COLLABORATIVE HEALTHCARE INFORMATION SYSTEMS IN PRIVACY PRESERVATION BASED ON K-ANONYMIZATION MODEL

ASMAA HATEM RASHID

FACULTY OF COMPUTER SCIENCE
AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2014

COLLABORATIVE HEALTHCARE INFORMATION SYSTEMS IN PRIVACY PRESERVATION BASED ON K-ANONYMIZATION MODEL

ASMAA HATEM RASHID

THESIS SUBMITED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

FACULTY OF COMPUTER SCIENCE
AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2014

UNIVERSITY OF MALAYA

ORIGINAL LITERARY DECLARATION

Name of Candidate: **Asmaa Hatem Rashid** (I.C. / Passport: **G2020396**)

Registration metric number: **WHA100031**

Name of Degree: **Doctor of Philosophy (PhD)**

Title of the thesis: **Collaborative Healthcare Information Systems in Privacy Preservation Based on K-Anonymization Model**.

Field of study: **Information Systems**

I do solemnly and sincerely declare that:

(1) I am the sole author/writer of this work;
(2) This work is original;
(3) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract form, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the work and its authorship have been acknowledged in this work;
(4) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
(5) I hereby assign all and every rights in the copyright to this work to the University of Malaya ('UM'), who henceforth shall be owner of the copyright in this work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
(6) I am fully aware that if in the course of making this work I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candidate's Signature: Date: **24 November 2014**

Subscribed and solemnly declared before.

Witness's Signature: Date: **24 November 2014**

Name:

Designation:

ABSTRACT

Collaboration is an important requirement in health information systems (HISs) because it produces reliable and rigorous evidence that can inform critical decisions related to healthcare services. It aids in the provision of proper and fast treatment to patients. Data privacy preservation is a crucial impediment in achieving collaboration through data sharing in line with collaborative health research through HISs. The study aims (i) to identify the factors and obstructions in technology acceptance in sharing health information among medical staff in a selected hospital in Egypt; and (ii) to determine methods to enhance data sharing based on privacy preservation among the medical staff. As a result, this study has developed a collaborative healthcare information management system (CHIMS) prototype based on the k-Anonymization model which helps to improve collaboration in the sharing of information among medical staff. The K-anonymization measures privacy preservation by generalizing data and preventing re-identification. Generalized data are extensively used in various realms, such as medical research, educational studies, and targeted marketing. In this study, data were collected from two government hospitals in Egypt as case studies. The qualitative approaches used were observation and semi-structured interviews. The semi-structured interviews were conducted with 12 participants from among the medical staff in the selected hospital. The aim of these interviews was to identify the factors that affect technology acceptance and the adoption of collaborative activities. The outcomes of these interviews are to be used to determine the requirements for the CHIMS systems. A member check was used to validate the researcher’s conclusions. Questionnaires were distributed among 60 participants comprising medical staff to evaluate the CHIMS. The results revealed that significant factors were involved, such as management, abilities and skills, culture, attitude towards technologies, and age and time. Accordingly,

privacy concerns significantly affect the technology acceptance and adoption in the sharing of information among medical staff. Nonetheless, the improvement of collaboration among medical staff in data sharing based on privacy preservation in medical research similarly enhances research findings and increases the reliability of healthcare services. The CHIMS was implemented in the selected hospital to evaluate the system's usability and effects in improving collaboration among physicians in sharing information through collaborative health research. The questionnaires method was conducted in the evaluation process. The CHIMS was found to be satisfactory as the mean level of the evaluation of the CHIMS system's acceptance was 4.11 and the scale of Cronbach's alpha score was 0.85. These results demonstrate that the combination of sharing health data based on privacy preservation through HIS improves the collaboration among medical staff and research findings. The proposed model provides a new version of the data intended for scientific research among researchers based on the preservation of privacy; this feature was not available in the old system of the selected hospital. Further research should consider examining collaboration among the HISs of different hospitals regionally when addressing the prevention and control of diseases.

ABSTRAK

Kerjasama adalah suatu keperluan yang penting dalam sistem maklumat kesihatan kerana ia menghasilkan bukti padat yang boleh dipercayai yang dapat memaklumkan keputusan kritikal yang berkaitan dengan perkhidmatan penjagaan kesihatan. Ia membantu dalam penyediaan rawatan yang wajar dan pantas kepada pesakit. Pemeliharaan privasi adalah halangan penting dalam mencapai kerjasama melalui perkongsian data selaras dengan kerjasama penyelidikan kesihatan melalui sistem maklumat kesihatan. Kajian ini bertujuan (i) untuk mengenal pasti faktor-faktor dan halangan terhadap penerimaan teknologi dalam perkongsian maklumat kesihatan di kalangan kakitangan perubatan di hospital yang terpilih di Mesir, dan (ii) untuk menentukan kaedah untuk meningkatkan perkongsian data berdasarkan pemeliharaan privasi di kalangan kakitangan perubatan. Hasilnya, kajian ini telah membangunkan prototaip sistem pengurusan maklumat kerjasama penjagaan kesihatan (CHIMS) berdasarkan model ‘K-Anonymization’ yang membantu meningkatkan kerjasama dalam perkongsian maklumat di kalangan kakitangan perubatan. ‘K-anonymization’ tersebut mengukur pemeliharaan privasi dengan mengeneralisikan data dan mencegah pengenalan semula. Data yang telah digeneralisikan digunakan secara luas dalam pelbagai bidang, seperti penyelidikan perubatan, kajian pendidikan, dan pemasaran yang disasarkan. Dalam kajian ini, data telah dikumpulkan dari sebuah hospital kerajaan di Mesir sebagai kajian kes. Pendekatan kualitatif yang digunakan adalah pemerhatian dan temu bual berstruktur separa. Temu bual berstruktur separa tersebut telah dijalankan dengan 12 peserta daripada kalangan kakitangan perubatan di hospital yang terpilih. Tujuan temubual ini adalah untuk mengenal pasti faktor-faktor yang mempengaruhi penerimaan teknologi dan penggunaan aktiviti kerjasama. Hasil temubual ini akan digunakan untuk menentukan keperluan untuk sistem CHIMS. Satu pemeriksaan ahli telah digunakan untuk mengesahkan kesimpulan yang dibuat oleh penyelidik. Borang

soal selidik telah diedarkan di kalangan 60 peserta yang terdiri daripada kakitangan perubatan untuk menilai CHIMS tersebut. Keputusan menunjukkan bahawa faktor-faktor penting yang terlibat adalah seperti pengurusan, kebolehan dan kemahiran, budaya, sikap terhadap teknologi, dan umur dan masa. Oleh itu, kebimbangan mengenai privasi memberi kesan yang ketara kepada penerimaan dan penggunaan teknologi dalam perkongsian maklumat di kalangan kakitangan perubatan. Walau bagaimanapun, peningkatan kerjasama di kalangan kakitangan perubatan dalam perkongsian data berdasarkan pemeliharaan privasi dalam penyelidikan perubatan juga meningkatkan hasil penyelidikan dan kewibawaan perkhidmatan penjagaan kesihatan. Sistem CHIMS telah dilaksanakan di hospital yang terpilih itu untuk menilai kebolehgunaan sistem tersebut dan kesannya dalam meningkatkan kerjasama di kalangan pakar-pakar perubatan untuk berkongsi maklumat melalui kerjasama dalam penyelidikan kesihatan. Kaedah soal selidik telah dijalankan dalam proses penilaian. Sistem CHIMS didapati memuaskan kerana tahap purata penilaian kebolehgunaan sistem tersebut adalah 4.11 dan skala skor alpha Cronbachnya adalah 0.85. Keputusan ini menunjukkan bahawa gabungan perkongsian data kesihatan berasaskan pemeliharaan privasi melalui sistem maklumat kesihatan meningkatkan kerjasama di kalangan kakitangan perubatan dan hasil penyelidikan. Model yang dicadangkan memperuntukkan versi baru data yang bertujuan untuk penyelidikan saintifik di kalangan penyelidik berdasarkan pemeliharaan privasi; ciri ini tidak terdapat dalam sistem lama hospital yang terpilih itu. Kajian lanjut harus mempertimbangkan kerjasama di antara sistem-sistem maklumat hospital yang berbeza di rantau ini apabila menangani pencegahan dan kawalan penyakit.

ACKNOWLEDGEMENT

First and Foremost, thanks to ALLAH, God of all, for everything in my life. Nothing in my life could be done without His permission, and no success could be gained without His mercy. Thanks to my Country, and to all the people who have supported and assisted me during this study. In presenting this thesis I would like to acknowledge the assistance of several persons, first of all, I would like to pay tribute to my principle supervisor Dr. Norizan Mohd Yasin for his guiding hand throughout the duration of my study at the University of Malaya. His professionalism, charm and reasonableness helped me overcome seemingly insurmountable obstacles along the way. You are a role model to follow. Thanks to the University of Malaya for giving us the chance to study and do researches in a highly scientific environment. My appreciation also extends to the staff and my fellow students within the faculty of Computing & Information Technology whose fellowship and friendly encouragement are so much appreciated.

A respect and love to my parents and all other family members for their love, patience, encouragement and support. Thanks for your support and unconditional love. Even though we are thousands of miles away, you were always there whenever I needed you. You can take all the credit for much of what I have achieved and what I will achieve in the future. This thesis would have never been possible without my loving husband Shady. Thank you for your love and support, you helped me to keep things in perspective. I always be forever thankful to God for giving me a wonderful husband like you, I really love you from the bottom of my heart. Your endless love, education, values, and support in every aspect of my life mean the world to me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLELS

LIST OF ABBREVIATIONS

ICT	Information and Communication Technology
HISs	Health information systems
IS	Information Systems
PITAC	President's Information Technology Advisory Committee
NIH	National Institute of Health
EHRs	Electronic Health Records
TAM	Technology Acceptance Model
EMR	Electronic Medical Record
HIPPA	Health Insurance Portability and Accountability Act
LMICs	Low- and Middle-Income Countries
CHIMS	collaborative healthcare information management systems
RP	Research Plan
HIS	Healthcare Information System
IT	Information Technology
WHO	World Health Organization
TRA	Theory of Reasoned Action
PU	Perceived Usefulness
PEOU	Perceived Ease Of Use
AS	Administrative Simplification
ePHI	Protected Health Information
PPDP	Privacy Preserving Data Publishing
PPDM	privacy preserving data mining
RD	Research Design
IARC	International Agency for Research on Cancer

UNDP	United Nations Development Program
BiOSCED	Biostatistics and Cancer Epidemiology Department
HMIS	Hospital Management Information System
RQs	Research Questions
MD	Medical
MI/HIS	Medical Informatics/Health Information Systems
NE	New Employee
EXE	Experienced Employee
DNCI+No.	Interviewee code
PACS	Picture Archiving And Communication System
ERD	Entity Relationship Diagram
UML	Unified Modeling Language

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The use of information and communication technology (ICT) in healthcare is increasing (Ernstmann et al., 2009) because of its potential to improve the effectiveness and efficiency of healthcare (Kohn, Corrigan, & Donaldson, 1999). Health information systems (HISs) help ensure that patients immediately receive appropriate treatment. Aggelidis and Chatzoglou (2009) mentioned that the use of information systems in the healthcare sector is widely accepted, particularly in hospitals (Aggelidis & Chatzoglou, 2009). Information systems (ISs) improve the quality of services being provided (Scott, 2007). Researchers reported that the failure of hospitals to adopt new ISs will increase inconvenience and loss of trust among patients (E. Ammenwerth, S.Gräber, G.Herrmann, T.Bürkle, & J.König, 2003; Lu, Xiao, Sears, & Jacko, 2005). Thus, HISs have gradually replaced traditional hospital procedures (E. Ammenwerth, et al., 2003; Lu, et al., 2005), and studies have proposed various frameworks for building trustworthy IS solutions for hospitals.

1.1.1 Collaborative HISs

This study investigates the collaborative activities involved in sharing healthcare information among specialists in cancer treatment and research hospitals (hospital A and hospital B) in the Arab Republic of Egypt. Collaboration in HISs is important because, through this practice, patients are provided proper and fast treatment as well as suitable medical data for research (H. Yang, Liu, & Li, 2010). Moreover, organizations are often willing to collaborate with other entities that conduct similar activities, such as hospitals, with the goal of mutual benefit (A. Gkoulalas-Divanis & Loukides, 2011). Significant knowledge patterns can be derived and shared among the collaborative partners by the aggregate of their datasets. Furthermore, public organizations usually must share a portion of their collected data or knowledge with other organizations that have a similar purpose, with some having to make this data and knowledge public. The National Institute of Health (NIH) has endorsed research that aims to improve human health and has provided a set of guidelines for sharing NIH-supported research findings with research institutions (A. Gkoulalas-Divanis & Verykiosc, 2009).

In June 2004, the President's Information Technology Advisory Committee (PITAC) released a report entitled “Revolutionizing Health Care through Information Technology” (Committee, 2004). One of its key points was to establish a nationwide system of Electronic Health Records (EHRs) that encourages the sharing of medical knowledge through computer-assisted clinical decision support. PITAC, defined as a Federal Advisory Committee in America, was authorized by Congress under the High-Performance Computing Act of 1991 (P. L. 102-194) and the Next Generation Internet Act of 1998 (P. L. 105-305) (Program, 2004). The PITAC provides independent advice on maintaining America's pre-eminence in advanced information technologies. Comprised of leading IT experts from the industry and academia, PITAC helps guide the Administration's efforts accordingly to accelerate the development and adoption of information technologies vital for American prosperity in the 21st century (Program, 2004). Data publishing is equally ubiquitous in other domains. EHR is a type of health information technology that assists in storing health data, collaborating to provide better care, reducing paperwork by eliminating the need for paper-based records, and improving administrative efficiency by decreasing healthcare costs. EHRs also improve healthcare by decreasing medical errors with the assurance that all healthcare providers possess accurate and timely information (Bowman, 2012; Wu et al., 2006). Sittig and Singh (2011) and Sullivan (2006) mentioned that EHRs are essential for transforming the present healthcare system into one that is more efficient, secure, and consistent in delivering high-quality care (Sittig & Singh, 2011; Sullivan, 2006). In a hospital environment, the collaboration among medical staff increases the awareness of team members regarding their respective knowledge and skills, which leads to further improvements in decision making and improved research findings in the healthcare sector. Consequently, collaboration is an important requirement in health information systems (HISs) because it produces reliable and rigorous evidence that can inform critical decisions related to healthcare services. It aids in the provision of proper, fast treatment to patients, and healthcare information for research.

1.1.2 Technology Acceptance Model in the Healthcare Sector

As mentioned earlier, the success of these technologies depends on the acceptance level of its users (Ammenwerth et al., 2004). In this context, the technology acceptance model (TAM) (Fred D Davis, 1989), which has been applied and empirically tested over a broad spectrum of ICT applications, is one of the most well-recognized theoretical models (Schepers & Wetzels, 2007; Yousafzai, Foxall, & Pallister, 2007). Recent studies have provided evidence that TAM is an effective predictor of the behavioural intent to accept technology in the health sector (Ducey, 2013; R.J. Holden & Karsh, 2010; Melas, Zampetakis, Dimopoulou, & Moustakis, 2011; Yarbrough & Smith, 2007). ICT has the potential to affect almost every aspect of the health sector. Information management and communication processes are pivotal in public health and are facilitated or limited by available ICT (Chetley, 2007).

Adopting the ISs in a domain of healthcare is crucial, similar to several other domains. Governments, physicians, and hospital administrators are all aware of the benefits of using and enhancing healthcare technologies. In a healthcare system, one of the most important keystones is information. How this information is used differs in each HIS sub domain, which are kept and processed throughout the system (R.J. Holden & Karsh, 2010). Despite the fact that information technology contributes to the organizational structure and progress of healthcare in hospitals, the resistance to use new technologies results in people being unable to adopt the technology. The problem of user acceptance becomes a significant issue with the onset of the computerized, technology-dependent healthcare industry. Research on technology acceptance is a very important field in IS. TAMs are investigated to explain and predict system usage. Although a considerable amount of work has been conducted in this area, certain studies have investigated technology acceptance in healthcare issues (Richard J Holden & Karsh, 2009; R.J. Holden & Karsh, 2010).

PEKER (2010) mentioned that the decisions of the users when adopting the system differ in time (PEKER, 2010). Users can adapt to the system at the very beginning of the implementation process. However, the actual benefits may not be achieved because of a lack of continuous usage. Though this system is considered to give important benefits that improve the quality of patient care, health professionals are unconvinced about other advantages, such as data security, decreased financial cost, decreased amount of work, and the rapid accessibility of patient data from the system (PEKER, 2010). They even believe that the cost of this kind of system will outweigh the benefits. This belief eventually disappears after the positive effects of the Hospital Management and Information Systems are recognized. Based on the studies by Ömürbek (2009), Holden, Karsh (2010) and Yarbrough, and Smith (2007), users will become aware of the benefits of ISs as the need for more secure, stable, and effective systems increases (Ömürbek & Altın, 2009). The growing significance of the reactions of end users to HIS has elevated the importance of theories that predict and explain HIS acceptance and use.

The purpose of IS in the healthcare sector, especially in hospitals, is not only to offer a great potential for improving the quality of the services they provide- as well as the efficiency and effectiveness of the personnel- but also to reduce organizational expenses. However, the main question cited in the literature is whether hospital personnel are willing to use state-of-the-art information technology as they perform their tasks (R.J. Holden & Karsh, 2010; Yarbrough & Smith, 2007).

Venkatesh and Davis (2000) mentioned that significant progress has been noted in the field of IS over the past years with regard to explaining and predicting consumer attitudes toward online collaboration (V. Venkatesh & Davis, 2000). An improved understanding of how people face the possibility of using ISs is therefore necessary in developing new implementation methods. The proposed methods must identify the attitudes of the users toward a system, thereby helping developers improve their systems and maximize possible levels of user acceptance. To date, technology acceptance and online transaction research is considered a mature field in ISs research (P. J. Hu, P. Y. Chau, O. R. L. Sheng, & K. Y. Tam, 1999; Viswanath Venkatesh, Morris, Davis, & Davis, 2003). However, despite the large volume of studies in this area, and although the TAM is considered a well-recognized model in the field of ISs (Gefen, Karahanna, & Straub, 2003), systematic research within the context of healthcare remains lacking, thus indicating a significant gap of knowledge in HIS. Therefore, extending TAM and gaining empirical evidence to support HIS adoption within health organizations by conducting more replication studies is necessary to increase confidence and acceptance of the TAM as a suitable theory in healthcare field (Ducey, 2013; Melas, et al., 2011). Research on online collaboration has been described as one of the most mature areas in IS literature (Bjørn & Ngwenyama, 2009; Ducey, 2013; Paul J Hu, et al., 1999).

