited empirical research about the factors that have an impact on the adoption of Cloud Computing in the Saudi healthcare context. Thus, the first contribution of this research is to study the factors that will affect Cloud Computing adoption in Saudi healthcare organisations. To the best of our knowledge, this study is among the first exploratory studies to address the Cloud Computing adoption decision-making process in healthcare organisations in Saudi Arabia.
- This research adopts an holistic view to build a framework that covers multiple perspectives so, in addition to the Technology perspective, it includes Human, Business, Organisation and Environment factors. The research combines different theoretical frameworks to provide an holistic assessment of the determinants of Cloud Computing adoption in Saudi healthcare organisations. The HAF-CCS framework was assessed and validated through the thesis and it has been shown that it is able to support the Cloud Computing decision-making process in Saudi healthcare organisations.
- The thesis helps to bridge the gap between theoretical knowledge and practice by developing a software tool to help healthcare organisations in assessing various perspectives in readiness for Cloud Computing adoption.
- For practitioners, this study presents several key findings that can support Cloud Computing adoption in healthcare organisations. The decision concerning the adoption of Cloud Computing in Saudi healthcare organisations is mainly a business decision not a technology decision. This can be demonstrated by the finding that business factors are among the most important factors that affect the decision regarding Cloud Computing adoption. The findings of this study indicate that significant differences exist in relative advantage, compatibility, attitude towards change, top manager support, decision-makers' innovativeness, internal expertise and prior technology experience across different adopting groups. Thus, this research highlights the importance of human and organisational attributes in an organisation's intention to adopt Cloud Computing.

- The thesis contributes to the body of knowledge by providing a comprehensive literature review about various aspects of Cloud Computing. The thesis critically reviewed a number of Cloud Computing adoption models, service model, the benefits of Cloud Computing and the issues of cloud implementation. It also includes literature about the use of Cloud Computing in healthcare organisations with a special focus on Saudi contexts.

9.4 Research Limitations

This thesis extends knowledge about Cloud Computing adoption in Saudi healthcare organisations. However, although the thesis has fulfilled its aim and objectives, it still has some limitations. The framework was developed for use in a Saudi Arabian context, but is based on a theoretical foundation which would allow the framework to be adapted for use in other contexts and environments. The factors used in the framework in healthcare applications could be adapted to include factors specific to different countries such as other Gulf States, etc. Although the researcher made rigorous attempts to eliminate bias through careful design and administration of the survey and the triangulation of the research findings (i.e. by conducting interviews with seven decision makers at Saudi healthcare organisations), bias cannot be entirely avoided. So, a possible limitation of the study is the limited bias by having more participants from healthcare professional background due to the nature of decision makers in Saudi healthcare organisations. The sample size of the study was 201 which was above the required sample size which suggested by statisticians (i.e. 100) (Williams et al., 2012). Another limitation of the study is that, as Cloud Computing-specific regulations are not available in Saudi Arabia, Cloud Computing adoption was assessed based on general IT regulations in the country. Although, this is something outside the researcher’s control, the development of Cloud Computing-specific regulations may require healthcare organisations to reassess this factor and other related factors such as the external expertise factor. Although the research validation includes two case studies at two different cities in Saudi Arabia, it would be useful to include an additional case study in another region of Saudi Arabia to cover more geographical areas.

9.5 Further Work and Recommendations

The overview of the research, the discussions, the findings and the limitations of the thesis suggest a number of areas for future work, as follows:

- **New Business Models for Healthcare Organisations**

The implementation of Cloud Computing in healthcare organisations may lead to changes in the healthcare business model. Current healthcare systems as discussed in the thesis (Chapter 3 Section 3.5.1) are doctor-centred or hospital-centred models. Cloud Computing can support the movement towards a new, patient-centric, business model. Future work will include an investigation into how Cloud Computing can support healthcare organisations to move towards new business models such as a patient-centric model. The findings of the thesis also indicated that the IT departments of healthcare organisations are currently working under a cost-centric model. Further work is required to identify how Cloud Computing can change this model to a profit-centric one, and to identify whether this model is the most appropriate one for healthcare organisations.

