

# Strategic Framework for Cloud Computing Decision-Making in Healthcare Sector in Saudi Arabia

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**Abstract**—This paper outlines some of the challenging issues faced by traditional healthcare services in Saudi Arabia (SA) covering a relatively large geographical area including remote areas requiring healthcare facilities similar to urban areas. There are also issues of shortages of healthcare professionals together with an increase of chronic diseases, such as diabetes, hypertension, heart diseases etc. Many initiatives have been undertaken to reform healthcare systems including e-Health and the concept of Cloud Computing. This paper discusses some of the issues for e-health projects and how Cloud Computing will help in solving some of these issues. Then, the paper proposes a strategic framework for Cloud Computing decision making processes based on a Holistic Approach Framework for use in Saudi Arabia to assist in improvements for stakeholders involved in healthcare services.

**Keywords:** *Cloud Computing; e-health; Strategic framework; Saudi Arabia.*

## I. INTRODUCTION

Improving the healthcare system is one of the main priorities for many governments and organisations and the traditional healthcare system is facing many issues.

The increase of life expectancy is an issue for the traditional healthcare system for instance life expectancy in Canada is 82 years, 75 years in SA, 80 years in the UK and in the USA 79 years [1]. Geography is another obstacle for the development of the healthcare system for many nations for example Canada covers an area of 10 million km<sup>2</sup> with a population of approximately 30 million and in comparison SA has 2.2 million km<sup>2</sup> and a population of 27 million both countries having remote sparsely populated areas [2]. Providing healthcare for all citizens with the same quality particularly in rural areas such as in SA results in challenging issues for traditional healthcare organisations [3]. The shortage of healthcare professionals, such as physicians, nurses and pharmacists together with the increase of chronic diseases, such as diabetes, hypertension, and heart diseases, and childhood obesity contribute to the issues for healthcare systems [2] and these factors contribute the higher operational cost of health services provision in SA. Total expenditure on health in SA has been increased from 5.5% in 2008 to 6.8% in 2012 of the national budget [4].

Many initiatives have been implemented to deal with these challenges and to find ways to reform the healthcare systems for examples privatisation of healthcare services and the movement toward preventive healthcare. Another initiative is the use of information and communication technology (ICT) in health organisations to deliver healthcare more efficiently and effectively. This movement towards applying ICT in healthcare systems is subsumed by the term e-health. Eysenbach [5] 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 characterizes 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 preferable because it takes e-health beyond the technology aspect [6]. 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 mobile phones and Cloud Computing can fit well in this definition.

E-health encompasses many applications, systems and services. Each system has different functions and different stakeholders’ perspectives. E-health or Health Information technology (HIT) provides many benefits for health organisations and patients. It eases the information sharing for patients, physicians and other clinicians [7]. The adoption of HIT in hospitals improves health care quality and safety [8]. E-health also reduces human errors in medical procedures [7]. Many e-health applications have been used as a medium for education and behaviour change for patients and physicians [8].

Current e-health practices face many challenges from development to implementation. The challenges of e-health projects can be categorized into six general categories (Economic, Technical, Organizational, Behavioural and Environmental and Legal) [9]–[11]. One of the main issues facing e-health is the need to change the traditional business model of healthcare system. Current healthcare systems are

doctor-centred, reactive and focused on disease. This should be changed to patient-centred, proactive and preventive and focused on quality of life and well-being [6]. The higher cost of implementing HIT projects is considered another critical barrier for e-health. The cost of IT systems in healthcare services is very expensive due to the higher cost in terms of capital expenditure (CAPEX) and operational expenditure (OPEX). Maintenance, supporting and updating ICT projects in health organisations are challenging and require further funding and support. Another obstacle that faces some e-health projects is the need for skill enhancement in the development, management and maintenance of ICT projects in healthcare organisations [12]. Additionally, change will be required in work procedures and routines for the healthcare providers. This change will affect the healthcare services and the related administrative processes [9]. However, this issue has been overlooked by researchers [11]. Support from top management is vital for widespread adoption of e-health. This support can be hindered because of the high cost and other risks that allocated with HIT projects [11].