1.1.3 Privacy Preservation in Collaborative HISs

By increasing the number of healthcare ISs adopted by medical institutions, the healthcare system has changed dramatically and healthcare data has accumulated rapidly in the past decades (L. Chen, J.-J. Yang, Q. Wang, & Y. Niu, 2012; Egan & Haile, 2012). Electronic Medical Record/Electronic Health Record (EMR/EHR) systems (Dean et al., 2010; Makoul, Curry, & Tang, 2001) are increasingly being adopted. For instance, the EMR/EHR system use in United States, among office-based physicians, increased from 18% in 2001 to 72% in 2012 (Hsiao & Hing, 2012). The collaboration and sharing of this healthcare data among different organizations can result in significant benefits for medical treatment and scientific research, as well as other relevant sectors. Using and sharing electronic healthcare data could improve the efficiency and reduce the costs of a medical institution (Lei Chen, et al., 2012; S. J. Wang et al., 2003). Privacy protection and data-keeping utility remain problems that must be solved (A. Gkoulalas-Divanis & Loukides, 2011). Information privacy in the healthcare sector is an issue of increasing importance. The adaption of healthcare ISs and the increasing need for information among patients, providers, and payers, all point toward the need for better information protection (Appari & Johnson, 2010). The frequency of identity theft continues to increase. Consequently, concerns about the ability of organizations to protect the personally identifiable data with which they are entrusted has also increased (Appari & Johnson, 2010).

According to Piwowar, Becich, Bilofsky, and Crowley (2008), sharing healthcare data is also crucial to academic health centres for research (Piwowar, Becich, Bilofsky, & Crowley, 2008). However, the wide usage and sharing of healthcare data have also resulted in several concerns. In addition, privacy violation has become a public concern (Barrows & Clayton, 1996; Harrison & Ramanujan, 2011). Detailed person-specific data is contained in healthcare data. Thus, analysing the shared data may easily reveal sensitive information about individuals. Research shows that patients could be easily identified using identifiers or specifically combined information (such as age, address, and sex) from a certain healthcare dataset (Lei Chen, et al., 2012).

1.1.4 K-Anonymization Model

Recent developments in healthcare technology enable the collection, storage, management, and sharing of massive amounts of medical data (E. C. Lau et al., 2011). HISs are increasingly adopted in the healthcare sector (Dean, et al., 2010; Makoul, et al., 2001). The use of HISs allows specialists to access comprehensive medical information, to extract knowledge, and reduce medical errors, as well as to collaborate with other specialists and healthcare entities to improve the diagnosis and treatment of diseases. At the same time, reusing medical data offers the potential to improve medical research findings. However, reusing medical data must be performed in a way that addresses important privacy concerns.

Preserving the privacy of medical data is not only an ethical but also a legal requirement that is posed by several data sharing regulations and policies worldwide. For example, in 1996, the Health Insurance Portability and Accountability Act (HIPAA) Title II was enacted in the USA (A. Act, 1996; Nosowsky & Giordano, 2006). One of the purposes of this act was to increase the protection of patients' medical records against unauthorized usage and disclosure. Hospitals, clinical offices, health insurance companies, and other entities governed by HIPAA are now asked to comply with regulations. In 1997, the European Council announced Recommendation R (97) 5 regarding the protection of medical data to enhance the protection of personal healthcare data (DIRECTIVE, 1997). Similar regulations have been enacted in many other countries (Lei Chen, et al., 2012). For example, contracts and agreements cannot guarantee that sensitive data will not be carelessly misplaced and end up in the wrong hands. A task of the utmost importance is developing methods and tools for publishing data in a more hostile environment, so that the published data (shared data) remains practically useful while preserving individual privacy. This undertaking is termed "privacy-preserving data publishing" (B. Fung, Wang, Wang, & Hung, 2009; A. Gkoulalas-Divanis & Loukides, 2011; A. Gkoulalas-Divanis & Verykiosc, 2009). Privacy-preserving data publishing and information security communities have recently begun addressing these issues. Numerous techniques have been developed to address the first problem, which is avoiding potential misuse posed by an integrated data warehouse (Vaidya, Zhu, & Clifton, 2006).

In the past few years, research communities have responded to the challenges of privacy preservation through collaborative activities in sharing data (as mentioned in C. Clifton & Atallah, 2007) to eliminate privacy concerns from patients and help medical institutions or participants comply with privacy protection regulations. These approaches encompass several fields of research. The problems they are trying to address could be classified into three categories:

1- The first category focuses on privacy protection in data sharing during data usage. These kinds of approaches attempt to protect patient privacy by transforming the healthcare data before it is shared. The privacy information may be wiped or reduced after the transforming process. The de-identification approach simply detects the private data and deletes it (Neamatullah et al., 2008). To retain the usability of the transformed data as much as possible, many new models and methods are proposed. Privacy-preserving data publishing models, such as K-anonymity and l-diversity (Benjamin C. M. Fung, Ke Wang, Rui Chen, & Philip S. Yu, 2010), and privacy-preserving data mining models and methods, such as privacy-preserving decision trees and associate rule mining (Aggarwal & Philip, 2008), have been developed as a result of these studies.

2- The second category focuses on privacy data management. Many access control models and systems have been developed to enhance the flexibility of privacy data management and compliance with regulations. Elements such as access purpose, data content, and personal preferences have been brought into these data access management models (Byun, Bertino, & Li, 2005; H. E. Smith, 2001).

3- The third category focuses on privacy data storage and management. Privacy for data storage and management in a cloud environment has attracted plenty of attention in recent years. Approaches for privacy-aware data storage and auditing in a cloud environment are proposed to protect private data (Itani, Kayssi, & Chehab, 2009; C. Wang, Wang, Ren, & Lou, 2010).

All approaches listed above may be used in privacy data sharing or management in some way. Many abstract frameworks have been proposed to realize privacy protection during data sharing, such as a framework for privacy preserving data sharing proposed by Chen (2004). Kennelly (2009) developed an Internet data-sharing framework for balancing privacy and utility. However, to the best of our knowledge, few research works about healthcare data sharing frameworks that preserve the privacy of users offer a practical view for real life application (Lei Chen, et al., 2012).

Nevertheless, one set of methods that would allow health information to be used and disclosed under existing legal frameworks is de-identification. De-identification refers to a set of methods that can be applied to data to ensure that the probability of assigning a correct identity to a record in the data is very low (El Emam & Fineberg, 2009; El Emam, Jonker, & Fineberg, 2011a). Recent studies (Bayardo & Agrawal, 2005b;

Campan & Truta, 2009; El Emam et al., 2012; El Emam & Dankar, 2008b; El Emam et al., 2009; Goryczka, Xiong, & Fung; Wei Jiang & Chris Clifton, 2006; Jurczyk & Xiong, 2009; LeFevre, DeWitt, & Ramakrishnan, 2005; Parmar, Rao, & Patel, 2011; Sacharidis, Mouratidis, & Papadias, 2010; Sokolova et al., 2012; Sweeney, 2002a, 2002c; Tassa & Gudes, 2012; Truta & Vinay, 2006) indicate that the K-anonymity model provides a formal way of generalizing this concept because K-anonymity provides a measure of privacy protection by preventing the re-identification of data to fewer than a group of K data items. As stated in Sweeney and Samarati (Pierangela Samarati, 2001; Sweeney, 2002a, 2002c), a data record is K-anonymous if and only if it is indistinguishable from its identifying information, including K-specific records or entities. The key step in making data anonymous is to generalize a specific value. Generalized data can be beneficial in many situations (Lei Chen, et al., 2012; W. Jiang & C. Clifton, 2006). Many applications are used to generalize data in different areas, including medical research, education studies, and targeted marketing.

The subsequent discussion explains the main features of the K-anonymity model as mentioned in recent literature. K-anonymity is a simple and effective (Sweeney, 1997; Sweeney, 2002c) model that provides a measure of privacy protection by preventing the re-identification of data to fewer than a group of K-data items (Wei Jiang & Chris Clifton, 2006; Narayanan & Shmatikov, 2009). It provides a formal way of generalizing this concept (Pierangela Samarati, 2001; Sweeney, 2002a, 2002c), and minimizing data utility loss while limiting disclosure risk to an acceptable level (Morton, Mahoui, & Gibson, 2012). In addition, the K-anonymity model is a simple and practical model for data privacy preservation (Chiu & Tsai, 2007), and it guarantees that the data released is accurate (Barak et al., 2007). Gkoulalas and Loukides (2011) mentioned that 62% of individuals worry that their electronic medical records will not remain confidential (A. Gkoulalas-Divanis & Loukides, 2011), and 35% expressed privacy concerns regarding the collaboration (publishing and sharing) of their data (Ludman et al., 2010). Figure 1.1 shows the motivation for this work.

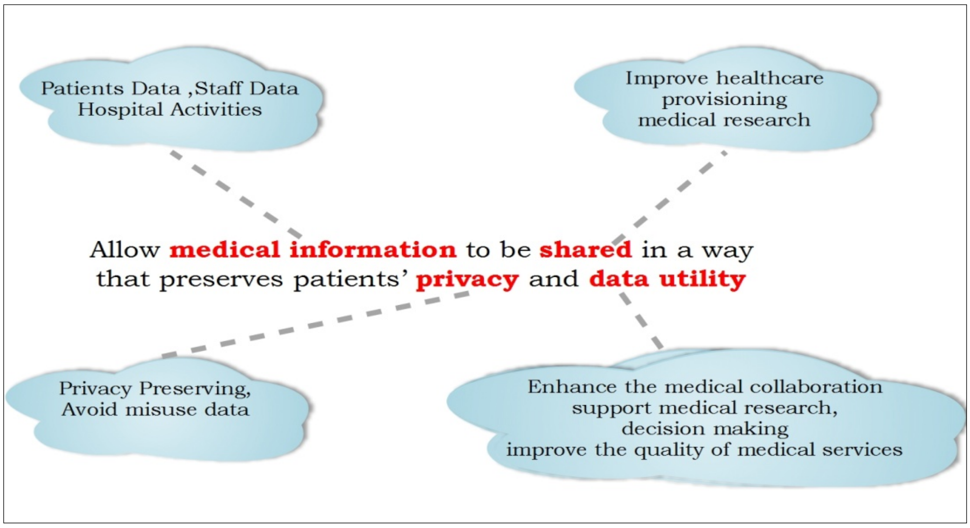


Figure 1.1: Research Motivation (A. Gkoulalas-Divanis & Loukides, 2011)

As shown in Figure 1.1, the motivational importance of the subject is to allow the collaboration of medical data by privacy preservation and data keeping utility (although HISs are known to directly affect patient care in both positive and negative ways) and to encourage work and research in the area of data confidentiality and privacy preservation in various areas, particularly in the healthcare sector.

1.1.5 Collaborative Healthcare information Management Systems CHIMS

Cancer is a major public health problem in developing countries. According to the International Agency for Research on Cancer (Dey & Soliman, 2010), the rate burden of cancer is rising. Almost 70% of cancer cases are from low- and middle-income countries (LMICs). Two-thirds of the world population resides in the Arab world and Asia, which also has the largest regional concentration of LMICs. In 2007, cancer claimed the lives of approximately 7.6 million people worldwide (Lingwood et al., 2008; Quan et al., 2008).

In Egypt today, the number of new cancer patients per year is estimated to be 70,000. Added to this number are another 250,000 patients accumulated from previous years that require medical care. Accumulated patients represent more than three times the number of new cases. This patient load will expand in the future as the population continues to grow and as the prevalence of known etiologic factors increase. Egyptian patients with cancer usually present themselves for treatment at a relatively advanced stage of their disease, which has a negative impact on treatment results (Inas. Elattar, 2005).

However, this study is primarily concerned with the collaboration among specialists in selected Egyptian hospitals, such as physicians and researchers, when sharing healthcare information using HISs for research based on privacy preservation within the same hospital departments and/or among different hospitals. It aims to improve this collaboration among medical staff to enhance healthcare services and research findings. This aim can be achieved by developing an integrated collaborative HIS that supports the sharing of appropriate and relevant healthcare information based on the requirements of specialists (Skilton, Gray, Allam, Morry, & Bailey, 2008). HISs should use web-based applications for sharing healthcare information among practitioners, especially physicians, who work at different healthcare centres to enhance research work in the field (Skilton, Gray, Allam, & Morrey, 2007). Given the importance of research systems in improving collaboration among specialists and in enhancing services, the collaborative healthcare information systems (CHIMS) model is proposed for developing an integrated collaborative system.

1.2 Problem Statement

Healthcare information systems (HISs) in healthcare organizations, such as hospitals, are important for providing and sharing healthcare information among medical staff, especially physicians and researchers (H. Yang, et al., 2010). In addition, collaboration is an important requirement for HISs (N.S. Ahmed & Yasin, 2012). The term "collaboration" in the field of healthcare is defined as the communication that occurs among healthcare practitioners when sharing information and skills regarding patient care (Gaboury, Bujold, Boon, & Moher, 2009; Scandurra, Hägglund, & Koch, 2008; Weir et al., 2011). Furthermore, healthcare information is valuable to many organizations for scientific research or analysis (L. Chen, J. J. Yang, Q. Wang, & Y. Niu, 2012). Sharing this healthcare data among different organizations can significantly benefit both medical treatment and scientific research in relevant sectors (Hillestad et al., 2005; S. J. Wang, et al., 2003; H. Yang, et al., 2010). Nevertheless, healthcare data typically contains considerable private information. Sharing this data would directly pose a threat to patient privacy. Thus, developing practical models to balance healthcare data sharing utility and privacy preservation is necessary in order to improve collaboration among physicians (L. Chen, et al., 2012; B. C. M. Fung, K. Wang, R. Chen, & P. S. Yu, 2010; A. Gkoulalas-Divanis & Loukides, 2011; LeFevre, DeWitt, & Ramakrishnan, 2006; B. Wang & Yang, 2011).

The collaboration among physicians in sharing information using HISs in the patient treatment or research activities within the hospital environment in many developing countries, including Egypt, is very weak (Organization, 2010; M. C. Reddy, Gorman, & Bardram, 2011). This weakness occurs due to decentralized and autonomous units and a lack of shared goals within healthcare systems; many HISs are isolated from one another because of the fragmented nature of healthcare systems (Fried, Carpenter, &

Deming, 2011). Disintegrated HISs and manual systems hinder information sharing and collaboration among physicians, thus impeding and delaying optimal use of healthcare resources because large amounts of data are difficult to manage and control in a system that uses paper (Tierney et al., 2010; VanVactor, 2012). Another important factor that affects collaboration among physicians is the concern of privacy, which raises the necessity of improving collaboration among medical staff through HISs. Effective implementation of HISs requires trust from both the providers who use them and the patients they serve (Blumenthal, 2009; Lei Chen, et al., 2012; Goldzweig, Towfigh, Maglione, & Shekelle, 2009). In such cases, sharing information regarding patients' treatment and medical research among hospitals is difficult. The aforementioned factors critically affect technology acceptance in hospitals and collaboration among physicians, which can lead to poor patient outcomes (Reddy, et al., 2011). The bigger challenge is strengthening sharing of healthcare information among physicians and researchers in the same or different hospitals, many of which still rely on paper-based records, especially in Egypt. As such, introducing new activities to hospitals is a difficult process. These activities are important in enhancing healthcare services. Collaborative HISs based on privacy preservation rarely handle healthcare information sharing among physicians and researchers at different places. They need to collaborate and communicate with each other to improve research findings that lead to enhanced care for patients. The need to address such collaboration among physicians and researchers in research activities based on privacy preservation is of utmost importance.

1.3 Objectives of the Research

This study aims to:

1- Identify factors that affect technology acceptance with regard to collaboration in sharing information among specialists within selected Egyptian hospitals based on privacy preservation;

2- Determine the main obstacles in adopting technology with regard to collaboration in sharing information among specialists within selected Egyptian hospitals based on privacy preservation;

3- Determine the characteristics required in the developed model to improve collaboration among specialists in the field of healthcare based on privacy preservation with regard to sharing of information; and

4- Develop, evaluate, and validate a CHIMS model intended to improve collaboration among specialists with regard to sharing health information.

1.4 The Research Questions

Based on the objectives listed in Section 1.3, the following research questions have been formulated:

1- What factors affect technology acceptance within selected Egyptian hospitals with regard to collaboration in sharing information among specialists based on privacy preservation? (Objective 1)

2- What are the key obstacles that affect the collaboration among specialists with regard to sharing information within selected Egyptian hospital based on privacy preservation? (Objective 2)

3- What are the characteristics required in the developed model to improve collaboration among specialists in the field of healthcare based on privacy preservation with regard to sharing of information? (Objective 3)
4- What system requirements should be in the CHIMS model? (Objective 4)
5- How can we evaluate, rate, and validate the use of CHIMS in improved collaboration with regard to sharing health information among specialists based on privacy preservation? (Objective 4)

1.5 Significance of the Study

Healthcare information systems in the health sector are important for enhancing collaboration among medical staff through the sharing of healthcare information in a hospital environment. An extensive literature review found no studies on the development of a collaborative HIS environment to improve the interaction among medical staff in hospitals. Therefore, this study proposes a CHIMS model to improve collaboration among medical staff with regard to sharing health information in collaborative research based on privacy preservation. Subsequently, through this study, the following effects would be achieved:

1- The integration of a healthcare system leading to decreased, decentralized, and more autonomous data in healthcare organizational units using the proposed CHIMS model for selecting objectives and functions and for collaborating with other units.
2- Enhanced healthcare services by improving technology acceptance with regard to sharing information; sharing this healthcare information among different healthcare organizations will result in significantly beneficial medical treatment, scientific research, and other relevant sectors.

3- Improved trust in technology in the healthcare sector through enhanced medical staff skills and enhanced research work by sharing healthcare data within the same hospital or with different hospitals.

4- Creating an integrated navigation system for medical staff; allowing researchers to search for relevant information to improve research findings.

5- Development of a more open and flexible collaborative HIS structure that quickly adapts to changes in the healthcare environment.

1.6 Scope of the Research

This study aims to identify factors that affect technology acceptance within select Egyptian hospitals. It also examines obstacles in adopting technology to enhance collaboration among medical staff with regard to sharing healthcare information for research within the hospital environment. Furthermore, this research proposes an integrated collaborative HIS model to improve collaboration among medical staff (physicians and researchers) with regard to sharing healthcare information and skills within the hospital environment.