- **Web Portal**

One of the contribution of the thesis is a software tool which can support Cloud Computing decision-making. Further work will be to upgrade the tool to develop it into a web application for the automated collation of quality and performance data for future Cloud Computing evaluation and contract negotiation, as shown in Figure 9.1. The proposed tool could support decision-making by measuring the performance of Cloud Computing solutions. The proposed tool could expand the tasks to include skills assessment tools and change management activities which can support Cloud Computing adoption inside healthcare organisations. The new tool could also act as a monitoring tool which can evaluate the vendor performance and measure SLA activities to report any SLA violation.

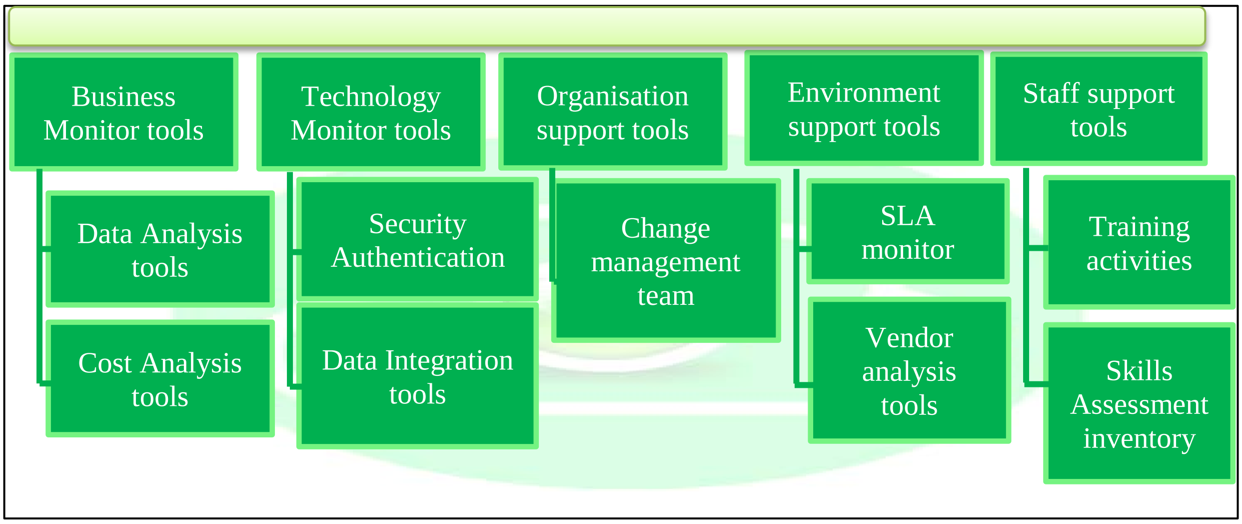


Figure 9.1 Web Portal Map

- **Saudi National E-health Cloud System (SNECS)**

The researcher proposes that a Saudi National E-health Cloud System (SNECS) be applied at a national level in the country, as shown in Figure 9.2. The proposed system consists of four main parts: the cloud environment, the stakeholders, the technologies and the applications. The HAF-CCS can be used to evaluate healthcare organisations that are planning to join the SNECS.