To overcome e-health issues and problems, many healthcare organisations are moving towards new business models and leveraging technologies. One of the new computing models is Cloud Computing.

The aim of this paper is to develop a strategic framework for Cloud Computing decision making processes based on Holistic Approach Framework. This paper is organised as follows. Section II describes current E-health implementation in Saudi Arabia. Section III presents the concept of Cloud Computing and why it useful in the domain of e-health. Section IV discusses the related works. In section V, the proposed framework will be presented. Section VI concludes the paper.

## II. E-HEALTH IN SAUDI ARABIA:

The Saudi government has noticed 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 [13]. The adoption of HIT in Saudi healthcare organisations is still low for many reasons [14]. Khudair [15] discussed the implementation of ICT in healthcare organisations from physicians' perspective. The researcher expounded the reasons as poor leadership, the weakness of the information system infrastructure and technical support and the absence of implementation strategy. Khalifa [14] found that factors related to human dimensions such as shortage of health informatics specialists, lack of experience of computer applications and lack of experience and knowledge of using EMRs (Electronic Medical Records) are the main barriers that hinder successful implementation of EMRs. The paper also stated that financial barriers such as high initial cost of EMRs implementation and high operation and maintenance costs of EMRs are the second category of barriers that challenge EMR use in Saudi hospitals. Alkrajji, Jackson and Murray [16] studied the barriers to the adoption

of health data standards in SA. They found other barriers in addition to the barriers mentioned in [14]. Issues related to technology context such as complexity, compatibility and insufficient IT infrastructure could delay the adoption of health data standards. Hasanain and Cooper [17] found social barriers such as language and resistance to the use of new systems affected EMR implementation in Saudi hospitals. They also mentioned some technical 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 SA is still facing difficulties. 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 [17]. Despite these barriers, Healthcare providers in Saudi Arabia have demonstrated a willingness to implement and improve e-health services. This creates a foundation for the use of new technologies and models that may move them forward such as the adoption of Cloud Computing.

## III. MIGRATION OF E-HEALTH TO CLOUD E-HEALTH:

### A. The concept of Cloud Computing:

The continuous revolution and evolution of ICT has affected the way that organisations conduct their business. The ICT industry has moved through many stages, starting from mainframe computing to Cloud Computing. Cloud Computing is a new computing paradigm that has changed the way of delivering IT services [18].

Although there is no generally accepted definition of Cloud Computing [19] [20], most of the definitions emphasise some aspects. First of all, Cloud Computing is a model of delivering IT services and resources not new technology. Secondly, the provisioning of resources is automatic and with a minimum of human interaction. Thirdly, the access to the large pool resources is over a network. Fourthly, IT services and resources are available on demand with dynamic scalability and elasticity. The provisioning of IT resources should be independent of device and location (i.e., ubiquity). Finally, the use of IT resources must be built on a clear business model and clear measurement methods. Figure 1 provides a Cloud Computing definition schema based on National Institute of Standards and Technology's (NIST) definition [21].

In literature, researchers have recognised many benefits and advantages for Cloud Computing. Costs reduction in either operational [20] [22] or upfront costs [20] is considered as one of the main benefits of Cloud Computing. For example, Maharashtra Government in India saved Rs. 50 Crore by using Cloud Computing solutions [23]. Decreasing the upfront cost will eliminate obstacles to entry in new markets [20] [24]. This could be a clear advantage particularly for Small and Medium sized Enterprises (SMEs) [20]. On-demand promises of Cloud Computing provide scalability and elasticity advantages that allow the organisations to react quickly for their customer demand [22]. Another business benefit from Cloud Computing is the flexibility to react to changing market conditions [20]. Green computing is another advantage of Cloud Computing since it

