

EFFECTS OF CRITICAL SUCCESS FACTORS ON MATURITY LEVEL OF
HOSPITAL INFORMATION SYSTEMS

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DEDICATION

To my beloved wife, my lovely daughter and my dear family members

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In the name of Allah, the Most Gracious, the Most Merciful, for giving me the determination and completion this study.

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ABSTRACT

Hospitals are regarded as the most important part of a healthcare system. Generally, hospitals use Hospital Information System (HIS) as an infrastructure for recording, retrieval, and transmission of data, facilitation of decision-making processes, and other healthcare-related functions. An issue in HIS is that the implementation of the system in hospitals has always been associated with a high risk of failure. This study, therefore, aims to first assess the maturity of HIS in Iranian hospitals and then, examine the related Critical Success Factors (CSF) in order to mitigate the implementation risks of HISs to the authorities. Eleven hospitals under the administration of Medical University of Isfahan, Iran, were selected. Data was collected through a checklist designed based on Electronic Medical Record Adoption Model (EMRAM) expectations. Questionnaires were distributed to employees of the eleven identified hospitals using stratified sampling method in which 126 completed questionnaires were returned. The results revealed that all of the hospitals have reached to elementary stages of (EMRAM). In addition, 26 CSFs were found to be effective in HIS implementation success in the hospitals but some factors were found to be higher in the level of effectiveness. The findings were then evaluated by 14 experts who are familiar with the selected hospitals, the HIS concept and project implementation. The final results which included a comprehensive picture about the initial maturity status of HIS and also 12 more effective CSFs for successful implementation of HIS in the hospitals can provide guidance for hospital top managers and healthcare policy makers in developing appropriate strategic IT plans and HIS implementation frameworks.

ABSTRAK

Hospital dianggap sebagai bahagian yang paling penting dalam sistem penjagaan kesihatan. Umumnya, hospital menggunakan Sistem Maklumat Hospital (HIS) sebagai infrastruktur untuk perekodan, mendapatkan semula, dan penghantaran data, memudahkan proses membuat keputusan, serta lain-lain fungsi berkaitan penjagaan kesihatan. Suatu isu dalam HIS ialah pelaksanaan sistem tersebut di hospital sering dikaitkan dengan risiko kegagalan yang tinggi. Kajian ini, oleh itu, bertujuan untuk pertama menilai kematangan Hiss di hospital Iran dan kemudian, memeriksa Faktor Kejayaan Kritikal (CSF) yang berkaitan untuk mengurangkan risiko pelaksanaan HIS kepada pihak berkuasa. Sebelas hospital di bawah pentadbiran Universiti Perubatan Isfahan, Iran telah dipilih. Data dikumpulkan melalui senarai semak direka bentuk berdasarkan jangkaan Model Penggunaan Rekod Perubatan Elektronik (EMRAM). Soal selidik diedarkan kepada kakitangan di sebelas hospital terpilih menggunakan kaedah persampelan berstrata yang mana 126 soalselidik lengkap dipulangkan. Hasil kajian menunjukkan bahawa semua hospital ini mencapai tahap awal daripada EMRAM. Selain itu, 26 CSF telah didapati berkesan dalam kejayaan pelaksanaan HIS di hospital tetapi beberapa faktor didapati tahap keberkesanan lebih tinggi. Hasil kajian kemudiannya dinilai oleh 14 pakar yang biasa dengan hospital terpilih, konsep HIS dan pelaksanaan projek. Hasil kajian yang memberikan gambaran keseluruhan tentang status kematangan HIS dan 12 lagi CSF yang berkesan bagi kejayaan pelaksanaan HIS di hospital menjadi panduan kepada pengurus hospital dan pembuat dasar penjagaan kesihatan dalam membangunkan pelan IT strategik dan rangka kerja pelaksanaan HIS yang sesuai.