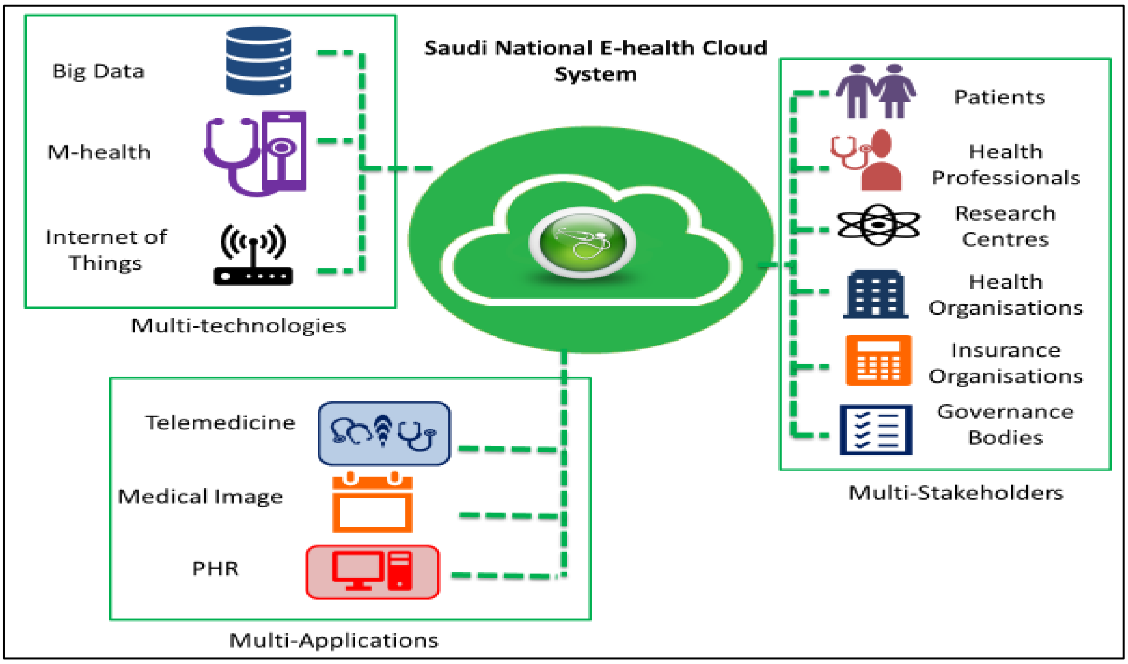


Figure 9.2 Proposed Saudi National E-health Cloud System (SNECS)

The cloud environment is the basic component of this system. The proposed system will provide the main cloud services, which are SaaS and PaaS, but not IaaS. New services can be added such as Data as a Service. Different stakeholders will be involved in this system. Stakeholders that have been chosen for this system are those who can affect or be affected by it. Patients are one of the main stakeholders of the system since they will use the system and their data is the basic component of it. Patients will be connected to their healthcare organisations not to the system directly. The movement towards a patient-centric model requires patients to manage and control their personal health data through their Personal Health Record (PHR). Cloud Computing technologies provide patients with many solutions for managing their PHR. Many governments have elected that healthcare organisations should give patients access to their medical records. The proposed system will help in this movement by making the information available to all patients anywhere at any time via any device. The proposed system will use some of the technologies such as IoT, M-health and Big Data, and these advanced technologies may help in the improvement of Saudi healthcare services.

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Appendix A

The Questionnaire

- Cover letter

1. Data collected from this study is solely for the purpose of studying factors affecting Cloud Computing adoption in Saudi Health organisations. The collected data will be used for research purposes only.

2. Data collection is collected in an anonymous and confidential manner. No personal details are required and hence individuals will be non-identifiable. An email address is required only if you wish to be informed about the findings of this study.

3. Participation in this research study is completely voluntary. You have the right to withdraw from participation at any time. There is no need to state a reason for withdrawal.

4. Staffordshire University code of ethics will be followed during all the phases of this research.

5. By selecting 'Next' button, you acknowledge that you have read the consent form and are willing to participate in this study.