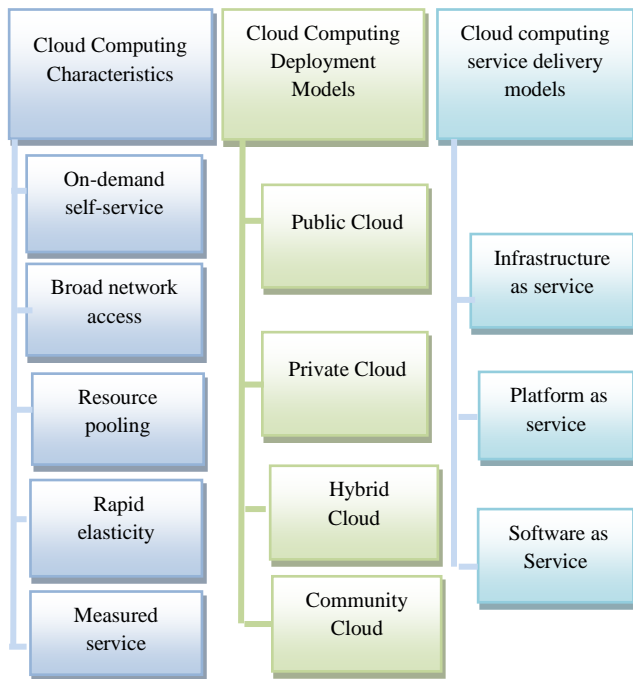


Figure 1. Cloud Computing Definition Schema

has the potential to reduce companies' carbon footprints [18]. Cloud Computing can eliminate IT obstacles to innovation [20] [25]. Cloud Computing also helps organisations to provide new services that were not possible before as result of higher cost for IT solutions [20]. As a result, all the benefits and advantages of Cloud Computing enables organisation to become more focused on their core business [20].

Cloud Computing has its own disadvantages and risks. One potential risk is Data Lock-In where customers may have difficulty of extracting their data from the Cloud [26]. User privacy could provide an issue for Cloud Computing [20] and security issues are the main obstacles for some organisation for not going Cloud [22]. Lack of proper regulations and standards is another barrier to Cloud Computing adoption. However, there is more research being undertaken to deal with the obstacles of Cloud Computing either via technology [22] or policies and legislations [20].

#### B. E-health Cloud:

The Cloud computing market in healthcare is reported to reach more than \$5.4 Billion by 2017 [27]. Many researchers suggested that the health care industry should move toward Cloud computing. Some researchers have discussed the opportunities and challenges of Cloud Computing in e-health [3] [28] [29]. They indicated many advantages for cloud in e-health such as better patient care, reduced cost, enhanced the support for research, and overcome the shortage. However, they pointed out some issues like privacy and security issues, data ownership and lack of legislations and standards. Examples of real and lead projects in the healthcare domain include the MUNICH platform and DACAR project. DACAR is a first e-Health Cloud platform in Europe aiming

to develop and implement a secure platform in the Cloud to support Data Capture and Auto-Identification technology [3]. DACAR has been implemented successfully in London's Chelsea and Westminster hospital [30].

Cloud computing may solve some of the 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 can eliminate the obstacle of shortage of health informatics and IT since less technicians than before will be required by the healthcare organisations [30]. Cloud-based medical applications will also make IT departments at healthcare organisations to focus more on supporting the implementation of e-health projects by moving some of their responsibilities to the Cloud providers' side. For healthcare organisations, Cloud Computing will provide better integration and exchange of medical records across multiple organizations. By using Cloud Computing, Saudi healthcare organisations will be able to have sufficient computing resources to deal with large amount of data that are created by e-health services. This feature will also help R&D departments in healthcare organisation on the national level. Cloud Computing with collaboration with other technologies such as Internet of Things, m-health and Big data will help reshape healthcare services in Saudi Arabia.

Some researchers recommended that Cloud Computing in general and in e-health particularly is still in its early stages and need more research and efforts [3] [22] [28].

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 and risk assessment to avoid the risks and gain the full advantages of this new model [28].

#### IV. RELATED WORK:

In healthcare, few studies have discussed Cloud Computing decision-making procedures [3]. Kuo [28] recommended four aspects to be assessed when adopting the health Cloud Computing: management, technology, security, and legal. Kuo also proposed a Healthcare Cloud Computing Strategic Planning (HC2SP) model. This model could react as a SWOT analysis for health organisations to determine how to migrate from traditional health services to cloud-based services. This model did not focus on the decision making process. Lian, Yen and Wang [31] studied the decision to adopt Cloud Computing. They integrated 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. Hence, the result of this paper would not be generalised to large hospitals. Rijnbouts and et al. [29] categorised the challenges that are facing the use of Cloud Computing in e-health

services into six categories (technical, privacy, legal, organisational, economical and medical). However, this paper ignored environmental issues. Additionally, this model did not focus on the decision making process.