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LIST OF ABBREVIATIONS

CME	-	Continuing Medical Education
CMS	-	Clinical Management System
CPD	-	Continuing Professional Development
CSF	-	Critical Success Factor
EHR	-	Electronic Health Record
EMG	-	Muscle Tape
EMR	-	Electronic Medical Record
ER	-	Engagement Readiness
GDP	-	Gross Domestic Product
HDI	-	Human Development Index
HI	-	Health Informatics
HIE	-	Health Information Exchange
HIMSS	-	Healthcare Information and Management Systems Society
HIS	-	Health/Hospital Information System
HIX	-	Health Information Exchange
HMIS	-	Hospital Management Information Systems
IDN	-	Iranian Diabetes Network
IUMS	-	Isfahan University of Medical Science
LHP	-	Lifetime Health Plan
MI	-	Medical Informatics
MM	-	Motivational Model
MHME	-	Ministry of Health and Medical Education
MPCU	-	Model of PC Utilization
MRI	-	Magnetic Resonance Imagery
EMRAM	-	Electronic Medical Record Adoption Model

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents the overview of this research. It begins with the background of this research. Then, the research problem is clarified. After that, the research objectives and the scope of this research are explained. The significance of this research to the knowledge also is enlightened and finally an outline of the thesis structure is provided.

1.2 Background of Research

E-Health is defined differently by scholars and institutions (Eng, 2001; Denise, 2003 and World Health Organization, 2003; Sharifi *et al.*, 2012). As an example, Kwankam (2004) has defined it as any electronic exchange of health related data through an electronic connectivity for improving efficiency and effectiveness of health care delivery in and among healthcare organizations. However, growing numbers of experts believe that e-Health will fuel the next breakthroughs in health systems improvement throughout the world (Rockefeller foundation, 2008). Besides, Bangert and Doktor (2002) have articulated that, “e-Health can provide enhanced patient access to better health care, reduced total health care costs and, as a consequence of easy access to the most appropriate specialist expertise, higher overall quality of the health care delivered”.

The benefits of e-Health can be categorized into six different areas, namely clinical, economic, organizational, patient-related, professional and technical (Fitzgerald, Piris and Serrano, 2008). These areas can be divided into more detailed motivation drivers as like operational cost reduction, business process rationalization, fraud prevention, on-line authorization, data availability, and high visibility of the projects to the citizens, health service coordination and citizens' privacy protection (Peng, 2009). As a whole, the most important factors to deploy Information Technology (IT) to health care are to acquire efficiencies in several fields namely delivery and administration of health care (Lorenzi *et al.*, 2009); improving the quality of health care (Skok and Ryder, 2004; Varshney, 2009); cost reduction (MacKinnon and Wasserman, 2009; Chattopadhyay *et al.*, 2008; Mair and Whitten, 2000), medical error reduction (Ball and Lillis, 2001; Hersh *et al.*, 2001); providing health care resources to the rural areas (Wootton, 2001); ethical improvement through the privacy issues (Wickramasinghe *et al.*, 2005); education and e-learning facilitation (Umhoff and Winn, 1999); equity in health care (Williams *et al.*, 2003); patients' and their families' awareness (Jennett and Andruchuk, 2001); integration of enterprise-wide systems (MacKinnon and Wasserman, 2009); time and workflow efficiencies (Bates, 2003) and allowing data mining techniques for information to predict risk and measuring medical care against benchmarks (Coile, 2000).

However, both developed and developing countries have made some efforts to implement e-Health systems in their countries. It can be claimed the most developed e-Health plans have been implemented in Korea (Korea E-Health Association, 2004), Hong Kong (Kim, 2009) and some Western Europe countries such the UK (Deloitte, 2008). In addition, developing countries are mainly trying to utilize e-Health in their societies, but are facing the lack of proper national e-Health plan to have a strategic viewpoint to e-Health development in their countries (Obiso, 2009). The main reasons are inadequate infrastructural, technological, human resource, etc. facilities (Khalifehsoltani and Gerami, 2010) which are required to pursue such costly, important and complicated plans in their countries. Yet, within these countries, Malaysia (Amiruddin, 2010), and some Arab countries such as UAE (ESCWA, 2005) are doing better. Iran as a developing country also has its own plans and projects such as FAVA (Sharifi *et al.*, 2012; Khalifehsoltani and Gerami, 2010, DailyNews, 2011) showing the importance of e-Health for medical authorities in this

country and are trying to utilize full potential capabilities of e-Health in their health care system, as well.