1- Given the diverse means of collaboration among medical staff, especially among physicians, this study focuses only on collaboration among physicians when sharing information through collaborative research within the same hospital and with other hospitals.

2- This research only covers select government hospitals, not private ones, because of the difficulty in establishing connections and distributing healthcare information between government and private hospitals.

3- This research was restricted to selected cancer institutes in government hospitals because of the difficulty in studying the entire healthcare system.

4- Teaching hospitals were also among those considered to address the research unit activities within the hospital environment.

5- The selected cancer centre is a leader in the Middle East and Africa. It serves more than 15,000 new cases and more than 250,000 patients visit every year (I. Elattar, 2004; J. Ferlay et al., 2010; E. Salim, 2010).

1.7 Limitations of the Research

The study focused only on the collaboration among physicians with regard to sharing information through collaborative research based on privacy preservation among physicians and researchers in selected hospitals in Egypt. Other types of collaboration among medical staff, such as through chatting and video conferences, were not considered in this research. The implication of this study is that sharing healthcare information among medical staff using collaborative HISs based on privacy preservation is likely indicative of a greater potential to enhance research findings that can improve human health and healthcare services such as research.

1.8 Research Plan

The research plan (RP) is the schema to be followed when conducting research. It aids and organizes the steps and processes for the execution of the requirements; it also improves performance so that the research goals are achieved in an ideal way (Creswell, 2007; Vaishnavi, Vaishnavi, & Kuechler, 2007). Figure 1.2 shows the RP.

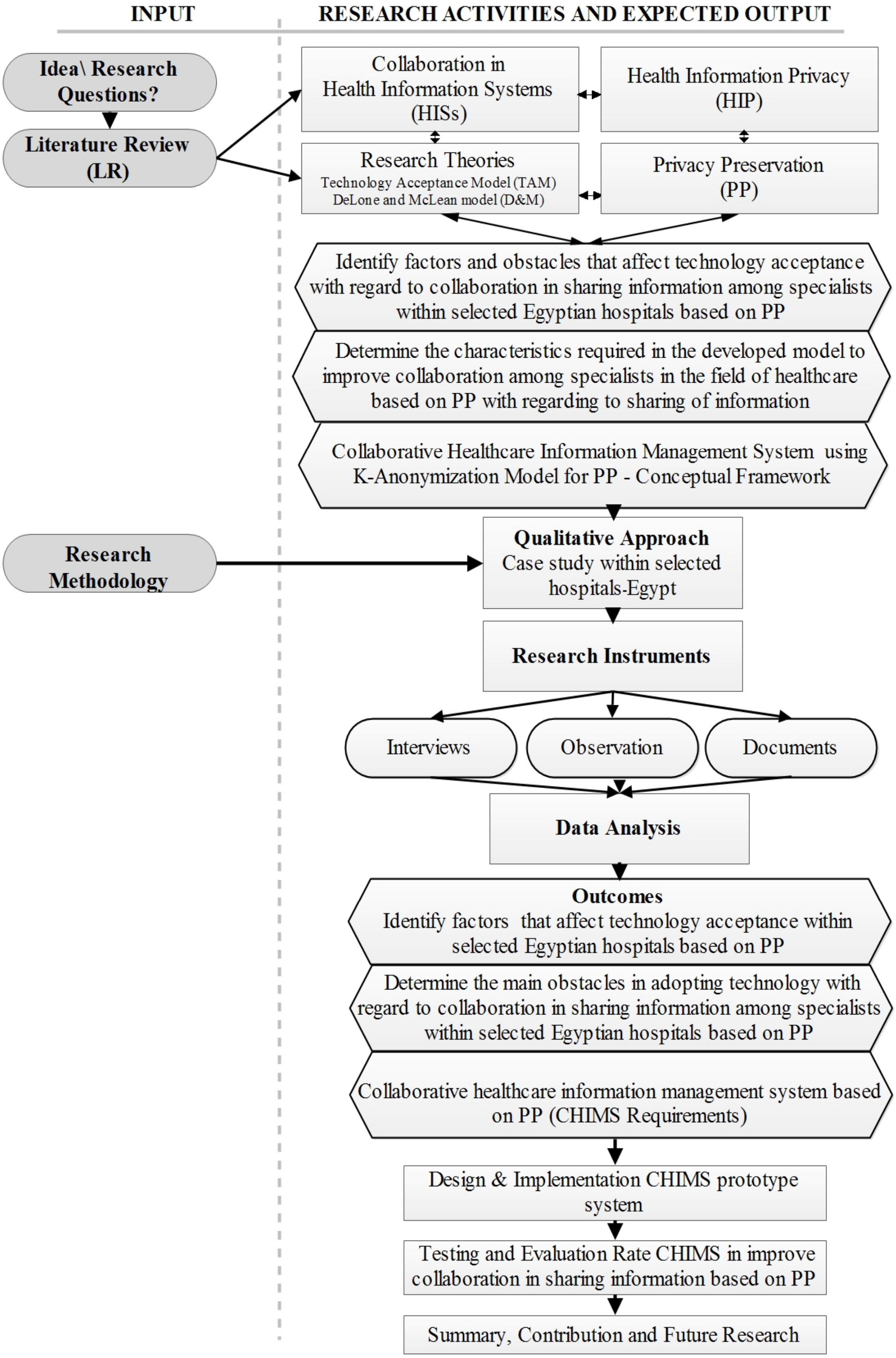


Figure 1.2: Thesis Research Plan

1.9 Organization of the Thesis

The previous section in this chapter explains the background of the study and introduces the use of HISs in healthcare organizations to improve the collaboration among medical staff when sharing healthcare information in research through privacy preservation within the hospital environment. This section is followed by the statement of the problem, the main objectives, the research questions, the scope of research, the limitations, the research plan, the significance of the study, the organization of the study, and a summary.

Chapter 2 examines the healthcare ISs and collaboration feature in healthcare research based on privacy preservation in terms of sharing healthcare information among medical staff within the same hospital and within other hospitals. The chapter also explains the TAM in the healthcare sector and explains the factors that affect the adoption of HISs in the healthcare sector. Chapter 2 also reviews privacy preservation for healthcare information via collaborative HIS and related theories. Furthermore, this chapter introduces the concept of the anonymization approach, its features, and its implementation in designing K-anonymization-based IS in general and in developing a collaborative HIS environment in particular, which are followed by a summary and a discussion of its implications.

Chapter 3 discusses the research design, the instruments used, and the data collection methods. It then explains how the proposed system was implemented, tested, and evaluated.

Chapter 4 presents the details of the selected Egyptian hospital that participated in this research as a case study.

Chapter 5 presents the results of the data analysis that addresses the research questions and requirements of the participants for the CHIMS model.

Chapter 6 presents the design and implementation of the CHIMS, such as a description of the development platform and the use of various modules. Later, this chapter shows the evaluation process of the CHIMS and its results.

Chapter 7 summarizes the entire research by examining the steps taken to achieve the objectives of the study. It discusses the findings and gives recommendations on directions for future research. Finally, it provides the concluding remarks for the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The review of relevant literature assisted the researcher in determining the extent of the research conducted with regard to the topic. Furthermore, the review exercise made it easier for the researcher to define the research problem. The review process also yielded new concepts and terms relevant to the study. It helped to identify and discuss the theoretical framework used as the foundation for the development of collaborative healthcare information systems (HISs) to improve collaboration among specialists in terms of sharing information in the healthcare field.

This chapter begins with a brief introduction to HISs in the healthcare sector. This introduction is followed by: (1) a review of related literature on collaboration among medical staff using HISs regarding to sharing healthcare information within the hospital in research; in order to identify factors that affect technology acceptance with regard to collaboration in sharing information using HISs based on privacy preservation; (2) a review of the technology acceptance model (TAM) in the healthcare sector; (3) an overview and critical analysis of several models for the preservation of privacy in collaborative HISs and identifying the privacy preservation challenges; and (4) a discussion of the k-anonymization model and its features. This discussion follows the anonymization approach to build collaborative HISs based on the preservation of privacy. The next section discusses the adaptation of the k-anonymization model in collaborative HISs to propose a conceptual model of collaborative HISs (CHIMS) to address the research problem. Finally, the literature review is summarized in relation to the research questions and a proposed conceptual model for a collaborative HIS environment is presented based on the anonymization approach.

2.2 Healthcare Information Systems (HISs): Introduction

The application of information technology (IT) has become significant in the healthcare sector. The rapid and significant advances in information and communication technology (ICT) as well as infrastructures have undoubtedly provided benefits and opportunities to countries and organizations, particularly in the healthcare field (Buntin, Burke, Hoaglin, & Blumenthal, 2011). Healthcare organizations consist of individual centres, such as hospitals. Technology in hospitals is supported by autonomous HISs (Fedele & Srl, 1995). HIS systems, such as electronic health records (EHRs), in hospitals include electronic information, such as inpatient records and laboratory data (Al-Khawlani, 2009; Mäenpää, Suominen, Asikainen, Maass, & Rostila, 2009). These HISs are used in hospitals under different names based on the work environment and the different healthcare services provided (K. Li & Yao, 2006). Several examples of medical ISs in hospitals are hospital ISs, RIS, LIS, and PACS. HIS systems use effective processes to meet the needs of the departments in providing healthcare information to the medical staff (K. Li & Yao, 2006; SADREDDINI, 2012). HISs were first presented in hospitals three decades ago to help medical staff with their daily work (Tzu-Hsiang. Yang, Sun, & Lai, 2011). The healthcare sector has always relied on technology. According to the World Health Organization (WHO) (2004), technology forms the backbone of the services given to prevent, diagnose, and treat illness and disease.

Tan (2005) describes HISs as a synergy of three disciplines: healthcare management, organization management, and information management (Tan, 2005). Rada (2008) agrees with these views and recognizes that HISs are only partly based on the application of management information system concepts to healthcare (Rada, 2008). Rodrigues (2009) mentioned that HISs are powerful ICT-based tools that enable a more effective and efficient delivery of healthcare (Rodrigues, 2009). Locatelli, Restifo, Gastaldi and Corso (2012) mentioned that the HISs are comprised of several different applications that support the needs of healthcare organizations, physicians, patients, and policy makers when collecting and managing data related to both clinical and administrative processes (Locatelli, Restifo, Gastaldi, & Corso, 2012).

HISs benefits also reduce paperwork by eliminating the need for paper-based records and by improving administrative efficiency (Buntin, et al., 2011). HISs improve healthcare by decreasing the number of medical errors and ensuring that all healthcare providers will have accurate and timely information (D. Bates et al., 2001). Health information technology has generally been increasingly viewed as the most promising tool for improving the overall quality, safety, and efficiency of the health delivery system (Black et al., 2011; Kaushal, Barker, & Bates, 2001; Sinha, 2010). The ultimate aim of HISs in healthcare is providing optimal informational support to healthcare professionals, managers, and policy makers for quality decision making, care, and treatment. HISs are highly secure, economical, easy-to-use, and always available (Lippeveld, Sauerborn, & Bodart, 2000; Sinha, 2010; Unertl, Johnson, & Lorenzi, 2012).

In the process of achieving these goals, the improvement in the adoption of HISs, such as EHRs and innovations in healthcare delivery, have reached unprecedented levels (Fichman, Kohli, & Krishnan, 2011). A number of studies on the benefits of HISs have been conducted in the healthcare sector. These studies determined their effect on outcomes, including quality, efficiency, and provider satisfaction. Three systematic reviews of peer-reviewed studies about the benefits of adopting HISs in healthcare systems have been conducted and covered from 1994 to 2010 (Buntin, et al., 2011;

Goldzweig, et al., 2009; Wu, et al., 2006). Buntin and Burke (2011) cover the findings of these reviews and mentioned that 92% of recent articles on health IT reached conclusions that were generally positive (Buntin, et al., 2011). Moreover, they found that the benefits of this technology were beginning to emerge in smaller practices and organizations as well as in larger organizations that were early adopters. However, dissatisfaction with EMRs among some providers continued to hinder the potential of health IT. These realities highlight the need for studies that document the challenging aspects of the more strategic implementation of health IT and how these challenges may be addressed. Figure 2.1 summarizes the aforementioned findings on the benefits of health IT to the healthcare sector.

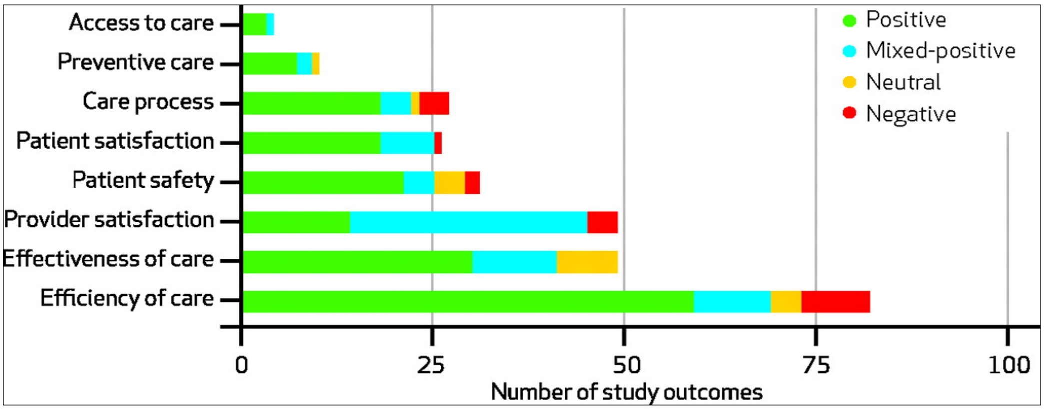


Figure 2.1: Evaluations of Outcome Measures of Health Information Technology, By Type and Rating (Buntin, et al., 2011)

2.3 Collaboration and HISs Within Hospital Environments

The term "collaboration" in the healthcare field is defined as the communication among healthcare practitioners when sharing information and skills regarding patient care (Gaboury, et al., 2009; Scandurra, et al., 2008; Weir, et al., 2011).

Collaboration in healthcare occurs when healthcare professionals assume complementary roles and cooperate with one another; they share responsibility for problem solving and decision making, and work toward common goals in patient care (Baggs & Schmitt, 1988; Fagin, 1992; O'Daniel & Rosenstein, 2008; Patel, Pettitt, & Wilson, 2012). Collaboration among medical staff increases the awareness of team members regarding their respective knowledge and skills, which leads to further improvements in decision making (Christensen & Larson, 1993; O'Daniel & Rosenstein, 2008). According to Reddy, Gorman, and Bardram (2011), an established cooperation among physicians and healthcare workers requires an appropriate communication system (M. C. Reddy, et al., 2011). In the field of healthcare, various types of communication and information exchange occur among medical staff to support collaboration (Abdullah, Selamat, Sahibudin, & Alias, 2005). Face-to-face collaboration and verbal communication among medical staff in hospitals are examples of such collaboration. Another type of collaboration is synchronous collaboration, which uses video conference and telemedicine systems (Hameed et al., 2008). Another type of collaboration is asynchronous collaboration, in which hospital staff use electronic health records (EHRs) as tools for communication (Collins, Bakken, Vawdrey, Coiera, & Currie, 2011). Finally, a distributed synchronous collaboration is another type of collaboration wherein practitioners can cooperate with each other by sharing healthcare information and activities at different times and places. HISs are a type of asynchronous and distributed synchronous collaboration. Such systems provide patient information about their work to medical staff (Tzu-Hsiang. Yang, et al., 2011). HISs use many types of collaboration among medical staff. HISs in hospitals were developed to allow the easy exchange of patient information among medical staff. As noted in various studies, HISs can be an important factor in improving collaboration among medical staff who share healthcare information with other health workers within and outside their hospitals (Gaboury, et al., 2009; Mäenpää, et al., 2009; Tzu-Hsiang. Yang, et al., 2011). The literature review in this section covers a number of relevant issues regarding collaboration among medical staff from different departments or hospitals. This section discusses the collaboration among medical staff in terms of sharing healthcare information through HISs. The factors that affect collaboration among medical staff that use HISs have been identified. Researchers have directed their attention toward studying the role of collaboration in healthcare and how to support collaboration among medical staff more effectively.

Kuziemsky and Varpio (2011) carried out a study to enhance care delivery and develop an HIS design to support it. They determined that poor collaboration among medical staff motivated the design for HISs that support asynchronous collaboration among care providers, which was still lacking. The previous study also discovered that processing an HIS that supports such collaboration is necessary. Therefore, the aforementioned researchers proposed a model that enhances such collaboration and provide a basis for HIS designs that support asynchronous collaboration within the hospital (Kuziemsky & Varpio, 2011).

Li and Yao (2006) and Yang, Liu, and Li (2010) explained that integrated HISs in hospitals can improve the level of medical services and allow medical staff to collaborate with each other across distances. The same researchers also noted that current HISs in hospitals are isolated from each other and are usually designed to serve individual departments within hospitals. The lack of shared information results in poor collaboration among medical staff in hospitals (K. Li & Yao, 2006; Tzu-Hsiang. Yang, et al., 2011).

Results show that poorly computerized systems may result in a lack of collaboration among medical staff and consequently lead to patient harm (M. C. Reddy, et al., 2011; Weir, et al., 2011). According to Reddy (2011), establishing collaboration among medical staff requires an efficient communication system. In the field of healthcare, medical staff collaborate by using various types of communication and methods of sharing information (M. C. Reddy, et al., 2011).

Accordingly, the collaboration in HISs is important because it provides patients with proper and fast treatment as well as suitable medical data for research (H. Yang, et al., 2010). Moreover, organizations are often willing to collaborate with other entities who conduct similar activities, such as hospitals, to achieve mutual benefits (A. Gkoulalas-Divanis & Loukides, 2011). Significant knowledge patterns can be derived and shared among collaborative partners through the aggregation of datasets. Furthermore, public organizations usually have to share a portion of their collected data or knowledge with other organizations that have a similar purpose; sometimes, organizations are even required to make this data and knowledge public. The National Institute of Health (NIH) has endorsed research and aims to obtain significant findings that can improve human health. It has also provided a set of guidelines for the sharing of NIH-supported research findings with research institutions (A. Gkoulalas-Divanis & Verykiosc, 2009).

In June 2004, the President's Information Technology Advisory Committee (PITAC) published a report entitled "Revolutionizing Health Care Through Information Technology" (Committee, 2004). One of the key points of this report was the establishment of a nationwide system of EHRs that encourages the sharing of medical knowledge through computer-assisted clinical decisions. Data publishing is equally ubiquitous in other domains. EHRs are a type of health IT that assist in storing health data and improving collaboration to provide better care. EHRs also reduce the necessity for paperwork by eliminating the need for paper-based records and by improving administrative efficiency, thereby decreasing healthcare costs. EHRs improve healthcare by decreasing medical errors with an assurance that all healthcare providers will have accurate and timely information (Bowman, 2012; Wu, et al., 2006).