6. Cloud Computing is defined as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". NIST definition

Thank you for your cooperation
Please if you need to know more about this research contact the researcher on:

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Mr. Fawaz Alharbi
PhD Researcher at School of Computing- Staffordshire University- UK
Lecturer at Shaqra University- Saudi Arabia

Appendix

Demographic Questions

1. Please indicate your role in your organisation:	Please tick one answer: ☐ Administrative ☐ IT specialist ☐ Health professional
2. Please indicate the type of your organisation:	Please tick one answer: □ One of the Ministry of Health organisations □ Another governmental health organisation (e.g. NGHA, Military Hospitals, etc.) (please specify) (please specify) □ Private healthcare organisation □ Other (please specify)
3. In which region of Saudi Arabia do you mainly work?	Please tick one answer: □ Central Province □ Western Province □ Eastern Province □ Southern Province □ Northern Province
4. What is the size of your organization?	Please tick one answer: □ Less than 50 employees. □ 50 to 500 employees. □ More than 500 employees. □ I do not know.
5. How long have you been working in healthcare?	Please tick one answer: □Less than 2 years □Between 2 and 5 years □Between 5 and 10 years □ More than 10 years

Cloud Computing Adoption

6. What is your organisation's plan for Cloud Computing adoption?	Please tick one answer: □ We have already adopted some Cloud Computing services. □ We intend to adopt Cloud Computing services in the next 2 years. □We do not intend to adopt any Cloud Computing services for the foreseeable future. □I do not know
7. Which IT Services/Applications do you consider are most likely to be moved to a Cloud Computing service provider in healthcare organisations in general? please tick all that apply	Please tick all applicable: □Payroll □Human Resources □Procurements □Accounting and Finance □Application development on the cloud □Electronic Health Record (EHR) □ Radiology Information System □ Laboratory Information System □ Pharmacy Management System □ Picture Archiving and Communication system (PACS) □ Computerised Physician Order Entry system (CPOE) □Other (please specify)

	☐I do not know

Technology Context

	Please rate your level of agreement with the following statements:				
	1	2	3	4	5
	Strongly Disagree	Generally Disagree	Neutral	Generally Agree	Strongly Agree
8. Cloud Computing will allow my organisation to accomplish specific tasks more quickly.	☐	☐	☐	☐	☐
9. The use of Cloud Computing will provide real benefits for the patients.	☐	☐	☐	☐	☐
10. Cloud Computing will increase the productivity of organisation's staff.	☐	☐	☐	☐	☐
11. My organisation has provided Internet access to all its members.	☐	☐	☐	☐	☐
12. The IT infrastructure of my organisation can support the adoption of Cloud Computing.	☐	☐	☐	☐	☐
13. My organisation makes good use of IT to achieve its goals.	☐	☐	☐	☐	☐
14. Cloud Computing services will be compatible with the current business strategy of my organisation.	☐	☐	☐	☐	☐
15. Cloud Computing technology is compatible with the current IT infrastructure (Hardware/ Software) of my organisation.	☐	☐	☐	☐	☐
16. Cloud Computing is compatible with the healthcare values and goals.	☐	☐	☐	☐	☐
17. Integrating Cloud Computing with current IT systems in my organisation will be easy.	☐	☐	☐	☐	☐
18. Developing and maintaining Cloud Computing requires a lot of specialist resources (i.e. workforce).	☐	☐	☐	☐	☐
19. Cloud Computing will allow my organisation to accomplish specific tasks more quickly.	☐	☐	☐	☐	☐

Human Context

	Please rate your level of agreement with the following statements:				
	1	2	3	4	5
	Strongly Disagree	Generally Disagree	Neutral	Generally Agree	Strongly Agree
20. My organisation usually tries to use the latest technologies.	☐	☐	☐	☐	☐
21. My organisation is open to experimenting with the latest technologies.	☐	☐	☐	☐	☐
22. My organisation has enough human resources with necessary skills to adopt Cloud Computing services.	☐	☐	☐	☐	☐
23. IT staff in my organisation will find it easy to learn about Cloud Computing applications and platforms.	☐	☐	☐	☐	☐
24. IT staff in my organisation are familiar with Cloud Computing services.	☐	☐	☐	☐	☐
25. IT staff in my organisation have previous experience in Information System/Information Technology project development.	☐	☐	☐	☐	☐