Yet, e-Health is the least developed e-technology (MacKinnon, 2009) compared to other fields like e-commerce, e-banking, e-procurement, and e-auctions. The main challenges blocking broad, successful and sustainable e-Health in almost all the countries can be classified into political, social and organizational challenges as well as technical and semantic level challenge categories (Jordan *et al.*, 2009). There are frequent evidences which largely point to failures or unsustainable e-Health implementations in both cases in the countries (Mushtaq and Hall, 2009; Heeks, 2002) with different reasons such as lack of standardization of e-Health applications (Lorenziet *al.*, 2009); cost of such systems (Ferreira *et al.*, 2008; Richards *et al.*, 2005); the training cost (Richards *et al.*, 2005) and the diversity of platforms resulting technical difficulties (Ammenwerth *et al.*, 2003; Aoki *et al.*, 2003). Nevertheless, unsustainable implementation or even implementation fails of e-Health projects, particularly Hospital Information Systems (HISs) which backs to the complex nature of health environment is a matter of concern by both academic institutions and empirical implements in the world. Thus, the main aim of this research is to concentrate on this important issue in the hospitals that will be clarified and discussed in more details, later.

1.3 Statement of the Problem

E-Health implementation difficulties have also been reported in both developed and developing countries and the frequently reported evidences have been mentioned in Europe (Greenhalgh, 2008; Barjis, 2010), in the US (Ash, and Bates, 2005; Dowling *et al.*, 2010) and in developing countries (Gagiliardi and Jadad, 2002; Maloney, Ilic and Green, 2005). Several reasons have been mentioned for such difficulties in developed (Kim, 2009) and also developing countries (Fedorov, 2011; Amiruddin, 2006) which are mostly the same such as slow adoption of health care staff, funding shortages and lack of skilled human resources. Iran also as a developing country is facing almost the same challenges and difficulties

(Jahanbakhsh, Tavakoli and Mokhtari, 2011). Thus, considering these difficulties one major issue is to assess the maturity of HISs in the hospitals as a part of e-Health projects in the countries.

The necessity of this assessment backs to this fact that software programs become considered as medical devices in health care environment (Miller, Gardner, 1997) and sophisticated services could be presented using this platform. To handle this issue, some different assessment models in IS context are proposed to adopt with e-Health context. These assessment models are started from traditional financial measures, such as return on investment (Rubin, 2004) and went through Technology Acceptance Model (TAM) Davis's (1989) and Theory of Reasoned Action and Theory of Planned Behavior (Fishbein and Ajzen, 1975) and finally reached to DeLone and McLean's IS model (Saghaeiannejad *et al.*, 2012) and proposed model by Powers and Dickson (1973) which were along with limitations and considerations to full adoption in e-Health context. Therefore, these models are no originally emerged maturity model in e-Health context and are not capable to fully adopt in this context as well (Saghaeiannejad *et al.*, 2012).

Lack of such maturity assessment model in Health Information Technology (HIT) caused to provide Electronic Medical Record Adoption Model (EMRAM) by Healthcare Information and Management Systems Society (HIMSS) (HIMSS, 2014). Therefore, EMRAM is considering as a worldwide-recognized Hospital Information Systems (HISs) maturity assessment model, to assess the maturity of HISs in the hospitals now. EMRAM is also the only HIT initiated model to assess the maturity of HISs (Hospital Information System) in the world. This is a model that ranks the hospitals from zero stage (totally paper based system) up to seven stage (fully automated and without physical paper system) as shown in Table 2.3. Refer to HIMSS (2014), the current maturity stage of different hospitals in USA and Canada countries as well as Europe and Asia continentals is shown in Table 1.1. Yet, there is no research to clarify the HIS maturity of Iranian hospitals in accordance with EMRAM model. Thus, using an exploratory investigation in the selected Iranian hospitals, the maturity of HISs in accordance with the EMRAM in respective hospitals is one major aim of this research.