Sittig and Singh (2011) and Sullivan (2006) mentioned that the EHRs are essential for the transformation of the current healthcare system into one that is more efficient and secure, while consistently delivering high-quality care (Sittig & Singh, 2011; Sullivan, 2006).

A number of developing countries still use manual, stand-alone work systems in their hospitals. Studies also indicate that using manual and individual systems has resulted in insufficient collaboration among medical staff. Furthermore, a number of hospitals use both manual and computerized systems because of the complexity of healthcare system environments (Blaya, Fraser, & Holt, 2010; Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007; Fraser et al., 2005; Gaboury, et al., 2009; Heeks, 2002; Mamlin et al., 2006; Tierney, et al., 2010; VanVactor, 2012). According to Schabetsberger et al. (2006), replacing manual systems with computerized systems in hospitals can improve collaboration among medical staff with regard to sharing patient information (Schabetsberger et al., 2006).

Blumenthal (2009) mentioned that the medical staff in the healthcare sector work independently (Blumenthal, 2009). This study also indicates that working independently affects collaborations about patient treatment as well as obtaining research findings (Blumenthal, 2009; Goldzweig, et al., 2009).

Recent literature indicates numerous issues relevant to collaboration in the healthcare sector through HISs. Adams (2003) and Blumenthal (2009) highlighted the effect of a lack of connectivity when adopting HISs and staff collaboration in healthcare centres (K. M. Adams & Corrigan, 2003; Blumenthal, 2009). Decentralized and autonomous units show a lack of shared goals, which is common among healthcare systems (Fried, et al., 2011). Researchers have directed their attention toward studying the issues of trust and their influence on collaboration among medical staff. These studies indicate that security issues and privacy concerns are highly relevant to improving the collaboration among medical staff through HISs. For HISs to be implemented effectively, these systems must be trusted by both the providers who use them and the patients they serve (Blumenthal, 2009; Goldzweig, et al., 2009).

The socio-technical challenges faced by health workers, particularly clinicians, likewise serve a significant function. Mengiste (2010) carried out a study to explore the challenges of transforming paper-based systems into computerized systems in Ethiopia, another developing country (Mengiste, 2010). Many healthcare systems in this country still use manual systems. The study also showed that implementing HISs in Ethiopia is difficult because the country faces socio-technical challenges in adapting and implementing such systems. Ethiopia does not have adequate resources (such as infrastructure and stable healthcare systems) or knowledge on information technology. Finally, Mengiste's study recommended considering socio-technical issues and factors that affect the process of adapting and implementing HISs in different healthcare settings, especially in developing countries. Furthermore, many studies highlight the socio-technical challenges in healthcare field (Croll, 2009; Despont-Gros, Mueller, & Lovis, 2005; Gagnon et al., 2003; R.J. Holden & Karsh, 2010; Moores, 2012; Succi & Walter, 1999; Zheng, Padman, Krackhardt, Johnson, & Diamond, 2010), such as the fact that medical staff (i.e. physicians) have been shown to be non-receptive to ICT in their work despite their awareness of its myriad of benefits.

According to Ezzat, S. (2014), the main challenges of establishment collaboration of case-control studies and conducting epidemiologic studies of cancer in middle- and low-income countries, including Egypt (Ezzat, 2014), these challenges are as follows:

(1) Recruitment of cases

(a) Selection of study sites to recruit an adequate sample size.

(b) There is not enough cooperation between centres.

(c) Lack of interest among study clinicians.

(d) Variety of patient backgrounds.

(e) An increased number of participating centres requires adjustment of the study procedures to suit each centre.

(2) Confirmation of cases

(a) Standardizing the diagnosis of a disease that has a clinical component.

(b) Diseases with clinical diagnosis can be independent.

(c) Identifying study subjects with a specific disease before treatment is initiated from among many patients seen at study hospitals.

(d) ALL confirmation is based on different lab criteria.

(3) Recruitment of Controls

(a) Convincing the study collaborators that recruiting controls is as important as recruiting cases.

(b) Finding interviewers who are available during visiting hours.

(c) Finding visitors who meet the matching criteria for age and geographic residence.

(d) Orthopaedic controls.

(e) Not matching the residence.

(f) Other hospital controls.

(g) Population controls.

(4) Logistics of implementation

(a) Low budget.

(b) Low technology setting.

(c) Crowded and busy hospitals.

(5) Difficulty conducting the Questionnaires and Interviews

(a) Patients may come from different countries or different areas (rural and urban).

(b) Specific cultural sensitivities.

(c) Different languages (different dialects of Arabic).

(d) Translating questionnaires to standard Arabic whereas most patients have different spoken Arabic dialect.

(e) The issue of consent (as some people don't have this culture).

(6) Biologic Specimens

(a) Ensuring that the method of fixation is standardized between different centres.

(b) Obtaining sufficient tumour tissue.

(c) Obtaining tumour tissues for cases diagnosed outside the participating hospitals.

(d) Reluctance of collaborators and patients to share their tissue outside of their home country.

(7) Data Management

(a) Lack of high efficiency computer systems.

(b) Lack of available high speed internet.

(c) Absence of remote access to computers.

(d) Absence of institutional servers with automatic backups.

(8) Training

(a) Visa issues between different countries.

(b) Difficulty of agreeing on one place and time where collaborators are able to leave their routine hospital work.

(9) Regulatory Requirements

(a) Approval from institutional review boards (IRBs) at different sites.

(b) IRB committees don't meet until they have a sufficient number of protocols to review.

(c) Not all collaborators check their mail regularly, so they miss notifications that registrations need to be renewed.

Information privacy in the healthcare sector is an issue of growing importance. The adoption of health IT and the increasing need for information among patients, providers, and payers point toward the need for better protection of information (Appari & Johnson, 2010). Moreover, the number of concerns about the competence of the organization in protecting personally identifiable data it has been entrusted with has increased as the frequency of identity theft continues to rise (Appari & Johnson, 2010). The evolution and development of information and technology pose greater threats to the privacy of information and its confidentiality (Appari & Johnson, 2010; A. Gkoulalas-Divanis & Loukides, 2011; Wallis, 2006).

One of the most important keystones in the healthcare field is information. The methods of using information differs in each sub-domain of health ISs (R.J. Holden & Karsh, 2010). This information can be used throughout a number of systems for a number of different purposes (Locatelli, et al., 2012; Wickramasinghe & Geisler, 2008). Such information has to be integrated with data from other entities for it to be effective (Pascot, Bouslama, & Mellouli, 2011). In particular, patient data must be subject to strict rules in terms of confidentiality, security, and privacy safeguards (Locatelli, et al., 2012). For example, one issue involves health data being reused for other purposes, such as medical research, among different HISs. This challenge in the IT field involving health information privacy has received much attention in research communities. The response to the various threats confronting IT systems has come in various forms and from several disparate quarters. The U.S. government, through legislative enactments such as the Health Information Privacy and Accountability Act (HIPAA), has recently specified several security, privacy, confidentiality, and internal control compliance standards for organizations that handle certain data (Nosowsky & Giordano, 2006).

According to Ohno-Machado (2013), privacy is an important requirement for collaboration in data sharing (Ohno-Machado, 2013). However, privacy concerns tend to become obstacles in collaboration regarding sharing information (A. Gkoulalas-Divanis & Loukides, 2011).

El Emam and Dankar stated (2008) there is increasing pressure to share health information and even make it publicly available. However, such disclosures of personal health information can raise serious privacy concerns (El Emam & Dankar, 2008a).

Gkoulalas and Loukides (2011) stated that the privacy concerns affect sharing healthcare information with different parties (A. Gkoulalas-Divanis & Loukides, 2011), while also playing an important role in sharing healthcare information in order to improve collaboration among medical staff.

The studies in this section describe collaboration among medical staff with regard to the sharing of information for effective HISs within the healthcare environment. The failure to collaborate effectively results from a number of factors.

1. The first factor is having decentralized, autonomous units, and a lack of shared goals, which is common among a number of healthcare systems. Many HISs are isolated from one another because of the fragmented nature of healthcare systems.
2. Second, the lack of connectivity indicates a lack of HIS adoption in healthcare centres.
3. Third, the physical work system requires that most work in healthcare centres be founded on paper-based systems, which is common among a number of developing countries such as Egypt.
4. Fourth, medical staffs are forced to work independently because of the large number of patients.
5. Fifth, the socio-technical challenges faced by several health workers also play an important role in the healthcare field. Therefore, many developing countries need to introduce information technologies and effective collaboration in their healthcare systems (Mengiste, 2010).
6. Sixth, issues of trust, security, and privacy concerns serve important functions in the adoption and acceptance of HISs in healthcare sectors.
7. Seventh, the logistics of implementation include low budget, low technology setting, and crowded and busy hospitals.

8. Eighth, data management is poor, which is attributed to a lack of high efficiency computer systems, lack of available high speed internet, absence of remote access to computers, and absence of institutional servers with automatic backups.
9. Ninth, there is a training issue: there are many obstacles such as visa issues between different countries, and difficulty of agreeing on one place and time where collaborators are able to leave their routine hospital work.
10. Tenth, regulatory requirements: this refers to collecting approval from IRBs at different sites to conduct studies.

2.3.1 Collaborative HISs Models

The use of information and communication technology (ICT) in healthcare is increasing (Ernstmann, et al., 2009) because of its potential to improve the effectiveness and the efficiency of healthcare (Kohn, et al., 1999). Health information systems (HISs) are ICT applications that are important in healthcare organizations, which help to ensure that patients immediately receive appropriate treatment. According to (Aggelidis & Chatzoglou, 2009), the use of information systems (IS) in the healthcare sector is widely accepted, particularly in hospitals. These systems consist of independent units. Each unit, as an IS, has the autonomy to process activities but can also work cooperatively with other units (N.S. Ahmed & Yasin, 2012; Asnina, Osis, & Kirikova, 2008). As such, separate HIS units have to cooperate in a flexible manner (Tzu-Hsiang Yang, Sun, & Lai, 2009) to improve patient treatment and to provide up-to-date information, thus allowing physicians to make more informed decisions (Ruxwana, Herselman, & Conradie, 2010). HIS units are decentralized and autonomous (Tzu-Hsiang Yang, et al., 2009). Hence, the need for an integrated multi-HIS is required to develop an effective collaborative HIS environment is necessary (N.S. Ahmed & Yasin, 2012; H. Yang, et al., 2010). However, traditional collaborative HISs have developed databases containing patient information to share among medical staff from different units (M. C. Reddy, et al., 2011; Skilton, et al., 2008). The integration of HISs plays an important role in improving the levels of medical treatment in hospitals (N.S. Ahmed & Yasin, 2012). The literature review in this section covers the collaborative HIS systems based on recent studies in order to identify requirements for the collaborative HISs to be more effective in healthcare organizations, such as hospitals, as shown in Table 2.1.

Table 2.1: Collaborative HISs Models

Studies	Collaborative HISs Models	Discussion	System Architecture
(H.-J. Yu et al., 2013)	Proposed system is a cloud-based application. The objective of this system was to build an (PD) database implemented with security and clinical rule supporting functions, which made the data-sharing easier and improve the accuracy of data.	The proposed system allows medical staff to collect and store clinical data in a cloud, sharing the data with other physicians in a secure manner to achieve collaboration in research.	Integrated HISs, cloud-based application.
(Sadeghi, Benyoucef, & Kuziemsky, 2012)	Developed a Mashup based interoperability framework "integration and interoperability of healthcare applications in a controlled manner"	This framework allows patients and other healthcare actors to engage in collaborative processes through online applications facilitated by mashups.	Integrated HISs and Web based system.
(N.S. Ahmed & Yasin, 2012)	Proposed fractal approach in HISs in order to improve the cooperation feature among physicians which may enhance both physician skills and healthcare services.	The researchers found that there is a need to adapt the fractal features in current HISs in order to integrated environment.	Integrated HISs and Web based system.
(Lezzar, Zidani, & Atef, 2012)	Developed system is a synchronous web-based groupware accessible through a browser that enables real-time collaboration among collocated or geographically sepa-rated group members in Algeria.	The proposed collaborative planning system, which is designed to provide a flexible group interaction support for care coordination and continuity.	Integrated HISs “collaborative system” and Web based system.
(Sunil Kumar, Guru Rao, & Govardhan, 2012)	Proposed system to integrate a patient's EHRs from different sources in various locations	The proposed system focuses only integration patients’ information from heterogeneous regional healthcare system in real time to support decisions of the physicians in treating patients.	Integrated HISs

Table 2.1: Collaborative HISs Models (Continued)

Studies	Collaborative HISs Models	Discussion	System Architecture
(Collins, et al., 2011)	Development model for EHR interdisciplinary information exchange of ICU common goals	Proposed model for EHR interdisciplinary information exchange of the intensive care unit to support verbal communication between physicians and nurses with comprehensive patient information for cooperative work.	Comprehensive patient information.
(H. Yang, et al., 2010)	Presented the model for integrated healthcare systems in hospitals based on social and technical factors.	This model was proposed to adapt to the complex and dynamic nature of the medical environment and to meet the requirements of participation to access integrated HISs in a hospital.	Integrated HISs
(SADREDDINI, 2003)	Introduce a framework integrated distributed healthcare systems in a hospital as complete heterogeneous ISs, such as HISs and PACS into integrated system, which include patients information and images.	This framework was focused on integrating patient information within the hospital.	Integrated HISs
(K. Li & Yao, 2006)	Introduced framework architecture of cooperative work in integrated Heterogeneous Medical ISs within a hospital	The proposed framework architecture addressed requirements in cooperative systems among HISs. The integration of Heterogeneous systems in healthcare environment faces systems scalability and interoperability.	Integrated HISs
(Tzu-Hsiang Yang, et al., 2009)	Presented a new architecture for the integrated HISs in hospital by studying scalability and interoperability of a system in terms hardware and software. The same researchers proposed service oriented architecture using service standard Health Level7 (HL7) and Web-based service.	The researchers found that the model exhibited good performance in integration patient information in a complex environment..	Integrated HISs and Web-based service.
(Skilton, et al., 2007)	Proposed a new approach to connect with HISs in order to provide medical staff with integrated patient information available at different sources.	The aim of this approach was to increase flexibility and extensibility of the system.	Integrated HISs

Table 2.1: Collaborative HISs Models (Continued)

Studies	Collaborative HISs Models	Discussion	System Architecture
(Aknine & Aknine, 1999)	Proposed model or agent in a hospital information system based on observations on interactions between the caregiving team and the patient.	this model focuses only on patient information aggregated in a centralized location	Centralized location
(Budgen, Rigby, Brereton, & Turner, 2007)	Proposed the integration broker for heterogeneous information sources (IBIS) model to instead of data integration in central database.	This model was used to help physicians make accurate diagnosis of cases by providing complete patient information using Web-based applications.	Integrated HISs, Web-based applications.
(Y. Yang, Qin, Jiang, & Liu, 2008)	Presented a distributed system to provide full medical information of patients to authorized physicians and researchers in hospital based on Web application.	This system focuses only patient status, care, monitoring of chronic viral hepatitis.	Integrated HISs, Web-based applications.
(Heuser, Gerlach, Pollack, & Niederlag, 2001)	Proposed model for integration patient information within the hospital setting using Web-based applications, this system can set up centralized system.	This system allows physicians to quickly access to patient information.	integrated HISs, Web-based applications, centralized system

The integration of HISs plays an important role in improving the collaboration among medical staff in sharing information in order to enhance the levels of medical treatment in hospitals (N.S. Ahmed & Yasin, 2012; H. Yang, et al., 2010). The aim of the earlier studies in Table 2.1 was to identify requirements and features for the collaborative HISs to be more effective in healthcare organizations. Most of the models have developed databases that contain integrated patient information into a centralized system to enable information sharing among the medical staff within the hospital. According to Suter and Oelke et al. (2009), ten universal principles of successfully integrated healthcare systems were identified, which may be used by decision-makers to assist with integration efforts. These principles are as follows: (1) comprehensive services across the continuum of care, (2) patient focus, (3) geographic coverage and rostering, (4) standardized care delivery through interprofessional teams, (5) performance management, (6) information systems, (7) organizational culture and leadership, (8) physician integration, (9) governance structure, and (10) financial management. These principles provide guidance to decision makers and others who require information on how to plan for and implement integrated health systems (Suter, Oelke, Adair, & Armitage, 2009).

In this context, the recent studies, such as Yu et al. (2013), propose a system using a cloud-based application. This system comprises four subsystems: a data management subsystem, a clinical rule supporting subsystem, a short message notification subsystem, and an information security subsystem. After completing the surgery, the physicians input the data retrospectively, which is analysed to study factors associated with post-Pancreaticoduodenectomy (PD) common complications (delayed gastric emptying and pancreatic fistula) to validate the clinical value of this system. The objective of the proposed system was to build an international PD database implemented with security and clinical rule supporting functions, which made the data-sharing easier and improved the accuracy of data using integrated HISs based on cloud application.

Sadeghi and Benyoucef et al. (2012) developed a Mashup based interoperability framework- "integration and interoperability of healthcare applications in a controlled manner". This framework allows patients and other healthcare actors to engage in collaborative processes through online applications facilitated by mashups (Sadeghi, et al., 2012). The goal of the proposed framework system is to improve sharing data in collaborative processes using integrated HISs and interoperability based on web based applications. In addition, Ahmed and Yasin (2012) proposed a fractal approach in HISs in order to improve the cooperation feature among physicians which may enhance both physician skills and healthcare services. The goal of the proposed system is to improve sharing data in cooperation among physicians using integrated HISs based on web based application (N.S. Ahmed & Yasin, 2012). Lezzar, Zidani, and Atef (2012) developed a system of synchronous web-based groupware accessible through a browser that enables real-time collaboration among collocated or geographically separated group members in Algeria. The proposed system, using integrated HISs, “collaborative systems”, and web based systems will provide a flexible group interaction support for care coordination and continuity (Lezzar, et al., 2012).