Evaluating the existing frameworks for Cloud Computing decision-making, these frameworks are limited (i.e., they do not cover multiple perspectives). Current models and frameworks also focus mainly only on the operational and tactical level (i.e., ad hoc frameworks). Furthermore, while most of the frameworks are emphasising the technical side of Cloud Computing, they ignore the other sides such business and organisational. There is also a lack of quantitative measures in the reviewed frameworks. The use of quantitative measures within the framework is important because they make the decision-making process more accurate and objective [32]. Although, Low, Chen and Wu [33] 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 may vary across different countries. As a result, each country must be considered to be studied as individual case (i.e., private and public health care). Although, some concepts of Cloud Computing will be generic, some of the concepts will be different due to the variation of the contexts and country requirements. For example, Cloud Computing applications must comply with HIPAA privacy and security rules in USA [34].

Cloud Computing in Saudi Arabia has not received much attention [35] and little research has been conducted in studying the implementation of Cloud Computing in the country. For example, Alharbi [36] studied users' acceptance of Cloud Computing in Saudi Arabia based on Technology Acceptance Model (TAM). From an organisation level, Yamin [35] completed a survey of Cloud Computing awareness in Saudi Arabia. The study showed that Cloud technologies will be a new trend for Saudi's organisations. However, this research provided a general view of Cloud Computing adoption in Saudi Arabia. Yamin claimed that his study is the first of its kind in Saudi Arabia. This indicates that adoption of Cloud Computing in Saudi Arabia in general (and in healthcare sector in particular) needs more investigative efforts.

#### V. THE PROPOSED STRATEGIC FRAMEWORK FOR CLOUD COMPUTING DECISION-MAKING IN HEALTHCARE SECTOR:

Many researchers have recognised a need to use holistic and multidisciplinary approaches when studying or designing HIT frameworks in healthcare [37] [38]. The framework is supposed to support the decision maker in health organisations in by covering multi perspectives. It will be also designed in a flexible way to be adaptable to changing market conditions.

The decision of adopting Cloud Computing is potentially a complex process and consequently there are many perspectives to be considered. Thus, studying this process requires multi-perspective framework. The proposed

framework will integrate more than one theoretical framework to make the suggested framework more robust and cover multi aspects of the organisation. TOE has been chosen as a concept for this research together with Strategic Triangle and HOT-fit.

Since Cloud Computing is a new innovation of dealing with IT services [18] the appropriate framework is the one which is aiming to study innovation decision making at firm level. Technology-Organisation-Environment (TOE) Framework was introduced by Tornatzky, Fleischer and Chakrabarti [39]. This framework focuses on the process by which a firm adopts and implements technological innovations and how the technological context, the organisational context, and the environmental context can affect the implementation of new innovation. Oliveira and Martins [40] suggested that TOE framework is useful in studying the adoption decision-making process of 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 paper [20]. Many researchers have studied technology innovation based on TOE framework. Many examples could be mentioned here such as RFID Adoption in the Healthcare Industry [41], in web site development [42], in e-commerce [43], in Cloud Computing adoption by SMEs in England [44] and in Cloud Computing adoption by hospitals in Taiwan [31]. Although, TOE framework has been implemented by many researchers for different technology innovation, some researchers argued that the TOE framework does not contain all the variables in each context. 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 [33].

Business concepts must be taken into consideration by any decision maker [20]. Thus the strategic triangle will be combined with TOE framework to add the strategic value to the proposed framework. The strategic triangle is a concept developed by Frenzel [45] which emphasises the importance for the organisations to have an alignment between three strategies perspectives (Business, Organisation and Information). This research will apply some of the concepts of a strategic framework for outsourcing decision-making that was called Holistic Approach Business, Information, and Organisation (HABIO). HABIO is a well-documented framework used for outsourcing, and has been discussed by many academic researchers [32] [46] [47].