Table 1.1: Maturity stage of HISs in different countries and continentals (Himss, 2014)

Maturity Stage	USA (N=5447)	Canada(N= 640)	Europe (N=N/A)	Asia (N=N/A)	Iran
Stage 7	3.2 (175Hospitals)	0.0%	N/A (3Hospitals)	N/A (2Hospitals)	?
Stage 6	15.0% (797Hospitals)	0.6% (5Hospitals)	N/A (42Hospitals)	N/A (27Hospitals*))	?
Stage 5	27.5%	0.5%	N/A	N/A	?
Stage 4	15.3%	3.6%	N/A	N/A	?
Stage 3	25.4%	32.5%	N/A	N/A	?
Stage 2	5.9%	28.9%	N/A	N/A	?
Stage 1	2.8%	14.5%	N/A	N/A	?
Stage 0	4.9%	19.4%	N/A	N/A	?
* 1 Malaysian Hospital(Prince Court Medical Centre (277 beds)), 5 Indian Hospitals, 4 Chinese Hospitals, 4 Taiwanese Hospitals, 5 Singaporean Hospitals, 2 Saudi Arabian Hospitals and 6 UAE Hospitals					

Meanwhile, the e-Health environment mainly has been described as the followings: a multidisciplinary and multi-resources, different types of medical equipment and advanced technologies, variations of policies, operating procedures, and finally data types and standards (Azrin, 2010). As Cha´vez, Krishnan and Finnie (2009) have articulated, “these complicated e-Health systems have over and over again failed to deliver completely or at least late to deliver expected services and being over budget”. Yet, research on IT implementation in the healthcare sectors to uncover the root cause of their difficulties has been limited (Fichman, Kohli, and Krishnan, 2011; Wilson and Tulu, 2010). For example, Mair *et al.* (2009), Pagliari *et al.* (2005), Bend, (2004), and Eng, (2001) have reported only some limited kinds of IT adoption failures in health care environment. Such scholars have uncovered mainly limited reasons such as lack of funding by stakeholders, privacy issues, lack of legal implementation framework, lack of skilled personnel and proper data

formats, the lack of timeliness and reliable data and finally e-readiness issues for such failures (Ojo *et al.*, 2008; Shon and Marshall, 2000; Al-Shorbaji, 2008).

Nevertheless, the e-Health implementation is a complex task for the reason that it is a multi-dimensional nature project and a multi-professional approach (Chattopadhyay *et al.*, 2008). It is a dynamic process which involves different implementation interventions (Hinske and Ray, 2007) such as ICT components, applications, services, processes, organizations, governments and different stakeholders. The complexity reduction in these types of e-Health projects is very important (Bygstad and Hanseth, 2011) and there are approaches to mitigate implementation failure risks of such complex IT projects (Fichman, *et al.*, 2005; Benaroch, 2002). One major approach, which is considered, is Critical Success factors (CSFs) for successful implementation of e-Health projects, particularly HISs in health care environments. There are different researches highlighting several important CSFs which are playing a crucial role in the success of Information Systems (IS), particularly Enterprise Resource Planning (ERP) projects (Lapointe and Rivard, 2005; Finney and Corbett, 2007) in the world. In this context, several different CSFs are extracted by different scholars, which are listed in Table 2.4. MacKinnon and Wasserman (2009) and also Ben-Zion, Pliskin and Fink (2014) believe these CSFs in the context of ISs, particularly ERP systems is also applicable into e-Health projects due to their similarity in purpose and function between them.

Yet, the point is, there are limited specific researches highlighting some CSFs in the context of e-Health implementation in the world (Axelsson *et al.*, 2011). For example, Lapointe and Rivard (2005) examined important CSFs for effective implementation of HIS projects in three hospitals and they highlighted only one CSF, which was the importance of staff resistances in such health care organizations. Amatayakul (2000) has mentioned to eight CSFs namely end-user involvement; knowledge requirement assessments; systems support; organizational vision; communicate the value of the new system to users; need for an integration and migration plan for the new system; longer-term system infrastructure and evaluate the system to manage benefits delivery. Moreover, Vitacca *et al.* (2009) referred to competencies to implement e-Health and telemedicine; patient-centered care;

partnering with patients; public health perspective; ICT plan and quality improvement as CSFs in this area. In addition, Kaye *et al.* (2010) has listed multidisciplinary team; innovative leadership; communicate clear benefits; process for implementation; financial incentives for clinicians; collaborative processes; training for clinicians as uncovered CSFs in this context. Leonard (2004) also has mentioned to only four CSFs namely buy-in from stakeholders; training; dealing with unplanned events and amount of resistance. Axelsson *et al.* (2011) are researchers who mentioned to highly committed developers and their understanding of the organization as two CSF in this area. Furthermore, Deutsch *et al.* (2010) have cited health policy related goals and implementation approach; communication and reporting; acceptance and change management; project management and legal requirements related to data protection as four listed CSFs in this environment. Besides, Chen and Hsiao (2012) have mentioned to only four CSFs namely project team competency; top management support; ease of system use and systems quality.