Organisation Context

	Please rate your level of agreement with the following statements:				
	1	2	3	4	5
	Strongly Disagree	Generally Disagree	Neutral	Generally Agree	Strongly Agree
26. The organisation's top management involves itself in the process when it comes to IS/IT projects.	☐	☐	☐	☐	☐
27. The organisation's top management supports the adoption of Cloud Computing.	☐	☐	☐	☐	☐
28. The implementation of Cloud Computing will be accepted by IT staff in my organisation.	☐	☐	☐	☐	☐

29. The implementation of Cloud Computing will be accepted by healthcare professionals in my organisation.	☐	☐	☐	☐	☐

Environment Context

	Please rate your level of agreement with the following statements:				
	1	2	3	4	5
	Strongly Disagree	Generally Disagree	Neutral	Generally Agree	Strongly Agree
30. Government regulations in Saudi Arabia are sufficient to protect the users from risks associated with Cloud Computing.	☐	☐	☐	☐	☐
31. There are Saudi laws regarding ownership and responsibility for patient data.	☐	☐	☐	☐	☐
32. The use of Cloud Computing allows sensitive data to be protected from unauthorized people.	☐	☐	☐	☐	☐
33. Cloud Computing is recommended by the government of Saudi Arabia	☐	☐	☐	☐	☐
34. In Saudi Arabia, Many healthcare organisations are currently adopting Cloud Computing.	☐	☐	☐	☐	☐
35. Using Cloud Computing will allow my organisation to easily switch its IT providers.	☐	☐	☐	☐	☐
36. In Saudi Arabia, there are many IT providers with experience in healthcare systems.	☐	☐	☐	☐	☐
37. In Saudi Arabia, there are many IT providers with good credibility and reputation.	☐	☐	☐	☐	☐

Business Context

	Please rate your level of agreement with the following statements:				
	1	2	3	4	5
	Strongly Disagree	Generally Disagree	Neutral	Generally Agree	Strongly Agree
38. Cloud Computing can reduce the operating cost of Information technology in the healthcare organisations.	☐	☐	☐	☐	☐
39. My organisation has sufficient financial resources to use cloud computing technology.	☐	☐	☐	☐	☐
40. The use of Cloud Computing will provide new opportunities for the organisation.	☐	☐	☐	☐	☐
41. The use of Cloud Computing will allow the organisation to provide services that could not be provided before.	☐	☐	☐	☐	☐
42. The adoption of Cloud Computing will affect business processes in my organisation positively.	☐	☐	☐	☐	☐
43. Cloud Computing will affect medical services in my organisation positively.	☐	☐	☐	☐	☐

44. Please feel free to add any comments.	

Appendix B

ANOVA Test

- Business Context

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * SA	Between Groups	(Combined)	6.171	10	0.617	0.444	0.923
	Within Groups		263.869	190	1.389		
	Total		270.040	200			

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * HA	Between Groups	(Combined)	5.996	10	0.600	0.431	0.930
	Within Groups		264.043	190	1.390		
	Total		270.040	200			

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * Business	Between Groups	(Combined)	25.501	25	1.020	0.730	0.822
	Within Groups		244.539	175	1.397		
	Total		270.040	200			

- Technology Context

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * RA	Between Groups	(Combined)	28.475	10	2.847	2.240	0.017
	Within Groups		241.565	190	1.271		
	Total		270.040	200			

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * CO	Between Groups	(Combined)	39.540	12	3.295	2.687	0.002
	Within Groups		230.500	188	1.226		
	Total		270.040	200			

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud	Between Groups	(Combined)	24.619	12	2.052	1.572	0.103
	Within Groups		245.421	188	1.305		

			Sum of Squares	df	Mean Square	F	Sig.
Computing adoption? * TR	Total		270.040	200			

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * Technology	Between Groups	(Combined)	76.445	40	1.911	1.579	0.025
	Within Groups		193.595	160	1.210		
	Total		270.040	200			