Human factors are also critical in the adoption of any new IT innovation. Those factors should be considered carefully when making the decision of adopting Cloud Computing in health industry. Hence, Human, Organisation and Technology-fit (HOT-fit) framework will be integrated with previous frameworks. HOT-fit was introduced in [48] as an evaluation framework for health information systems.

The proposed framework will be focused on five dimensions which are Organisation, Technology, Environment, Human and Business. The proposed strategic framework is presented in Figure 2.

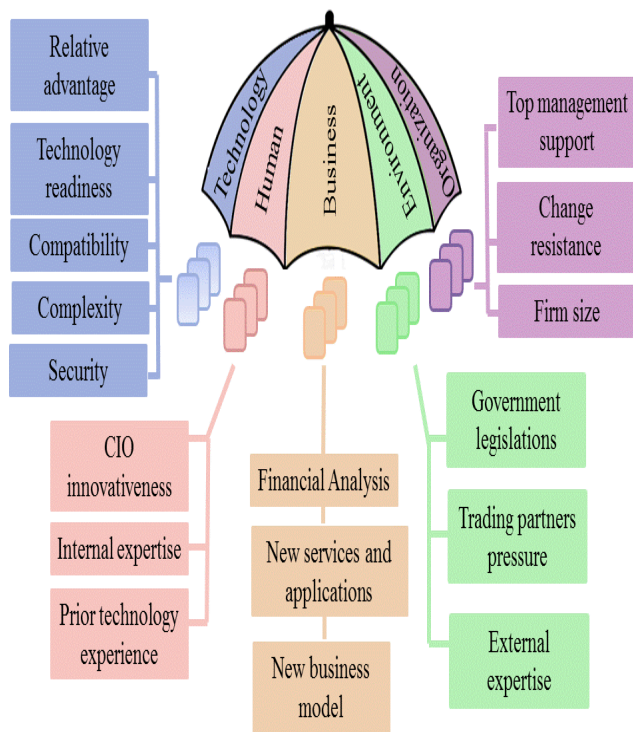


Figure 2. The Proposed Strategic Framework for Cloud Computing Decision-Making in Healthcare Sector

The technology dimension represents the technical issues that will affect the decision of Cloud Computing adoption. Health organisations which are intending to implement Cloud Computing need to assess all technological characteristics that available at the organisations. Relative advantage factor refers to checking if the adoption of Cloud Computing technology will have clear benefits over others technologies for certain health organisation. This factor is expected to be an important and positive significant factor for the decision of Cloud Computing adoption. Alharbi [36] showed that perceived usefulness will positively affect users' attitude towards adopting cloud computing in Saudi organizations. Technology readiness could be an enabler factor of the decision of Cloud Computing adoption [49]. Some researchers found that existing infrastructure has a negative impact on the adoption of health data standards in Saudi Arabia [16]. However, Cloud Computing can solve the problem of the availability of IT resources. E-health usually encompasses many health information systems. Thus, compatibility of Cloud Computing implementation with existing IT systems inside the health organisation should be another factor to be consider when adopting Cloud technology [50]. Some Saudi healthcare organisations found difficulty in making new systems compatible with current clinical systems [51]. Consequently, the complexity can be a significant determinant for Cloud adoption [49]. In the healthcare industry, data security and privacy protection are required not only demanded by the patients themselves, but in most countries they are also required by law. Thus, data

security should be essential factor that should be considered during any Cloud Computing implementation [50].

The organisational factors also have their influences on the success or the failure of e-health projects. They are internal factors of an organization that are controlled and by the organization itself. They play an important role in the decision-making process. Top management support can be a significant factor in Cloud adoption [44]. This factor refers to how executives identify the nature and functions of Cloud Computing technology and how this technology will affect the overall organisation [44]. Current research showed that employees in managerial positions in Saudi organizations had positive attitudes toward Cloud Computing adoption [36]. However, the situation in healthcare organisations may be different due to the nature of such organisations. The successful adoption of new technologies requires various changes to be made to the organisational structure, such change may face resistance from physicians, administrative and IT staffs [48]. A recent study showed that resistance to the use of new system is affecting EMR implementation in Saudis hospitals [17]. This factor should be considered when adopting Cloud computing solution in health organisation. Firm size could be also considered as a factor that will affect the adoption of Cloud Computing [33].