It should be noted, Standing and Cripps (2015) have criticized above researches and reached to user/stakeholder involvement; vision and strategy, and strategic alignment; communication and reporting; plan for ICT infrastructure; communication of benefits and funding and finally process for implementation/migration/integration and training. One of the latest research in this area is done by Ben-Zion, Pliskin and Fink (2014) with some more CSFs which is done based on literature review and without field analysis that will be analyzed in Chapter 4 as well. Thus, another major objective of this research is to identify CSFs in the context of HIS implementation in the hospitals and determine most effective CSFs for successful implementation of HIS projects in the hospitals.

1.4 Questions of the Research

The questions for this research are identified and listed below. In this case, the focus will be on answering the following main questions:

- i. What are the maturity stages in different Iranian hospitals according to the

EMRAM model?

- ii. Which CSFs are effective for implementation and utilization of HISs in the hospitals?
- iii. To which extent is the effect of each CSF on the successful implementation of HISs in the hospitals?
- iv. Is there an equal perceived distribution of CSFs from the hospital staff's point of view?

1.5 Objectives of the Research

The main objective of this study is to identify effective CSFs for successful implementation of e-Health projects (or particularly HISs) in the hospitals. However, this research includes following specific objectives that are:

- i. To evaluate the maturity stage of HISs in the Iranian hospitals in accordance with EMRAM.
- ii. To determine the applicable CSFs for effective implementation and utilization of HIS projects in the hospitals.
- iii. To determine the most important CSFs in successful implementation and utilization of HIS projects in the hospitals.
- iv. To determine the perceived importance of CSFs from the hospital staff's point of view.
- v. To validate the maturity stage of and identified effective CSFs in (i) and (iii) using expert panel approach.

1.6 Scope of the Research

The scope of this research is limited to Iranian hospitals. The Iranian hospitals are governed by the Ministry of Health and Medical Education and the Ministry of Welfare and Social Support. However, since the major population of Iranian hospitals is governed by the Ministry of Health and Medical Education

(MHME), the cases for this research are selected from those hospitals governed by this ministry. These hospitals usually are the biggest in terms of size, number of beds, medical staff and operational activities. They also are some of the most complex hospitals with extensive and professional services to the public in the country and surrounding area.

Moreover, Iran is divided into thirty one provinces. However, beside the capital city of Tehran, one of the most important provinces is Isfahan, located in the center of Iran. It has some of the most advanced medical hospitals and research centers in the country and even in the region along with some of the famous medical experts who are prescribing local and international (mainly Arab) patients in the hospitals or in their clinics. Thus, this city is one of the most important medical metropolitans in the Middle-East which has been selected for this research. These hospitals are administered by the Isfahan University of Medical Sciences(IUMS). Some hospitals are contributing to the educational aspects to the medical students along with treatment but others only have focused on treatment. To do this research stratified sampling is approached to investigate all educational hospitals under the administration of this university. Thus, eleven hospitals having above criteria are selected to examine the questions of this research. These hospitals are named A, till K with the specifications shown in Table 1.2. It should be noted, all medical and operational staffs not necessarily interacting with operating HISs in the hospitals, thus some of them were not in the scope of this research which will be clarified in Chapter Three.

Table 1.2: The specifications of selected hospitals in Isfahan

<i>Hospital</i>	<i>Name of Hospital</i>	<i>Number of medical and operational staffs</i>
<i>1</i>	<i>A</i>	1200
<i>2</i>	<i>B</i>	370
<i>3</i>	<i>C</i>	261
<i>4</i>	<i>D</i>	154
<i>5</i>	<i>E</i>	231
<i>6</i>	<i>F</i>	614
<i>7</i>	<i>G</i>	360
<i>8</i>	<i>H</i>	145
<i>9</i>	<i>I</i>	190
<i>10</i>	<i>J</i>	80
<i>11</i>	<i>K</i>	203

1.7 Importance of the Research

The importance of this research is found from different perspectives. From the methodological perspective, this research is one of the early academic researches in the world and particularly in developing countries, in the field of applying EMRAM (Electronic Medical Record Adoption Model) assessment model in the context of HIS maturity assessment. To do this assessment, a validated checklist is developed to be applied in this research and is available to be used for similar researches. Moreover, the use of a validated questionnaire developed by the researcher in the HIS context is another innovative tool which has been applied in this research and is applicable to other similar researches.