In sum, there are many studies that have developed the integrated HISs (Budgen, et al., 2007; Heuser, et al., 2001; K. Li & Yao, 2006; SADREDDINI, 2003; Skilton, et al., 2007; Sunil Kumar, et al., 2012; H. Yang, et al., 2010; Tzu-Hsiang Yang, et al., 2009; Y. Yang, et al., 2008) in order to (1) improve collaboration among medical staff within hospitals, (2) enhance the healthcare services, (3) improve the patients’ services outcomes, and (4) catalyse collaborative research. However, there was a lack of earlier research that looked into achieving a collaborative HIS based on privacy preservation regarding the sharing of healthcare information among physicians and researchers in research studies. The improvement of research findings by sharing healthcare information was not addressed in previous studies, as evidenced from most of the earlier studies, which focused on patient information and information on providing better services to patients. However, there was little research that looked at developing a collaborative HISs system model to improve research findings based on privacy preservation regarding the sharing of information. Therefore, the need to address such collaboration among physicians and researchers in research activities in the healthcare field based on privacy preservation is of utmost importance.

2.4 Research Theories

Health information systems (HISs) hold the promise to transform health care; however, their adoption and acceptance is challenged (Price & Lau, 2014). HISs have been described as one of the key tools to transform and improve quality of our healthcare systems (Blumenthal, 2009; Stead, Kelly, & Kolodner, 2005). However, the promise of these transformative tools has not been consistently seen (Francis Lau et al., 2012; Shekelle, Morton, & Keeler, 2006) and meaningful adoption in many jurisdictions remains low (Jha et al., 2009; Schoen et al., 2009). The deployment of HISs has been met with a wide variability in outcomes, from benchmark successes that lead to transformations in care (Wu, et al., 2006) to never being deployed in a clinical setting. Adoption of HISs has been a significant and increasing concern in healthcare (Wu, et al., 2006) and an important problem to be addressed (Heeks, 2006). Adoption needs to be better described and understood with approaches that are accessible to the people planning and implementing these systems.

The adoption is the process that "involves the multitude of activities, decisions, and evaluations that encompass the broad effort to successfully integrate an innovation such as technology into the functional structure of a formal organization" (Hall GE, 1973). An adoption model provides a simplified and limited explanation of the complex process of integration over time. For information systems, this involves the complex socio technical aspects that occur over time from initial deployment to integration into practice (William H. Delone & McLean, 2003). Adoption models, while they can be quite different, should have a number of common features to be considered an adoption model. These are: (a) they describe a number of dimensions related to adoption; (b) they are designed for a specific audience; and (c) they allow for variability in assessment (Lahrmann & Marx, 2010).

Several existing adoption models have been applied to healthcare and to healthcare technology. An extensive review of diffusion of innovation in healthcare (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004) recommends that we seek to better understand why innovations are rejected (discontinued) once adopted. The CBAM has been applied to telemedicine (Armer, Harris, & Dusold, 2004). TAM has been used in over 20 studies in healthcare to study use acceptance and adoption (R.J. Holden & Karsh, 2010). TAM2 has also been applied (Chismar & Wiley-Patton, 2003).

Adoption models have been developed specifically for healthcare. The Fit between Individuals, Task and Technology (FITT) framework highlights that adoption depends on the alignment of three factors: technology, individual, and task (Ammenwerth, Iller, & Mahler, 2006). HOT-fit was used to understand critical adoption factors for HISs (F Lau, Price, & Keshavjee, 2010). The Clinical Adoption Framework contextualizes the IS Success Model (William H. Delone & McLean, 2003) into healthcare and extends it by providing meso and macro level factors that can influence the adoption of clinical information systems. The Design-Reality Gap Model from Heeks (Heeks, 2006) outlines seven dimensions, from information to management systems and structures related to HIS failure. Adoption models have been developed for specific domains within healthcare. HIMSS Analytics provides three EMR adoption models (EMRAM), one each for US hospital based HISs, Canadian hospital HISs, and for US Ambulatory EMRs (Palacio, Harrison, & Garets, 2010; Pettit, 2012). Each of the three EMRAMs provides an eight-point (0–7) scale of adoption of features of the HIS. Diagnostic imaging uses models to describe capability for collaborative jurisdictional infrastructure maturity (Bakalar & Whittick, 2005). The PACS maturity model (van de Wetering & Batenburg, 2009; van de Wetering, Batenburg, & Lederman, 2010) describes the process maturity of hospital based PACS systems in terms of functionality and integration into practice workflow. The EMR (Electronic Medical Records) Adoption Model (Price, Lau, & Lai, 2011) provides an adoption assessment tool that breaks down office-based EMR adoption into 10 functional areas. In sum, the literature review in this section aimed to explain the importance of technology acceptance in healthcare and review the recent adoption models as mentioned in many studies. The following section covers a number of relevant issues on technology acceptance in healthcare organizations.

2.4.1 Technology Acceptance Model (TAM): Introduction

The application of information technology has become important in the health sector. HISs are considered strategic tools for improving the efficiency of health care delivery and the effectiveness of physicians in the health care sector. Adopting technology in the field of healthcare is as important as in a number of other fields. Governments, physicians, and hospital administrators are aware of the benefits of using and enhancing healthcare technologies.

Although technology contributes to the organizational structure and progress of healthcare in hospitals, the resistance against using new technologies renders people unable to adopt the technology. The problem of user acceptance has become a significant issue. Healthcare professionals in hospitals cannot simply accept new technologies in the healthcare field that change their traditional practice patterns. Sufficient evidence supports the idea that healthcare professionals are not willing to accept and use clinical IT that interferes with their day-to-day work activities (Esmaeilzadeh & Sambasivan, 2012).

According to Holden and Karsh (2010) and Zampetakis, Dimopoulou, and Moustakis (2011), a great amount of work involving the acceptance of technology in information systems has been conducted, but only a limited amount of systematic research has been conducted in the context of healthcare, indicating a significant gap in knowledge (R.J. Holden & Karsh, 2010; Melas, et al., 2011).

The literature review in this section covers a number of relevant issues on technology acceptance in healthcare organizations such as hospitals. This section discusses acceptance theories and identifies the appropriate acceptance theory for the healthcare field. Thus, user acceptance is the key indicator of the successful adoption of newly introduced technologies.

Lewis, Agarwal, and Sambamurthy (2003) mentioned that attention to the important role of users when using the potential value of technology as well as the behaviour of users when new IT is introduced remains under discussion (Lewis, Agarwal, & Sambamurthy, 2003). According to Agarwal and Karahanna (2000), the strategic value of investing in a new IT can be obtained when the new IT is accepted and utilized consistently by users for achieving organizational goals (Agarwal & Karahanna, 2000). As the result of these studies, Walter and Lopez (2008) note that the when users accept new technology, they become more prone to change their long-standing work activities as they use the new system (Walter & Lopez, 2008).

Many studies indicate that autonomy and independence characterize the nature of work in healthcare (Blumenthal, 2009; Esmaeilzadeh & Sambasivan, 2012). These characteristics refer to the intention of individuals with regard to accepting and adopting new technology. The main challenge for any new technology is the intention to adopt and use the technology. If the usage rate is low, the technology can no longer be effective for organizations (Chang, Chen, & Chang, 2009; Mathieson, 1991). According to Esmaeilzadeh and Sambasivan (2012), eight theoretical models have been developed based on individual intention to accept new technology. According to the literature on theories of intention and IT adoption, the eight models are: Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Motivational Model (MM), Theory of Planned Behaviour (TPB), a combined theory of planned behaviour/technology acceptance model (C-TAM-TPB), Model of PC utilization (MPCU), Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT). Venkatesh, Morris, Davis G. B., and Davis F. D. (2003) combined all the existing models and put forward a unified model called the Unified Theory of Acceptance and Use of Technology (UTAUT) (Viswanath Venkatesh, et al., 2003). All of these models are designed to explain and predict the willingness of individuals to employ new technologies (Fred D Davis, Bagozzi, & Warshaw, 1992; Esmaeilzadeh & Sambasivan, 2012).

TAM theory (1989) is based on principles adopted by the TRA (1975), which designed it specifically to model user acceptance of ISs. The model suggests that when users are presented with new technology, a number of factors influence their decision about how and when they will use it (Fred D Davis, 1989). The two main factors are perceived usefulness (PU) and perceived ease of use (PEOU). Davis (1989) defined PU as the degree to which a person believes that, by making use of a particular system, his job performance would be enhanced (Fred D Davis, 1989). PEOU is operationally defined as the extent to which a person believes that using a particular system would be effortless (Fred D Davis, 1989). In other words, PU and PEOU are capable of predicting the acceptable behaviour of computer systems users (Hubona & Geitz, 1997). The TAM asserts that the influence of external variables on user behaviour is mediated by user beliefs and attitudes. These factors can be addressed during the system development stage to solve the acceptance problem of users (S. Taylor & P. Todd, 1995). These factors determine behavioural intention, which has been examined by a wide number of studies (Viswanath Venkatesh & Davis, 1996), as a better predictor of actual system usage. Intention to use new IT is defined as the willingness of the user to actually use the new IT (Esmaeilzadeh & Sambasivan, 2012). Figure 2.2 shows the proposed TAM by Davis (1989).

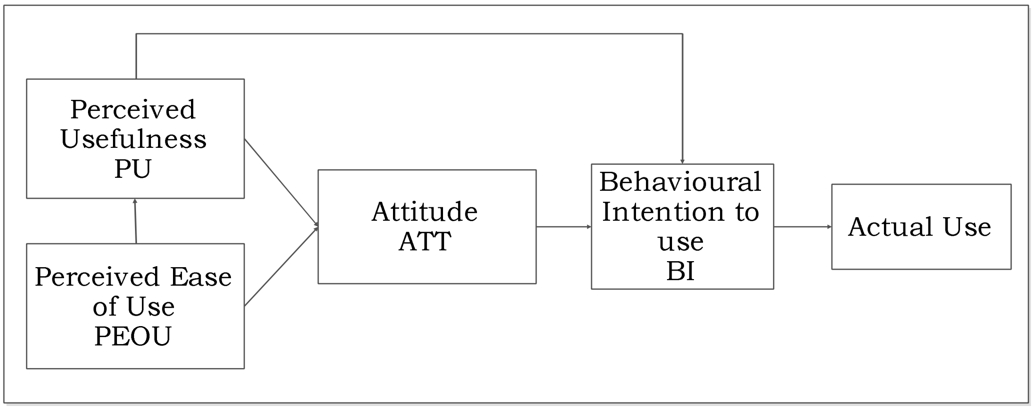


Figure 2.2: Technology Acceptance Model (Fred D Davis, 1989)

Based on the related literature, TAM (1989) is the most influential IT adoption model and is widely applied to explain the technology acceptance process in different contexts (Abu-Dalbouh, 2013; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010; Hossain & de Silva, 2009). Davis derived TAM from TRA (1975) mainly to explain technology use in various situations and cultures, so that user acceptance of systems will increase (Esmaeilzadeh & Sambasivan, 2012). Many studies note that the TAM theory is widely used in research contexts as well as with several types of technology applications (Abu-Dalbouh, 2013; Chau & Hu, 2001; S. M. Lee, Kim, Rhee, & Trimi, 2006; Raitoharju, 2007; Yarbrough & Smith, 2007). Another reason for the usefulness and popularity of TAM is its parsimony, simplicity, and understandability, which gives it the empirical support of a variety of user groups (Esmaeilzadeh & Sambasivan, 2012; Y.-S. Wang, Wang, Lin, & Tang, 2003). According to Abu-Dalbouh (2013), another reason is that the TAM uses factors of technology acceptance that are transferable to different user populations and different kinds of technologies. Many contexts and research constructions have confirmed the validity of the TAM model (Abu-Dalbouh, 2013; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010; King & He, 2006; Ma & Liu, 2004), including in the healthcare field (Abu-Dalbouh, 2013; Chau & Hu, 2002; Chismar & Wiley-Patton, 2003; Esmaeilzadeh & Sambasivan, 2012; R.J.

Holden & Karsh, 2010). The original work by Davis (1989) has been replicated and validated a number of times (D. A. Adams, Nelson, & Todd, 1992; Fred D Davis, 1989; Hendrickson, Massey, & Cronan, 1993; Segars & Grover, 1993; Subramanian, 1994; Szajna, 1994). It has also been replicated work, and the validity and reliability of his measurement scales have been demonstrated. They also showed the internal consistency and replication reliability of the PU and PEOU scales. Hendrickson et al. discovered that this model has high reliability and good test-retest reliability. The related literature has validated the theory and measurement scales by Davis; it has also shown that these scales can be used with different types of users and different types of technology (Croll, 2009).

According to Ketikidis, Dimitrovski, Lazuras, and Bath (2012), during the recent 10 years, numerous studies have used either the TAM or descendants of the TAM to predict intentions and the actual use of technology in several domains (Ketikidis, Dimitrovski, Lazuras, & Bath, 2012). However, a common feature of most of these studies is that they do not use the same measures of TAM or descendants of the TAM variables exactly; in some cases, the predictors of technology acceptance differ from the ones originally proposed in the respective models (R.J. Holden & Karsh, 2010; Turner, Kitchenham, Brereton, Charters, & Budgen, 2010). Thus, the TAM approach provides the general framework but new variables can be added as long as they are theoretically relevant and their addition reflects a decision based on evidence, and not a haphazard choice (Ketikidis, et al., 2012). In recent years, the legacy of technology acceptance literature included alternative models for UTAUT (Viswanath Venkatesh, et al., 2003), which has many similarities to the initial TAM approaches, but differs in the content and number of intentions predictors and actual use of technology (R.J. Holden & Karsh, 2010).

Ducey (2013) examined information technology (IT) adoption in the healthcare industry with TAM or TAM2. This study, an exhaustive literature review of applications of TAM and TAM2 in the healthcare industry, identified 20 articles from 1999 to 2011 (Ducey, 2013). The same researcher stated the extensive research had been done on the Technology Acceptance Model. The parsimonious framework has been successfully applied to predict adoption of a variety of technologies in many different contexts. While researched less extensively, the majority of the links in TAM2 have been confirmed by research. In sum, both contextualized models of IT adoption have abundant empirical support. This study provided evidence that TAM is appropriate in healthcare settings.

In sum, the available evidence suggests that TAM is appropriate for use in the healthcare field (Abu-Dalbouh, 2013; Ducey, 2013; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010; Ketikidis, et al., 2012). Specifically, perceived usefulness consistently predicted the adoption and use of health information technology by healthcare professionals. However, inconsistent results were obtained between PEOU and IT acceptance, possibly due to differences in intelligence, competence, and adaptability to new technologies, as well as the nature of the work between physicians and the general workforce (R.J. Holden & Karsh, 2010). According to Melas, Zampetakis, Dimopoulou, and Moustakis (2011), a strong need exists for developing and gaining empirical support for TAM within health organizations. More replication studies are required so that confidence will be gained on whether TAM is an appropriate theory for studies in the healthcare field (Melas, et al., 2011).

The literature review in this section covers a number of relevant issues regarding technology acceptance in the healthcare field. Finally, the findings of the related literature in this section identify evidence that the TAM theory is the appropriate acceptance theory for the healthcare field. This review of related literature proves that user acceptance is the key indicator of the success or failure of any health IT application in the healthcare field.

2.4.2. TAM: In Healthcare Field

Section 2.2 shows that IT, by means of HISs, has penetrated all aspects of the healthcare environment. Given that the acceptance of this technology in healthcare is vital, as mentioned in Section 2.4.1, some research has been conducted in an attempt to assess the acceptance by medical staff. This section explains the studies in healthcare that use the TAM and the other related models mentioned earlier.

The growing significance of the reactions of end users to HISs has elevated the importance of theories that predict and explain the acceptance and use of HISs. IT in the healthcare sector, especially in hospitals, offers great potential for improving the quality of the services they provide and the efficiency and effectiveness of the personnel, as well as for reducing organizational expenses. However, the main question that arises from the literature is whether hospital personnel are willing to use state-of-the-art IT while performing their tasks.

The TAM theory has been used to measure the acceptance of healthcare professionals with some success. Succi et al. (1999) suggested extending the TAM to consider a new dimension of PU, specifically that of professional status (Succi & Walter, 1999). The same authors contended that the nature and inherent characteristics of the clinician are the factors that affect the acceptance of technology. This factor will be discussed in more detail in the following paragraphs.

Medical staff members do not accept HISs for a wide variety of reasons. Succi et al. (1999) posited that the nature of the medical staff could be an important factor in the lack of acceptance of HISs (Succi & Walter, 1999). Research using the TAM theory has focused primarily on managers or people in business. Medical staff can be very different from these individuals. Sharma (1997) identified that medical staff, by the very nature of their professions, receive special privileges, such as autonomy, prestige, and institutional power (Sharma, 1997). The same author found that physicians enjoyed more professional status than almost any other profession. Their status stemmed from the nature of the medical profession and the characteristics of the physicians who work in that field. Succi et al. (1999) stated that professionals have special power and prestige because of their particular expertise in esoteric bodies of knowledge (Larson, 1977; Sharma, 1997). Thus, medical staff have the specialized ability to practice this knowledge, which is a product of intense and prolonged study and training; outsiders are not allowed to participate (Freidson, 1970).

Physicians also have professional autonomy wherein they are trusted, by the nature of the medical profession, to do their work without supervision. This autonomy is justified because of the belief that individuals outside of the profession do not understand it; thus, outsiders cannot possibly evaluate the practices of the medical profession (Succi et al., 1999). This belief is reinforced by the fact that performance measures that are easily applicable in business, for example, cannot be established as easily in healthcare. The job performance of physicians is not based on the number of patients they see or cure, because not all illnesses are curable and the physicians are expected to see all patients.

Reviewing a number of studies highlighting the difficulty in measuring the job performance of physicians implies two important factors (Croll, 2009; Despont-Gros, et al., 2005; Gagnon, et al., 2003; R.J. Holden & Karsh, 2010; Moores, 2012; Succi & Walter, 1999; Zheng, et al., 2010). First, unlike occupations in other fields, performance evaluation is not critical to the success of physicians. Second, in the medical profession, “professional autonomy is more central, complete, and prominent than in any other profession.” Physicians have professional dominance over nurses, as exhibited by their greater control over resources and their prestigious social status. Succi et al. stated that physicians are very likely to want to preserve and maintain this professional autonomy. This condition could also lead to the rejection of ICT, which could be perceived as altering the nature of this autonomy. HISs would change the way healthcare operates because these systems would help distribute medical knowledge to other non-clinician members of healthcare and consequently make the job performance of physicians more measurable. Thus, physicians would have more accountability to others outside their profession.

Physicians would also have to be trained to use this new technology and could see this as an affront to their professionalism if they find difficulty in doing so. They would have to work under time restrictions and may not have time for training. They may see the use of HISs as something solely for subordinates, such as nurses or secretaries. They may also see no need for such changes to their traditional work practice. Given that attitude is considered a determinant in TAM theory, examining the attitudes of physicians toward ICT is important.