Environmental context refers to the different attributes of the external world in which the organisation conducts its business [31]. The use of Cloud Computing in e-health will be affected by the relationship between different parties. Government legislation and policies can affect the decisions of health firms trying to adopt new technology [48]. With the current security and privacy issues in the Cloud, this factor must be considered carefully. Additionally, most health organisations rely on trading partners for their IT solutions so sufficient support from the Cloud vendors will be an influential factor affecting the decision of Cloud Computing adoption [33]. Instability of EMR vendors was found to be one of the barriers of EMR implementation in Saudi Hospitals [17]. Another factor that is associated with sufficient support from the vendor is the availability of external expertise [32]. E-health usually encompasses many health information systems and requires expertise from various domains such as medicine, IT and business processes. Thus the availability of such expertise will affect the decision of Cloud Computing adoption.

Human dimension should be considered before the implementation of any IT project as it is one of the factors that influence the adoption of an innovative technology [48]. Hospitals usually are slow in adopting new information technologies due to the decision makers' characteristics [52]. Thus, the innovativeness of decision makers' considerably influences the decision to adopt Cloud Computing [31]. Another factor which will affect the decision of Cloud Computing adoption is the capability of IT staff inside the hospital to deal with such technologies [31]. Physicians with insufficient technical knowledge can be consider as another barrier for e-health projects in general [11]. Thus, prior technology experience or the Cloud/IT skills of non-IT employees are also expected to impact the diffusion of Cloud Computing inside health organisations [53]. Human factors

were identified as the main obstacles of successful implementation of EMR in Saudi healthcare organisations [14].

Business perspective refers to the consideration of business issues related to the adoption decision. The first factor is the financial issues regarding to the implementation of Cloud Computing solutions. The cost should be analysed in both capital expenditure (CAPEX) and operational expenditure (OPEX). The decision regarding which deployment models should be implemented also needs to be discussed carefully [29]. The organisation should have clear procurement strategies for Cloud Computing. Another related issue is the impact of the adoption of Cloud Computing on medical and business processes [3]. The absence of implementation strategy has negatively affected e-health projects in Saudi Arabia [15]. The use of Cloud Computing will help the hospitals to move from the traditional health care model (doctor-centred model) to the new health care model (patient-centred model) [6]. Another factor that should be discussed is the strategic value that will be added to the health firm by using Cloud Computing technologies. Adopting Cloud Computing will give the possibility for new classes of applications and delivers services that were not possible before, such as mobile health, telemedicine and big data [3].

The proposed framework will help health organisations in the decision making process by evaluating various factors affecting the Cloud Computing adoption. Migrating towards Cloud needs a multi prospective strategy that supports Cloud Computing capabilities [52]. This framework will try to help the health organisation in bridging the gap between their IT projects and providing better medical care with lower cost and high standards.

## VI. CONCLUSION AND FUTURE WORK

E-health is one of the ambitious initiatives that try to solve the traditional healthcare challenges. However, e-health projects usually face many issues. The higher cost and complexity of e-health projects beside the shortage of skilled staff in ICT domain can be consider as obstacles of e-health. Cloud Computing is a leveraging technology that provides many solutions for e-health projects. Healthcare firms may have many concerns about Cloud Computing. Thus, adopting Cloud Computing solutions in healthcare domain requires strategic plan that cover multi prospective.

This paper provides a holistic framework that can support healthcare organisations in their movement toward Cloud Computing. This framework covers five main aspects that are Organisation, Technology, Environment, Human and Business.

In future, a questionnaire and focus groups will be used to collect the necessary data amongst Saudi healthcare informatics participants. Factor analysis will be used to test the validity and reliability of the items constructed to measure the identified factors.

Finally, this framework is still work-in-progress. So, it will have more enhancements in the near future to cover all

relevant factors that may affect Cloud Computing adoption in healthcare organisation in Saudi Arabia.

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