In practical perspective, since HIS covers a wide range of operational activities in hospital organizations; including Electronic Medical Record (EMR), e-payment, e-billing, staff and hospital asset information, e-prescription and e-records activities (Varshney, 2009) and it crosses some different nature domains, including

management systems, communication systems, computerized decision support systems and information systems (Mair *et al.*, 2009), it was beneficial to determine the maturity of HISs in the context of Iranian hospitals. Thus, it clarified the stage of maturity of HISs in the respective hospitals in accordance to EMRAM. Moreover, the identification of most effective CSFs on successful implementation of HISs in the hospitals, let the hospital stakeholders to concentrate on the more important issues during HIS implementation in the hospitals to succeed. The final outcome would be higher probability to adopt HISs in the respective hospitals.

Lastly, from the theoretical perspective, there are evidences that emphasize on the failures or unsustainable implementation of HIS projects (Mushtaq and Hall, 2009; Heeks, 2002) and there are limited studies which have been done to determine CSFs for successful implementation of HIS projects (MacKinnon and Wasserman, 2009; Standing and Cripps, 2015). Moreover, those limited researches have emerged limited CSFs in this context. This research gives a comprehensive view of CSFs for successful implementation of HIS projects in the hospitals. To do this, the relationship between different CSFs and HIS implementation success concept were examined and proper hypotheses presented and evaluated. Moreover, related exemplars to each CSF is also proposed and evaluated.

1.8 Conceptual Definitions

Critical Success Factor (CSF): Those characteristics, conditions or variables that, when properly sustained, maintained, or managed, can have a significant impact on the success of an organization to implement new technology (Leidecker and Bruno, 1984). In this context, it is a critical factor or activity required for ensuring the success of HIS implementation or utilization in hospitals.

E-Health: Any electronic exchange of health related data through an electronic connectivity for improving efficiency and effectiveness of health care delivery (Kwankam, 2004).

Electronic Medical Record Adoption Model (EMRAM): A ranking method for assessing the maturity of HISs in the hospitals given from zero up to seven stages (HIMSS, 2014).

Enterprise Resource Planning (ERP): An integrated software solution, sold by a vendor as a package that supports the seamless integration of all the information flowing through a company (Davenport, 1998).

Hospital Information System (HIS): A comprehensive, integrated information system designed to manage all the aspects of a hospital operation, such as medical, administrative, financial, legal and the corresponding service processing (Spil, 1999).

HIS Implementation and Utilization: The empirical process of acquiring and using a HIS in a hospital to reach perceived advantages of HIS for health and none health affairs in the hospital.

Success Factors (SF): Those factors which are taken into account to define the concept of “success” in this research. These factors are namely technical terms; economic and financial terms; smooth running of hospital operations; HIS-adopting hospital’s managers and employees; HIS-adopting hospital’s patients, suppliers and investors; time, and human resources advantages and finally complexity of HISs (Markus *et al.*, 2000, Garc’ia-S’anchez and P’erez-Bernal, 2007 and Zhang *et al.*, 2002).

1.9 Outline of the Thesis

This thesis is divided into five chapters. Chapter One presented an introduction to the study, the problems which should be addressed and the objectives as well as the rationale for this research effort. Finally, it continues to outline till the entire thesis will unfold.

Chapter Two is devoted to literature review for detailed understanding of e-Health as a whole which includes e-Health definition and its associated with the opportunities and challenges, current situation of e-Health in the world, particularly in Iran, and then e-Health and HIS implementation challenges will be investigated. This part includes the introduction of EMRAM and the current situation of HIS maturity of some different countries. Beside this, the extracted CSFs in the area of IS (particularly ERP) and also e-Health (particularely HIS) implementation and utilization have been introduced. Later, the problems, which this research aims to address and clarify, have been presented in more details. At the end of this chapter, the conceptual research framework is presented.