- Organisation Context

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * CR	Between Groups	(Combined)	26.008	8	3.251	2.558	0.011
	Within Groups		244.031	192	1.271		
	Total		270.040	200			
ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * TS	Between Groups	(Combined)	27.520	8	3.440	2.723	0.007
	Within Groups		242.520	192	1.263		
	Total		270.040	200			
ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * Organisation	Between Groups	(Combined)	38.189	16	2.387	1.894	0.023
	Within Groups		231.850	184	1.260		
	Total		270.040	200			

- Environment Context

ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * EE	Between Groups	(Combined)	4.237	8	0.530	0.383	0.929
	Within Groups		265.803	192	1.384		
	Total		270.040	200			
ANOVA Table							
			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan	Between Groups	(Combined)	20.911	12	1.743	1.315	0.213

for Cloud Computing adoption? * RC	Within Groups		249.129	188	1.325		
	Total		270.040	200			

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * TP	Between Groups	(Combined)	20.172	10	2.017	1.534	0.130
	Within Groups		249.867	190	1.315		
	Total		270.040	200			

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * Environment	Between Groups	(Combined)	72.810	62	1.174	0.822	0.807
	Within Groups		197.230	138	1.429		
	Total		270.040	200			

- Human Context

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * IE	Between Groups	(Combined)	30.186	8	3.773	3.020	0.003
	Within Groups		239.854	192	1.249		
	Total		270.040	200			

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * CI	Between Groups	(Combined)	21.718	8	2.715	2.099	0.038
	Within Groups		248.321	192	1.293		
	Total		270.040	200			

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * PE	Between Groups	(Combined)	16.481	8	2.060	1.560	0.015
	Within Groups		253.559	192	1.321		
	Total		270.040	200			

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
What is your organisation's plan for Cloud Computing adoption? * Human	Between Groups	(Combined)	41.537	22	1.888	1.471	0.089
	Within Groups		228.503	178	1.284		
	Total		270.040	200			

Appendix C

Semi Structured Interview

- Consent Form

STAFFORDSHIRE UNIVERSITY

Participant Identification Number:

CONSENT FORM

Project title:

Name of Researcher:

Please initial box

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐

3. I understand that any information given by me may be used in future reports, articles or presentations by the research team. ☐

4. I understand that my name will not appear in any reports, articles or presentations. ☐

4. I understand that Staffordshire University code of ethics will be followed during all the phases of this research. ☐

5. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Researcher	Date	Signature

Appendix

- Interview Document

Coded name	Interviewee Position	Interview date	Interview time	duration

General Information:

1. In your organisation are you:	
2. What are the main challenges / benefits of running your IT operations on-premises?	
3. What is the hospital policy with regard to the purchasing, adoption and implementation of IT applications?	

Cloud Computing Adoption:

4. What is your organisation's intention toward cloud computing adoption?	
5. Are using any Cloud Computing applications in your daily life? If so, what are they?	

Open questions:

6. What are the advantages of using Cloud Computing in healthcare organisations?	
7. What are the disadvantages of using Cloud Computing in healthcare organisations?	

Technical Context:

8. What technological factors do you think may impact the adoption of cloud computing in your organisation? Why?	
9. In your opinion, what solutions can overcome other technological barriers to the adoption of Cloud Computing in healthcare organisations?	

Organisational Context:

10. What organisational factors do you think may impact the adoption of cloud computing in your organisation? Why?	

11. In your opinion, what solutions can overcome organisational barriers to the adoption of Cloud Computing in healthcare organisations?	

Environmental Context:

What environmental factors do you think may impact the adoption of cloud computing in your organisation? Why?	
12. In your opinion, what solutions can overcome environmental barriers to the adoption of Cloud Computing in healthcare organisations?	

Human Context:

13. What human factors do you think may impact the adoption of cloud computing in your organisation? Why?	
14. In your opinion, what solutions can overcome human barriers to the adoption of Cloud Computing in healthcare organisations?	

Business Context:

15. What business factors do you think may impact the adoption of cloud computing in your organisation? Why?	
16. In your opinion, what solutions can overcome business barriers to the adoption of Cloud Computing in healthcare organisations?	