According to Wang (2003), medical staff are not completely aware of the full potential and application of new IT and they do fully use new systems (Y.-S. Wang, et al., 2003). According to Aggelidis and Chatzoglou (2009), medical staff members seem to react differently toward the introduction of new technologies based on their priorities. The literature indicates that healthcare staff are slow and very pragmatic in terms of accepting and using new technology (Lowenhaupt, 2004). Moreover, according to Horan, Tulu, Hilton and Burton (2004), medical staff acceptance of a new IT is a function of organizational readiness in the process of organizational change.

Finally, as a result of the literature review in this section, the existing variables embedded in TAM cannot completely determine the motives of medical staff in terms of adopting new technology. Another extension to the TAM is the need to explore other determinants that could influence PEOU, PU, and intention to use new health IT in the healthcare environment. As mentioned earlier in the literature review, the main challenge for any new technology is the intention to adopt and use the technology. If the usage rate is low, the technology cannot be effective for organizations. According to Delone and McLean (1992), an important measure of IT success is how much the system is accepted and used by users (W.H. DeLone & McLean, 1992). However, based on the IT adoption behaviour in the health sector, medical staff members do not fully utilize the potential resource of health IT. A growing concern within IT adoption research among medical staff members is the problems in adopting and using health IT. The following section discusses the Delone and McLean model of success in adopting and using technology.

2.4.3 DeLone and McLean Model of IS Success: Introduction

Organizations have been spending an increasing amount on IT, and their budgets have continued to rise, even in the face of potential economic downturns. However, fears about economic conditions and increasing competition create the pressure to cut costs, which requires organizations to measure and examine the benefits and costs of technology. Naturally, organizations are interested in knowing the return on these investments. The effects of IT are often indirect and influenced by human, organizational, and environmental factors. Thus, the measurement of IS success is both difficult and elusive. A plethora of utilitarian ISs are used in organizations, such as decision support systems, computer-mediated communications, HISs, e-commerce, knowledge management systems, as well as a number of others (Kanaracus, 2008; S. Petter, DeLone, & McLean, 2008).

The literature review in this section presents the DeLone & McLean success model and the important factors for the success of IT application in any sector. Moreover, this section describes the relationship between acceptance and success by discussing relevant studies. To measure the success of various IT, organizations have been moving beyond traditional financial measures. In an effort to understand the tangible and intangible benefits of their ISs better, organizations have turned to methods such as balanced scorecards (R. S. Kaplan & Norton, 1996) and benchmarking (P.B. Seddon, Graeser, & Willcocks, 2002). Researchers have created models for success (Ballantine et al., 1996; W.H. DeLone & McLean, 1992; Peter B Seddon, 1997), which emphasize the need for better and more consistent success metrics.

According to Petter et al. (2008), researchers have derived a number of models to explain what makes some ITs "successful" (S. Petter, et al., 2008). TAM, which was created by Davis (1989), uses the TRA to explain why some ISs are more readily accepted by users than others (Fred D Davis, 1989; Fishbein, 1975). However, acceptance is not equivalent to success, although the acceptance of an IT is a necessary precursor to success. Early attempts to define the success of IT were ill defined because of the complex, interdependent, and multi-dimensional nature of IT success. To address this problem, DeLone and McLean (1992) performed a review of research published from 1981 to 1987 and created a taxonomy of IT success based on this review.

DeLone and McLean (1992) identified six variables or components of IS success: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. These six variables are interdependent. Figure 2.3 shows this original IS success model (W.H. DeLone & McLean, 1992).

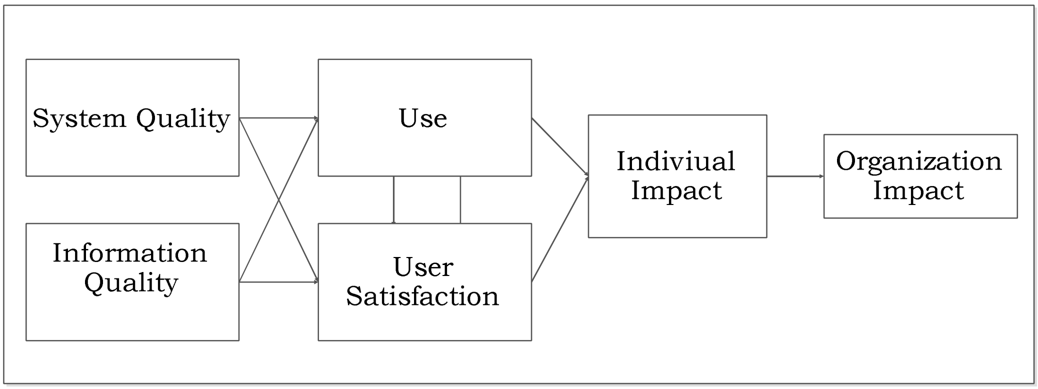


Figure 2.3: DeLone & McLean IS success model (1992)

Shortly after the publication of the DeLone & McLean success model, IS researchers began to propose modifications to this model. Accepting the call of the authors for "further development and validation", Seddon and Kiew (1996) studied a portion of the IS success model (i.e., system quality, information quality, use, and user satisfaction) (P.B. Seddon & Kiew, 1996). In their evaluation, they modified the construct and use because they "conjectured that the underlying success construct that researchers have been trying to tap is Usefulness, not Use." The concept of usefulness by Seddon and Kiew is equivalent to the idea of perceived usefulness in the TAM (1989) (F.D. Davis, Bagozzi, & Warshaw, 1989). They argued that, for voluntary systems, use is an appropriate measure; however, if system use is mandatory, usefulness is a better measure of IS success than use. DeLone & McLean (2003) responded that, even in mandatory systems, the considerable variability of use can still exist and, therefore, use deserves to be retained as a variable.

Since the introduction of the DeLone & McLean model in 1992, a number of studies have empirically tested and validated relationships within the model (Rai, Lang, & Welker, 2002), and discussed its practical applications (Bossen, Jensen, & Udsen, 2013; Goodhue & Thompson, 1995; Peter B Seddon, 1997). According to the study by Seddon (1997), the DeLone & McLean success model was confusing in its original form, partly because both process and variance models were combined within the same framework (Peter B Seddon, 1997). In the years that followed, several modifications were proposed to develop the DeLone & McLean model (1992). It was applied in different fields such as knowledge management (Jennex, Olfman, Panthawi, & Park, 1998; Kulkarni, Ravindran, & Freeze, 2007), e-commerce (William H Delone & Mclean, 2004) and healthcare IT (Bossen, et al., 2013; Pai & Huang, 2011; Van Der Meijden, Tange, Troost, & Hasman, 2003). DeLone and McLean (2003) reviewed empirical studies that had been performed during the years since 1992 and revised the original model accordingly; the updated 2003 model proposes that IS success includes seven dimensions: information quality, system quality, service quality, use, intention to use, user satisfaction, and net benefits. Figure 2.4. Shows the Delone & McLean update model (2003).

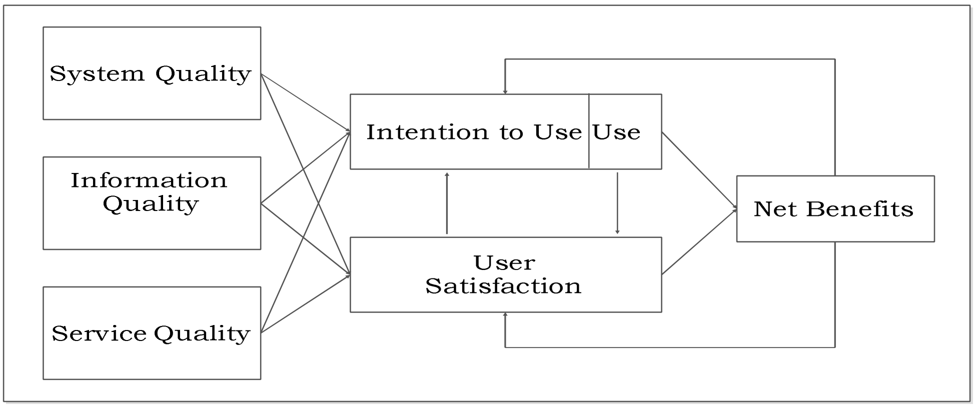


Figure 2.4: DeLone and McLean model (2003)

This updated IS success model integrated this recommendation (Pitt, Watson, & Kavan, 1995) to include service quality as a construct. Another update to the model addressed the criticism that an IS can affect levels other than the individual and organizational levels. Given that IS success affects workgroups, industries, and even societies (B. L. Myers, Kappelman, & Prybutok, 1997; P.B. Seddon, Staples, Patnayakuni, & Bowtell, 1999), DeLone and McLean replaced the variables, individual impact, and organizational impact with net benefits, thereby accounting for benefits at multiple levels of analysis. The constructs of the updated DeLone & McLean IS success model are as follows:

1) System Quality: Performance of the IS in terms of reliability, convenience, ease of use, functionality, and other system metrics (William H. Delone & McLean, 2003; S. Petter, et al., 2008; Stacie Petter & McLean, 2009).
2) Information Quality: Characteristics of the output offered by the IS, such as accuracy, timeliness, and completeness (William H. Delone & McLean, 2003; S. Petter, et al., 2008; Stacie Petter & McLean, 2009).
3) Service Quality: Support of users by the IS department, often measured by the responsiveness, reliability, and empathy of the support organization (S. Petter, et al., 2008; Pitt, et al., 1995).
4) Intention to Use: Expected future consumption of an IS or its output (Stacie Petter & McLean, 2009).
5) Use: Consumption of an IS or its output described in terms of actual or self-reported usage
6) User satisfaction: Approval or likeability of an IS and its output (William H Delone & Mclean, 2004; Ives, Olson, & Baroudi, 1983; Stacie Petter & McLean, 2009).
7) Net benefits: The effect of an IS on an individual, group, organization, industry, society, etc., which is often measured in terms of organizational performance, perceived usefulness, and effect on work practices (Stacie Petter & McLean, 2009).

The literature review in this section covers the factors of IS success in different fields. An important way of measuring IS success is how much the system is accepted and used by users. The Delone & McLean model (2003) provides significant factors that indicate the acceptance and success of a technology. Reflecting on this debate, the

Delone & McLean (2003) model clarified the Use construct. They note that, "Use must precede 'user satisfaction' in a process sense, but positive experience with 'use' will lead to greater 'user satisfaction' in a causal sense." According to the authors, given the variability of IS and their contexts, measuring the Intention to Use (an attitude) may be more appropriate than measuring Use (a behaviour). They went on to state that if Intention to Use was a measure, then increased User Satisfaction would lead to a higher Intention to Use, which would subsequently affect Use. This resulted in the addition of Intention to Use in the updated model.

2.5 Privacy Preserving Technology

The protection of privacy is an important issue when dealing with personal data. Thus, we need to provide a stringent definition for the protection of privacy. According to Dalenius (1977), the protection of privacy is when access to published data does not enable the attacker to learn any additional information about a victim, even if the attacker possesses background knowledge obtained from other sources (Dalenius, 1977). Parmar, Rao, and Patel (2011) defined privacy preservation as the protection of sensitive data before it is released for analysis. However, the data may reside at the same place or at different places (Parmar, et al., 2011).

Technological advances permit the electronic storage and transfer of health information because EHRs come with the promise of improving healthcare quality, preventing medical errors, and reducing healthcare costs. However, this technology also makes private information readily accessible and transmissible (Wallis, 2006). Mutual benefits have driven recent developments that have improved decision-making, especially in the fields of medical information, research, and public health organization, among others. A number of approaches have been proposed to eliminate the privacy concerns of patients and help medical institutions or participants comply with privacy protection regulations. These approaches cover a wide area in the research field. These approaches could be classified into three categories, based on the problems they are attempting to resolve: The first category focuses on privacy protection when sharing data during data usage; the second category focuses on privacy data management; the third category focuses on privacy data storage and management (L. Chen, et al., 2012; A. Gkoulalas-Divanis & Verykiosc, 2009). All the approaches listed above may be used in privacy data sharing or management in some way. The data sharing must be controlled and managed to ensure system integration. Integration is required, especially in the management of patient data, so that sensitive information, such as patient identification, can be secured (A. Gkoulalas-Divanis & Verykiosc, 2009; Qi & Zong, 2012). Several studies have focused on the management of data, such as medical applications, to ensure system integration. However, the management and sharing of data in different fields present challenges, such as the misuse of information, identification problems, and others (Chris Clifton et al., 2004; El Emam, et al., 2012; Rashid & Yasin; K. Smith, Seligman, & Swarup, 2008). The literature review in this section aims to explain the preservation of privacy in the healthcare field with regard to the collaboration among medical staff when sharing information about medical research. Section 2.5.1 discusses the definition of privacy. Section 2.5.2 explains and identifies the privacy preservation challenges in regard to collaborative healthcare data. Section 2.5.3 discusses the privacy of health information. Finally, Section 2.5.4 presents the models adopted for privacy preservation despite the necessity for sharing data.

2.5.1 Privacy: Definition

Creating an exact definition of privacy is difficult because such a definition will always depend on context. A number of definitions are related to privacy, and these definitions have changed over the years. Weston (1967) defines privacy as the desire of people to choose the extent to which they will expose their attitude and behaviour to others (Westin, 1970). Warren and Brandeis (1890) define privacy as the control an individual has over his or her information (Schoeman, 1984; Vedder, 2011; Warren & Brandeis, 1890). Garfinkel (2000) defines privacy in terms of self-possession, autonomy, and integrity (Garfinkel, 2000). Oliveira & Zaïane (2004) stated that privacy is the right of users to conceal their personal information (Oliveira & Zaïane, 2004). In Matatov, Rokach, and Maimon (2010) privacy referred to the preservation of sensitive data and personal information from unintentional and intentional attacks and disclosure (Matatov, Rokach, & Maimon, 2010). Worldwide privacy legislation, policies, guidelines, and codes of conduct have been derived from the set of principles established in 1980 by the Organization for Economic Cooperation and Development (OCED). These principles represent the primary components for protecting privacy and personal data, and comprise a commonly understood reference point. A number of countries have adopted these principles as statutory law, in whole or in part (Macinko, Starfield, & Shi, 2003). This study highlights privacy in the healthcare field with regard to sharing information in medical research, the preservation of sensitive data and personal information from misuse, and unintentional and intentional attacks and disclosure.

2.5.2 Privacy Preservation Challenges

Privacy preservation is an important issue when dealing with personal data and can be considered the backbone for the sharing data process. There are numerous real-world applications which require sharing data while meeting specific privacy constraints. Consequently, the literature review in this section aims to clarify the privacy preservation data sharing challenges.

Recent studies, which refer to an increase in privacy and security consciousness, have led to increased research and development into methods that compute useful information securely (Chris Clifton, et al., 2004; B. C. M. Fung, et al., 2010). Data sharing has long been a challenge for the database community. This need has become critical in numerous contexts, including integrating data on the Web and at enterprises, building ecommerce market places, sharing data for scientific research, data exchange at government agencies, monitoring health crises, and improving homeland security (Chris Clifton, et al., 2004). Additionally, large amounts of personal health data are being collected and made available through existing and emerging technological media and tools. While use of this data has significant potential to facilitate research, improve quality of care for individuals and populations, and reduce healthcare costs, many policy-related issues must be addressed before their full value can be realized. These include the need for widely agreed upon data stewardship principles and effective approaches to reduce or eliminate data silos and protect patient privacy (Hripcsak et al., 2014).

Unfortunately, data integration and sharing are hampered by legitimate and widespread privacy concerns (Chris Clifton, et al., 2004; B. C. M. Fung, et al., 2010). Companies could share information to boost productivity, but are prevented by fear of being exploited by competitors or antitrust concerns. Sharing healthcare data could improve scientific research, but the cost of obtaining consent to use individually identifiable information can be prohibitive, and these efforts must engage patients as partners (Hripcsak, et al., 2014). Sharing healthcare and consumer data enables early detection of disease outbreak (Tsui et al., 2003), but without provable privacy protection it is difficult to extend these surveillance measures nationally or internationally. Besides effective public safety and health care, collaboration and sharing between public agencies and public and private organizations can have a strong positive impact on public safety. But concerns over the privacy implications of such private/public sector sharing (Struck, 2002) have impacted areas of national priority, including homeland security: The Terrorism Information Awareness program was killed over privacy concerns (Chris Clifton, et al., 2004). Fire departments could share regulatory and defence plans to enhance their ability to fight terrorism and provide community defence, but they fear that the loss of privacy could lead to liability. The continued exponential growth of distributed personal data could further fuel data integration and sharing applications, but may also be stymied by a privacy backlash. It is critical to develop techniques to enable the integration and sharing of data without losing privacy. As noted above, there is widespread agreement on the value of personal health data for many uses beyond direct patient care and treatment. Thus, discussions about the privacy preservation data sharing are more important than ever. As part of the overall problem, the literature review in this section covers the fundamental challenges in privacy preserving data sharing as mentioned in the recent studies. The recent studies highlight the emergent privacy issues of healthcare data into two aspects, which are as follows:

1. **Legal Aspects**

In spite of the rising concerns of health data privacy (Hiller, McMullen, Chumney, & Baumer, 2011; Pei-Yun et al., 2012), there is a lack of understanding, on the part of patients, of rights and policies, which undermines informed consent. The boundary between Personally Identifiable Information (PII) and non-PII is not clearly defined in current systems, causing a mismatch between patients' expected privacy and the actual protections employed to safeguard their data (Grandison & Bhatti, 2010). Consequently, an increasing number of global legislative activities are now targeted at offering a solution to these issues. Therefore, the development of a coordinated health data use strategy and action plan should be a national priority, including the integration of public policies for health data use into healthcare system strategic initiatives (C. Clifton & Atallah, 2007; Hripcsak, et al., 2014).

2. Technical and Organizational Aspects

Many different technical safeguards are implemented in practice to protect personal health information (PHI). Some enforce security protection, such as building secure Internet connections via hypertext transfer protocol, secure (HTTPS) protocol, and firewall over data and message transmission. Others add an extra layer of authentication and confidentiality through cryptographic and biometric mechanism (Ball, Chadwick, & Mundy, 2003; Gerteis, Edgman-Levitan, Daley, & Delbanco, 1993). For example, some developed a public key infrastructure for protecting patient records (Hu, Chen, & Hou, 2010). Others presented temper-resistant hardware for achieving availability and interoperability in a protected environment (W.-B. Lee & Lee, 2008). In Yu and Chekhanovskiy (2007), a smartcard technology was proposed along with cryptographic key management to handle critical PII (W. Yu & Chekhanovskiy, 2007). Clifton & Atallah (2007) mentioned that some factors, such as organizations, secrets, and agreements with other manufacturers, stand in the way of needed sharing data based on privacy preservation (C. Clifton & Atallah, 2007).