Chapter Three contains the methodology of the research process. It also explains and justifies the process and techniques that is being used for obtaining required data. Then after, these research hypotheses are presented. This chapter also includes the evaluation process of gathering data. Finally, the validity and reliability of this research are investigated.

Chapter Four conducts to data analysis collected from hospital cases and the assessment of the results. The main content of this part of research is included, the HIS maturity assessment of hospital cases in accordance with EMRAM and also clarification and determination of effective CSFs for successful implementation and utilization of HISs in the hospitals. The applied tools for these activities are a validated checklist and questionnaire. Moreover, the findings in the previous parts of this chapter will be evaluated. To do this, using an expert panel approach, HIS maturity of hospital cases analysed and effective CSFs investigated and discussed.

Chapter Five looks on the overview of this thesis findings. At first, a summary of this research finding is presented. Then after, the contribution of this research from three different perspectives is explained. Later, suggestions in accordance with these findings are offered, and finally the future researches in this context is given.

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APPENDIX A

EMRAM Model Description

Stage 0: The organization has not installed all of the three key ancillary department systems (laboratory, pharmacy, and radiology).

Stage 1: All three major ancillary clinical systems are installed (i.e., pharmacy, laboratory, and radiology).

Stage 2: Major ancillary clinical systems feed data to a clinical data repository (CDR) that provides physician access for reviewing all orders and results. The CDR contains a controlled medical vocabulary, and the clinical decision support/rules engine (CDS) for rudimentary conflict checking. Information from document imaging systems may be linked to the CDR at this stage. The hospital may be a health information exchange (HIE) capable at this stage and can share whatever information it has in the CDR with other patient care stakeholders.

Stage 3: Nursing/clinical documentation (e.g. vital signs, flow sheets, nursing notes, eMAR) is required and is implemented and integrated with the CDR for at least one inpatient service in the hospital; care plan charting is scored with extra points. The Electronic Medication Administration Record application (EMAR) is implemented. The first level of clinical decision support is implemented to conduct error checking with order entry (i.e., drug/drug, drug/food, drug/lab conflict checking normally found in the pharmacy information system). Medical image access from picture archive and communication systems (PACS) is available for access by physicians outside the Radiology department via the organization's intranet.

Stage 4: Computerized Practitioner Order Entry (CPOE) for use by any clinician licensed to create orders is added to the nursing and CDR environment along with the second level of clinical decision support capabilities related to evidence based medicine protocols. If one inpatient service area has implemented CPOE with physicians entering orders and completed the previous stages, then this stage has been achieved.

Stage 5: The closed loop medication administration with bar coded unit dose medications environment is fully implemented. TheeMAR and bar coding or other auto identification technology, such as radio frequency identification (RFID), are implemented and integratedwith CPOE and pharmacy to maximize point of care patient safety processes for medication administration. The “five rights” of medicationadministration are verified at the bedside with scanning of the bar code on the unit does medication and the patient ID.

Stage 6: Full physician documentation with structured templates and discrete data is implemented for at least one inpatient careservice area for progress notes, consult notes, discharge summaries or problem list & diagnosis list maintenance. Level three of clinical decisionsupport provides guidance for all clinician activities related to protocols and outcomes in the form of variance and compliance alerts. A fullcomplement of radiology PACS systems provides medical images to physicians via an intranet and displaces all film-based images. CardiologyPACS and document imaging are scored with extra points.

Stage 7: The hospital no longer uses paper charts to deliver and manage patient care and has a mixture of discrete data, documentimages, and medical images within its EMR environment. Data warehousing is being used to analyze patterns of clinical data to improve qualityof care and patient safety and care delivery efficiency. Clinical information can be readily shared via standardized electronic transactions (i.e.CCD) with all entities that are authorized to treat the patient, or a health information exchange (i.e., other non-associated hospitals, ambulatoryclinics, sub-acute environments, employers, payers and patients in a data sharing environment). The hospital demonstrates summary datacontinuity for all hospital services (e.g. inpatient, outpatient, ED, and with any owned or managed ambulatory clinics).