Chris Clifton et al. (2004) listed the fundamental challenges in privacy preserving data integration and sharing listed as:

1. Privacy Framework

How can we develop a privacy framework for data integration that is flexible and clear to the end users? This demands understandable and provably consistent definitions for building a privacy policy, as well as standards and mechanisms for enforcement. Database security has generally focused on access control: Users are explicitly (or perhaps implicitly) allowed certain types of access to a data item. This includes work in multilevel secure databases, as well as statistical queries (Adam & Worthmann, 1989).

Privacy is a more complex concept. Most privacy laws balance benefit vs. risk (Keller & Stokes, 2003): access is allowed when there is adequate benefit resulting from the access. An example is the European Community directive on data protection, which allows the processing of private data in situations where specific conditions are met. The Health Insurance Portability and Accountability Act in the U.S. specifies similar conditions for the use of data. Individual organizations may define their own policies to address their customers' needs. The problems are exacerbated in a federated environment. The task of data integration itself poses risks, as revealing even the presence of data items at a site may violate privacy (Chris Clifton, et al., 2004). Some of the privacy issues have been addressed for the case of a single database management system in Hippocratic Databases (Agrawal, Kiernan, Srikant, & Xu, 2002). Other privacy issues have been addressed for the case of a single interaction between a user and a Website in the P3P standard (Cranor, Langheinrich, Marchiori, Presler-Marshall, & Reagle, 2002). None of the current techniques address privacy concerns when data is shared between multiple organizations, and transformed and integrated with other data sources (Chris Clifton, et al., 2004). A framework is required for defining private data and privacy policies in the context of data integration and sharing. The notion of Privacy Views, Privacy Policies, and Purpose Statements is essential towards such a framework (Chris Clifton, et al., 2004; A. Gkoulalas-Divanis & Loukides, 2011).

2. Schema Matching

To share data, sources must first establish semantic correspondences between schemas. However, all current schema matching solutions assume sources can freely share their data and schema. How can we develop schema matching solutions that do not expose the source data and schemas? Once two data sources (S and T) have adopted their privacy policies, they can start the process of data sharing. Schema matching lies at the heart of virtually all data integration and sharing efforts. Consequently, numerous matching algorithms have been developed (Rahm & Bernstein, 2001). All current existing matching algorithms, however, assume that sources can freely share their data and schemas, and hence are unsuitable (Chris Clifton, et al., 2004). To develop matching algorithms that preserve privacy, first the following components need to be developed: (a) Match Prediction: How to create matches without revealing data at the sources, or even the source schemas. An initial step is to start with learning based schema matching (Chris Clifton, et al., 2004). Schema matching in this approach is reduced to a series of classification problems that involve the data and schemas of the two input sources. As such, it is possible to leverage work in privacy-preserving distributed data mining, which has studied how to train and apply classifiers across disparate datasets without revealing sensitive information at the datasets (Lindell & Pinkas, 2002). (b) Human Verification of Matches: Suppose a match ‘m’ has been found. Now humans at both or one of the sources (S and T) must examine ‘m’ to verify its correctness. The goal is then to make certain such verification is privacy-preserving. The goal is to give humans enough information to verify matches, while preserving privacy. One way to achieve this can be randomly selecting some values for particular attributes and show the user only these values. It can be argued that revealing only a few attribute values does not reveal anything useful about the distribution. Since two attributes are found to be similar, it can be argued that a few samples don’t reveal too much useful information. A measure for privacy loss is definitely needed in this context (Chris Clifton, et al., 2004). (c) Mapping Creation: Once a match has been verified and appears to be correct, humans can proceed to the step of working in conjunction with a mapping tool to refine the match into a mapping. In this step, humans typically are shown examples of data, as generated by various mapping choices, and asked to select the correct example. It is necessary to ensure that people are shown data that allows generating mappings, but does not violate privacy (Chris Clifton, et al., 2004).

3. Object Matching and Consolidation

Data received from multiple sources may contain duplicates that need to be removed. In many cases it is important to be able to consolidate information about entities (e.g., to construct more comprehensive sets of scientific data). How can we match entities and consolidate information about them across sources, without revealing the origin of the sources or the real-world origin of the entities? Record Linkage is the identification of records that refer to the same real-world entity. This is a key challenge to enabling data integration from heterogeneous data sources. What makes record linkage a problem in its own right (i.e., different from the duplicate elimination problem) is the fact that real-world data is "dirty". In other words, if data were accurate, record linkage would be similar to duplicate elimination. Unfortunately, in real-world data, duplicate records may have different values in one or more fields (e.g. misspelling causes multiple records for the same person) (Chris Clifton, et al., 2004).

Record linkage techniques can be used to disclose data confidentially. In particular, a privacy-aware corporation will use anonymization techniques to protect its own data before sharing it with other businesses. A data intruder tries to identify as many concealed records as possible using an external database (many external databases are now publicly available). Therefore, anonymization techniques should also be aware of record linkage techniques to preserve the privacy of the data (Chris Clifton, et al., 2004).

On the other hand, businesses need to integrate their databases to perform data mining and analysis procedures. Such data integration requires privacy-preserving record linkage- record linkage in the presence of a privacy framework that ensures the data confidentiality of each business. Thus, we need solutions for the following problems: (a) Privacy preserving record linkage: that is, discovering the records that represent the same real world entity from two integrated databases, each of which is protected (encrypted or anonymized) (Chris Clifton, et al., 2004; Benjamin C. M. Fung, et al., 2010). In other words, records are matched without having their identity revealed. (b) Record linkage aware data protection: that is, protecting the data before sharing, using anonymization techniques that are aware of the possible use of record linkage, with publicly available data, to reveal the identity of the records (Chris Clifton, et al., 2004; Benjamin C. M. Fung, et al., 2010) (c) Online record linkage: linking records that arrive continuously in a stream. Real-time systems and sensor networks are two examples of applications that need online data analysis, cleaning, and mining (Chris Clifton, et al., 2004; Benjamin C. M. Fung, et al., 2010).

4. **Querying Across Sources**

Once semantic correspondences have been established, it is possible to query across the sources. How do we ensure that query results do not violate privacy policy? How do we query the sources so that only the results are disclosed? How can we prevent the leaking of information from answering a set of queries? Only a few general techniques exist today for querying datasets while preserving privacy: statistical databases, privacy-preserving joins computation, and privacy-preserving top-K queries. In statistical databases, the goal is to allow users to ask aggregate queries over the database while hiding individual data items (Adam & Worthmann, 1989). Privacy-preserving joins and the more restricted privacy-preserving intersection size computation have been addressed. (Agrawal, Evfimievski, & Srikant, 2003; Chris Clifton, Kantarcioglu, Vaidya, Lin, & Zhu, 2002). Here, each of the two parties learns only the query's answer, and nothing else. The techniques only apply to a specialized class of queries (Chris Clifton, et al., 2004; Benjamin C. M. Fung, et al., 2010).

5. Quantifying Privacy Disclosure

In real life, with any information disclosure, there is always some privacy loss. There is a need for reliable metrics to quantify privacy loss. Instead of simple 0-1 metrics (whether an item is revealed or not), we need to consider probabilistic notions of conditional loss, such as decreasing the range of values an item could have, or increasing the probability of accuracy of an estimate. In general, a starting classification could measure the following: probability of complete disclosure of all data, probability of complete disclosure of a specific item, or probability of complete disclosure of a random item. Privacy preserving methods can be evaluated on the basis of their susceptibility to the above metrics. Also, some of the existing measures can be used in this direction. Therefore, there is a need for developing different privacy metrics (Chris Clifton, et al., 2004; Benjamin C. M. Fung, et al., 2010).

Finally, the literature review in this section indicates that privacy preservation data sharing has received considerable attention from research communities. Moreover, privacy preservation, when data is reused in another field, such as collaborative medical research using HISs, has likewise been explored. Adding to data utility is a very important issue in the implementation of data privacy preservation. Privacy-preserving data sharing is a promising approach to information sharing, while preserving individual privacy and protecting sensitive information. In this section, the researcher reviewed the recent developments in the privacy preservation data sharing challenges. These findings address research questions 1 and 2 as a part of the answer to identify the privacy preservation data sharing challenges, such as the factors and obstacles based on recent studies.

2.5.3 Healthcare Information Privacy

The use of ICT in healthcare is increasing (Ernstmann, et al., 2009) because of its potential to improve the effectiveness and efficiency of healthcare (Kohn, et al., 1999). The success of these technologies depends on the acceptance level of its users (Ammenwerth, et al., 2004). HISs are important ICT applications in healthcare organizations, which help ensure that patients immediately receive appropriate treatment. According to Aggelidis and Chatzoglou (2009) and Scott (2007), the use of IT in the healthcare sector is widely accepted, particularly in hospitals. ISs improve the quality of services that are provided (Aggelidis & Chatzoglou, 2009; Scott, 2007). Researchers reported that the failure of hospitals to adopt new IT increases inconvenience and loss of trust among patients, as mentioned earlier (see Sections 2.3). Thus, HISs have gradually replaced traditional hospital procedures (E. Ammenwerth, et al., 2003; Lu, et al., 2005). Many studies have proposed various frameworks for building trustworthy IT solutions for hospitals. For example, Xia Chen (2004) proposed a framework of privacy preserving data sharing (Chen, Orlowska, & Li, 2004). This framework is designed for data sharing for the purpose of analysis and relies on dataset reconstruction technology. Kenneally and Claffy (2009) developed an internet data sharing framework for balancing privacy and utility (Kenneally & Claffy, 2009). The framework offers a consistent, transparent, and replicable evaluation methodology for risk-benefit evaluation. In this context, collaboration in HISs is important because patients are provided with proper and fast treatment, as well as suitable medical data from research through HISs. The NIH has endorsed research aimed at obtaining significant findings that can improve human health and has provided a set of guidelines for sharing NIH supported research findings with research institutions (Qi & Zong, 2012).

The development of IT and the collection of electronic information by data owners, such as governments, corporations, and individuals, have resulted in higher instances of data sharing. Many organizations are often willing to collaborate with other entities to perform a common action for mutual benefit (A. Gkoulalas-Divanis & Verykiosc, 2009; Qi & Zong, 2012). Collaboration is an important factor in HISs (N.S. Ahmed & Yasin, 2012). According to Ohno-Machado (2013), privacy is an important requirement for collaboration in data sharing (Ohno-Machado, 2013). However, privacy concerns tend to become obstacles. Gkoulalas et al. (2011) stated that 62% of patients were concerned about the disclosure of their EMRs (A. Gkoulalas-Divanis & Loukides, 2011). EHRs are computerized medical records created by an organization that provides medical care, such as hospitals or physicians' offices (Garets & Davis, 2012). EHRs are part of a local stand-alone HIS that has the capability to store, retrieve, and modify records. Thus, these records may not remain confidential. In the same study, 35% of respondents expressed privacy concerns regarding the sharing of their data (A. Gkoulalas-Divanis & Loukides, 2011; Ludman, et al., 2010). Studies have focused on data management through HISs to ensure system integration. However, the management and sharing of data among different centres or departments remain a huge challenge. The question being presented is about the storage of data coupled with the maintenance of a privacy level required for collaborative activities, such as research, as well as the prevention of misuse of data for other purposes. Enhancing privacy and security consciousness has led to increased investigations on methods that could compile useful information in a secure manner (Chris Clifton, et al., 2004). The decisions of individuals about whether or not to provide private information can be influenced by factors such as "collection: concern that extensive amounts of personally identifiable data are being collected and stored in databases", "unauthorized secondary use (internal): concern that information is collected from individuals for one purpose but is used for another", "secondary purpose (internally used within a single organization) without authorization from concerned individuals", "unauthorized secondary use (external): concern that information is collected for one purpose but is used for another", "secondary purpose after disclosure to an external party (not by the collecting organization)", "improper access: concern that data about individuals is readily available to people not properly authorized to view or work with the data", and "errors: concern that protections against deliberate and accidental errors in personal data are inadequate" (H. J. Smith, Milberg, & Burke, 1996). Smith et al. (1996) subsequently developed the concern for information privacy model, in which the collection of data, its improper access, its secondary use, and its errors motivate individuals to pursue information privacy. Privacy concern refers to the reluctance of individuals to release personal information (Dinev & Hart, 2006; Malhotra, Kim, & Agarwal, 2004). Privacy concerns are relatively different from security concerns. Security concerns refer to the secure transmission of personal information during transactions (Belanger, Hiller, & Smith, 2002).

Privacy preservation has received considerable attention in different fields, such as among governmental, financial, and medical researchers. This important research area has a considerable history of legislations passed to protect privacy, beginning from the Fair Credit Reporting Act of 1970 (F. C. R. Act, 1970), which was followed by the Family Educational Rights and Privacy Act (Rights, 2006). Four years later, the Right to Financial Privacy Act that was passed (Trubow & Hudson, 1978). The 1980s ushered the passage of the Privacy Protection Act of 1980- the precursor to the Electronic Communication Act of 1986 (Burnside, 1987), which in turn was quickly followed by the Employee Polygraph Protection Act of 1988 (P. J. Duffy, 1989). The 1990s likewise witnessed several laws passed to augment existing measures, including the Telecommunications Act (Aufderheide, 1999) and HIPAA (A. Act, 1996), both in 1996, followed by the Children's Online Privacy Protection Act in 1998 (Commission, 1998), and Title V of the Gramm–Leach Bliley Act in 1999, which was targeted at the financial sector. However, many people believe that these laws are insufficient for protecting the privacy and confidentiality of patient medical records. The Harries–Equifax healthcare information privacy survey of 1993 showed that over 80% of the American public had high levels of concern regarding personal privacy, and 60% believed that their medical records should not be used for any reason without their consent (Gostin et al., 1993).

In 1996, the Health Insurance Portability and Accountability Act (HIPAA) Title II (A. Act, 1996) was enacted in the US. One of the purposes of this act was to increase the protection of patients' medical records against unauthorized usage and disclosure. Hospitals, clinical offices, health insurance companies, and other entities governed by HIPAA were asked to comply with these regulations. In 1997, the Council of Europe announced the Recommendation R (97) 5 on the Protection of Medical Data to enhance the protection of personal health care data [10]. Similar regulations have been enacted in many other countries. Privacy preservation has similarly been the subject of substantial research. A plethora of computer privacy-related measures has since been propounded to address some of the identified gaps. The U.S. Congress enacted the HIPAA (A. Act, 1996) in 1996 as a means of providing privacy and confidentiality rights to ordinary patients and participants as well as other beneficiaries in group health plans. The most significant provisions of HIPAA that are of interest to this study are in Title II under the Privacy Rule. According to the requirements of Title II, the Healthcare System promulgated five rules regarding administrative simplification: the privacy rule, transactions and code sets rule, security rule, unique identifiers rule, and enforcement rule. As stated in the scope and limitations section, privacy and privacy preservation in a collaborative healthcare management system with regard to sharing healthcare information in medical research for improving research findings are the focuses of this study.

The privacy rule established regulations for the use and disclosure of Electronic Protected Health Information (ePHI) and took effect on 14 April 2003, with a one-year extension for certain small health plans. ePHI is defined as any information on the health status, provision of healthcare, or payment for healthcare that can be linked to an individual, but is interpreted rather broadly to include any part of the medical record or payment history of a patient that is stored in an electronic format (Williams, Solodar, Saul, & Rules, 2007). Finally, the literature review in this section indicates that health information privacy has received considerable attention from research communities. Moreover, privacy preservation, when data is reused in another field, such as collaborative medical research using HISs, has likewise been explored. Adding to data utility is a very important issue in the implementation of data privacy preservation. Sensitive information could be hidden by inserting false information into the database or by blocking data values. Although simple techniques do not modify the information stored in a database, such techniques can reduce the utility of information through the presentation of incomplete information. This reduction could have a negative effect to the medical field, given that medical staff members require clear data so that they can make transparent and evidence-based decisions that improve healthcare services.

2.5.4 Privacy Preserving Data Publishing (PPDP): Concept

Privacy concerns are important aspects of all information processing activities, particularly in healthcare environments in which information is critical and confidential in nature. For the past decades, technology development and HISs have increasingly been adopted by medical institutions. Changes in the healthcare system have likewise facilitated the rapid accumulation of healthcare data. The collaboration and sharing of this healthcare data among different organizations can result in significant benefits for medical treatment, scientific research, and relevant sectors. The efficiency of a medical institution and medical research findings could be improved through the use of HISs to share electronic healthcare information based on privacy preservation. This section explores the approaches adopted in the literature for privacy preserving data sharing, and identifies the appropriate approach in the healthcare field for sharing information. Many approaches are discussed to address research question 3.

Healthcare data is valuable to many organizations, particularly for the purpose of scientific research. Therefore, the demand for sharing healthcare data has grown rapidly (Lei Chen, et al., 2012). Healthcare data contains private information on patients, and to share this data could threaten patient privacy.

Privacy protection and maintaining data utility are issues that must be addressed (A. Gkoulalas-Divanis & Loukides, 2011). Information privacy in the healthcare sector is an issue of growing importance (Appari & Johnson, 2010). The adoption of HISs and the increasing need for information among patients, providers, and payers require better information protection (Appari & Johnson, 2010). Concerns regarding the competence of organizations to protect personally identifiable data are increasing as the frequency of identity theft incidents continues to rise (Appari & Johnson, 2010).

A number of studies have indicated the necessity of developing practical methods to balance healthcare data sharing and privacy protection (Appari & Johnson, 2010; Lei Chen, et al., 2012; A. Gkoulalas-Divanis & Loukides, 2011). In the past few years, research communities have responded to this challenge and proposed various approaches (C. Clifton & Atallah, 2007) to address privacy concerns of patients and to assist medical institutions or participants in complying with privacy protection regulations. These approaches are covered in various fields and can be classified into three categories based on the issues they address. The first category focuses on privacy protection of data sharing during data usage. This type of approach protects patient privacy by transforming the healthcare data before such data is shared. Privacy information may be erased or reduced after the transformation process. De-identification approaches simply detects private data and deletes it (Neamatullah, et al., 2008). A number of models and methods have been proposed to maintain the usability of the transformed data as much as possible. Privacy preserving data publishing models, such as K-anonymity and l-diversity, privacy preserving data mining models, and other methods, such as privacy preserving decision tree and privacy preserving associate rule mining (Aggarwal & Philip, 2008; Benjamin C. M. Fung, et al., 2010) have been developed as a result of these studies. The second category focuses on data privacy management. Several access control models and systems have been developed to enhance the flexibility and compliance with regulations of data privacy management. Elements, such as access purpose, data content, and personal preferences have been included in data access management models (Byun, et al., 2005; H. E. Smith, 2001). The third category focuses on private data storage and management. Private data storage and management in cloud environments has recently gained considerable attention. Approaches for privacy aware data storage and auditing in cloud environments have been proposed to protect private data (Itani, et al., 2009; C. Wang, et al., 2010).

Chen et al. (2012) mentioned that all of the aforementioned approaches may be used in private data sharing or management in some way. A number of abstract frameworks have been proposed to achieve privacy protection during data sharing. However, to the best of our knowledge, few studies have focused on preserving the privacy of healthcare data in a data sharing framework by providing a practical view for practical application.

El Emam, Jonker, and Fineberg (2011) highlighted de-identification as a set of methods to enable the use and disclosure of health information under existing legal frameworks (El Emam, Jonker, & Fineberg, 2011b). De-identification is a set of methods known as privacy preserving data publishing (PPDP) that can be applied to data to ensure that the probability of assigning a correct identity to a record in the data is very low. PPDP provides methods and tools for publishing useful information while preserving data privacy. A number of approaches have been proposed for different data publishing scenarios (Lei Chen, et al., 2012; B.C.M. Fung, K. Wang, R. Chen, & P.S. Yu, 2010).

Fung et al. (2010) provided a typical scenario for data collection and publishing, as shown in Figure 2.5. In the data collection phase, the data publisher collects data from record owners (e.g., X1 and X2 to Xn), whereas in the data publishing phase, the data publisher releases collected data to a data miner or to the public (also referred to as the data recipient) who will then conduct data analysis or relevant processing on the published data (B.C.M. Fung, et al., 2010). Fung et al. (2010) also demonstrated an example of a typical scenario in healthcare organizations such as hospitals. A hospital collected data from patients and shared the patient records to an external medical centre. In this example, the hospital is the data publisher, the patients are the record owners, and the medical centre is the data recipient.

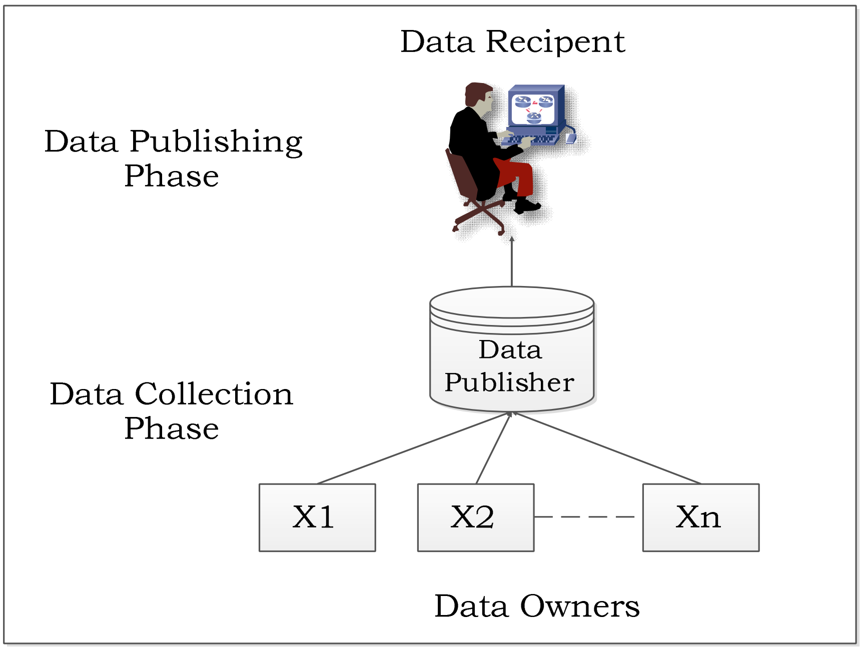


Figure 2.5: Scenario Collection & Publishing of Data (B.C.M. Fung, et al., 2010)

Gehrke (2006) proposed two models for privacy preserving data analysis and publishing (Gehrke, 2006).

1. The untrusted model. The data publisher is not trusted and may attempt to identify sensitive information from record owners. Various cryptographic solutions (Z. Yang, Zhong, & Wright, 2005), anonymous communications (Chaum, 1981; Jakobsson, Juels, & Rivest, 2002), and statistical methods (Warner, 1965) have been proposed to collect records anonymously from their owners without revealing their identities.
2. The trusted model. The data publisher is trustworthy, and record owners are willing to provide personal information to the data publisher. However, the trust is not transitive to the data recipient. Models of the data publisher are described in Figure 2.6.

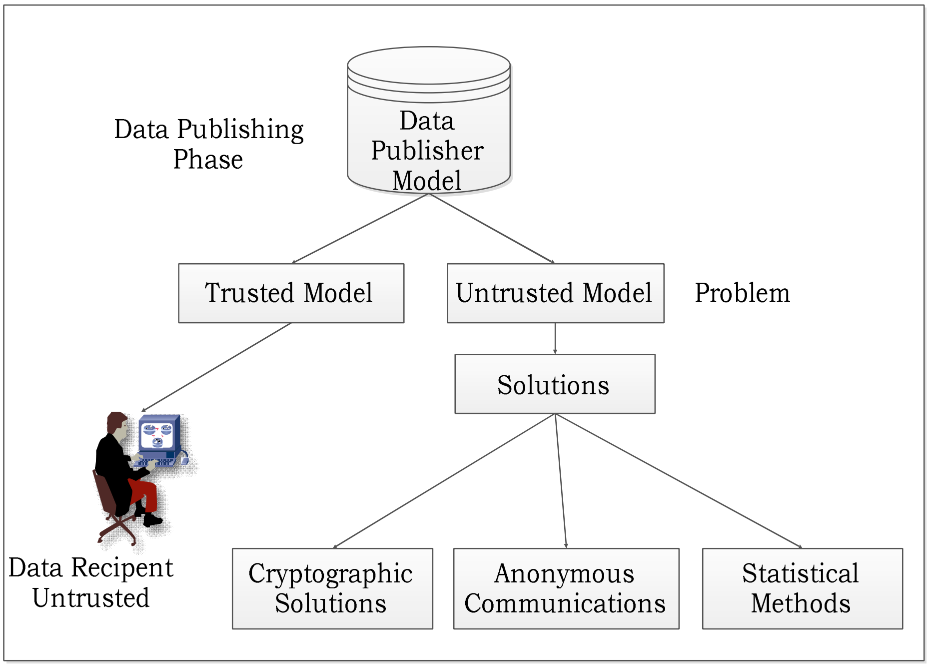


Figure 2.6: Models Classification for Data Publishing

Fung et al. (2010) stated that in practice, every data publishing scenario has its own assumptions as well as different requirements of the data publisher, data recipients, and data publishing purposes. The following are several desirable assumptions and properties in practical data publishing:

1. **The non-expert data publisher.** The data publisher is not required to have knowledge to perform data mining on behalf of the data recipient. Any data mining activity has to be performed by the data recipient after receiving data from the data publisher. The data publisher may not even know who the recipients are at the time of publication or has no interest in data mining (Benjamin C. M. Fung, et al., 2010). For instance, hospitals in California publish patient records on the web (Carlisle, Rodrian, & Diamond, 2007), but they do not know who the recipients are and how the recipients will use the data. The hospital publishes patient records because it is required by regulations (Carlisle, et al., 2007) or because it supports general medical research, and not because the hospital requires the results of data mining. Therefore, the data publisher is not required to do more than protect the data for publication in such a scenario.

2. **The data recipient could be an attacker**. In PPDP, one assumption is that the data recipient could also be an attacker. For instance, the data recipient, such as a drug research company, is a trustworthy entity. However, to guarantee that all the staff in the company are trustworthy would be difficult. This assumption makes the PPDP problems and solutions different from the encryption and cryptographic approaches in which only authorized and trustworthy recipients are given the private key to access clear text. A major challenge in PPDP is to preserve both privacy and information usefulness in anonymous data simultaneously (B. C. M. Fung, et al., 2010).

3. **Publish data, not the data mining results**. PPDP emphasizes publishing data records on individuals (i.e., micro data). Clearly, this requirement is more stringent than publishing data mining results, such as classifiers, association rules, or statistics on groups of individuals (Benjamin C. M. Fung, et al., 2010).

4. **Truthfulness at the record level.** In some data publishing scenarios, the fact that each published record corresponds to an existing individual in real life is important. We consider the example of patient records. A pharmaceutical researcher (the data recipient) may need to examine actual patient records to discover some previously unknown side effects of the tested drug (El Emam, Information, Division, & Information, 2011). If a published record does not correspond to an existing patient in real life, deploying data mining results in the real world would be difficult. Randomized and synthetic data do not meet this requirement. Although an encrypted record corresponds to a real-life patient, the encryption hides the semantics required to act on the patient represented. This perspective is important for truthfulness at the record level and preserving individual privacy.

Fung et al. (2010) stated that PPDP may not be necessarily related to a specific data mining task, and the data mining task may be unknown at the time of data publishing. Furthermore, several PPDP solutions emphasized the preservation of data truthfulness at the record level. However, PPDP solutions often do not preserve such a property. Privacy preservation and maintaining data utility at the same time have recently become important challenges in privacy preservation (B. C. M. Fung, et al., 2010; Aris Gkoulalas-Divanis & Loukides, 2013).

This study produced results that corroborate the findings in a number of works in the field of privacy preservation. The findings of this section have two common areas, namely, security and privacy protection, and privacy preserving data mining (PPDM) and privacy preserving data publishing (PPDP).

The former is a common area between two subjects in which the confidentiality of the data is associated with access control and authentication on the received data. These traditional areas are associated with recipients of the information that have the authority to receive such information. Privacy preservation is more complex and is different from confidentiality of information and the principle of receiving data, as well as the protection of data in which the recipient has the authority receipt. The general principle of this research is to release all data to facilitate the use of data sent or published in scientific fields, but the identities of people who are owners of such data and other sensitive properties found in the data must be protected. Therefore, the aim of this study falls outside the traditional work on access and authentication control (Sweeney, 2002c).The latter area, PPDM and PPDP, explains the differences between the two subjects. The results of the comparison are shown in Table 2.2.

Table 2.2: Comparison between PPDM and PPDP

	PPDM	PPDP
General Idea	PPDM is to allow data mining from a modified version of the data that contains no sensitive information	A new class of PPDM methods. PPDP allows the publication of useful information, while preserving data privacy (Benjamin C. M. Fung, et al., 2010; Gehrke, 2006). PPDP allow to anonymize the data by hiding identify of individuals, not hiding sensitive data.
Definition	Algorithms a new class of data mining methods, has been developed by the research community working on security and knowledge discovery (E. Bertino, I. N. Fovino, & L. P. Provenza, 2005a; B. Fung, K. Wang, R. Chen, & P. S. Yu, 2010).	Methods and tools for publishing useful information while preserving data privacy (Lei Chen, et al., 2012; B.C.M. Fung, et al., 2010).
Aim	Extraction of relevant knowledge from large amounts of data, while protecting at the same time sensitive information (Bertino, et al., 2005a).	Keep the underlying data useful based on privacy preservation "utility based method" (B. Fung, et al., 2010)
Example	**Example to describe the scenario between them** A hospital may publish the patient data to a cancer research institute; although willing to contribute its data to cancer research, the hospital is not interested in and has expertise in data mining algorithms because cancer research is normal work.	
Demonstration	PPDM focuses on the data without sensitive information (E. Bertino, I.N. Fovino, & L.P. Provenza, 2005b; B. C. M. Fung, Wang, & Yu, 2007) .	PPDP focuses on the data. Therefore, published records should be meaningful when examined individually(L. Chen, et al., 2012).
Techniques	PPDM is to allow data mining techniques such as Association Rule Mining, Classification, Clustering (B. C. M. Fung, et al., 2010)	PPDP seeks to anonymize the data by hiding identify of individuals, not hiding sensitive data. Hiding techniques such as k-anonymity, l-diversity, m-Invariance, T-Closeness (B. C. M. Fung, et al., 2010).

2.5.4.1 PPDP: Models

Data sharing can be accomplished in two different ways. The privacy challenges for each method differ significantly. Different approaches have been developed to deal with these challenges. In this section, we aim to present and discuss the models proposed in the privacy preservation data sharing.

David Ferraiolo (1992) stated that in one kind of data sharing, in which data is stored in one or several databases, the data user could send a request to the databases each time the user needs to access a small portion of data (David Ferraiolo, 1992). The databases may accept the request and send the user the requested data if the request complies with security and privacy policies. Role-Based Access Control (RBAC) is widely used in such scenarios. However, as the application becomes increasingly complex, such as the privacy protection issues in the medical field, simply using the RBAC model cannot meet these requirements. Personal data control or management of private data is difficult to achieve with the RBAC model (L. Chen, et al., 2012).

Byun et al. (2005) developed a purpose-based access control model of complex data for privacy protection based on the RBAC model. The brought-in-purpose inspection verifies not only the role of the user but also for using the request (Byun, et al., 2005). The purpose of using data would be carefully defined and strictly validated according to the privacy policy. Rostad (2008) introduced a personally controlled health record based on the RBAC and discretionary access control models to enable the patients to create their own privacy policy on their private data (Røstad & Nytrø, 2008).

Chen et al. (2012) proposed a framework for privacy preserving data sharing based on the k-anonymization model with the aim of practical application in a more comprehensive manner (L. Chen, et al., 2012). The framework focuses on three key problems of privacy protection during data sharing: privacy definition and detection, privacy protection policy management, and privacy preserving healthcare data sharing. Chen et al. (2012) also stated that personal healthcare data has been widely used for scientific research or commercial analysis in the last decade, and data is shared in another manner. Instead of querying a small portion of data each time, analyses require hundreds of thousands of personal records simultaneously. The institution utilizing this data may be a third party other than the data holders (such as hospitals or healthcare centres) or the data owner (patients). The shared personal data could easily spread everywhere. If the data centre simply sends a large amount of personal data to a third party, a vast privacy linkage may occur. The simplest means to deal with the privacy linkage problem is to detect all personal data and remove it from the shared datasets (Neamatullah, et al., 2008).

Fung et al. (2010) mentioned that removing all private data may significantly reduce the usability of a shared dataset. PPDP approaches were developed to maintain the balance of private data sharing and privacy protection (B.C.M. Fung, et al., 2010). In a typical PPDP model, such as K-anonymity, only identifiers, such as a name and ID that could be used to identify a certain person, would be deleted, whereas other private data such as age, address, and career would be transformed. Most studies on PPDP consider a more relaxed and practical notion of privacy protection by assuming that the attacker has limited background knowledge.

Researchers have developed various approaches similar to those introduced above to handle certain kinds of privacy preservation problems. According to Chen et al. (2012), several issues still plague the practical application of these approaches. Privacy must be clearly defined in a manner that could be recognized by all privacy protection approaches, and the definition has to be easily managed by system administrators to achieve privacy protection. Languages to express privacy definition and privacy policy should be developed to enable the mapping of requirements of privacy laws and regulations into the application systems (L. Chen, et al., 2012).

A number of frameworks for privacy preservation have been developed. Chen (2004) proposed a framework for privacy preserving data sharing (Chen, et al., 2004). The framework was designed to share data for analysis purposes and relied on dataset reconstruction technology. Kennelly (2009) developed an Internet data sharing framework to balance privacy and utility (Kenneally & Claffy, 2009). The framework offered a consistent, transparent, and replicable evaluation methodology for risk-benefit evaluation. In sum, the findings of prior literature reviewed suggest that this current study should focus on the first category of approaches, especially the privacy preservation before collaboration in sharing data to unknown parties. For example, the hospital publishes patient records because it is required by regulations or because it supports general medical research- not because the hospital requires the results of the data mining. Therefore, the data publisher is not required to do more than protect the data for publication in such a scenario. The next section discusses the K- anonymity model in privacy preserving data sharing. The details of the k-anonymization model as reported through recent studies are provided.

2.6 K-Anonymization Model

Recent advances in IT have enabled more organizations to collect, store, and use various types of information on individuals. In the past decade, the healthcare sector used personal healthcare data for scientific research or commercial analysis. However, the use of data containing personal information has to be restricted to protect individual privacy. Sweeney (2000) showed that 87% of the United States population may be uniquely identified by the combination of three quasi-identifiers, namely, birth date, gender, and zip code (Sweeney, 2000).

One of the most well-studied models of PPDP is k-anonymization, which was proposed by Samarati and Sweeney (Pierangela Samarati, 2001; P. Samarati & Sweeney, 1998;

Sweeney, 2002c). The most common implementation of k-anonymity is the use of transformation techniques, such as generalization, global recoding, and suppression (Bayardo & Agrawal, 2005a; Ciriani & De Capitani di Vimercati, 2007; El Emam & Dankar, 2008b; Iyengar, 2002; Pierangela Samarati, 2001; P. Samarati & Sweeney, 1998; Sweeney, 2002a, 2002c). K-anonymity defines each of the released records until they become indistinguishable from at least k−1 of other records when projected on the subset of public attributes, thereby hiding its relationship with the values of the sensitive attribute. As a consequence, each individual may be linked to sets of records of size at least k in the released anonymized table, such that privacy is protected to some extent (Sweeney, 2002c).

Any record in a k-anonymized dataset has a maximum probability 1/k of being re-identified. Bayardo and Agrawa (2005) stated that in practice, a data custodian would select a value of k commensurate to the re-identification probability or threshold risk that they are willing to tolerate (Bayardo & Agrawal, 2005a).

El Emam and Dankar (2008) stated that higher values of k imply a lower probability of re-identification, as well as more distortion to the data; hence, information loss is greater because of k-anonymization (El Emam & Dankar, 2008b). In general, excessive anonymization can cause the disclosed data to become less useful to recipients, as some analyses become impossible to conduct or may produce biased and incorrect results (El Emam & Dankar, 2008b). The same authors further stated that no empirical examination was done on how close the actual re-identification probability is to the maximum (El Emam & Dankar, 2008b). Ideally, the actual re-identification probability of a k-anonymized data set would be close to 1/k as it balances the risk tolerance of the data custodian with the extent of distortion introduced because of k-anonymization. However, if the actual probability is significantly lower than 1/ k, then k-anonymity may be overprotective, resulting in unnecessarily excessive distortions to the data (El Emam & Dankar, 2008b).

Kenig et al. (2012) mentioned that the values of the database are modified through the operation of generalization while keeping them consistent with the original ones. A cost function is used to measure the amount of information lost because of the generalization process. The objective is to modify the table entries such that the table becomes k-anonymous and information loss (or cost function) is minimized (Kenig & Tassa, 2012).

Recent studies have found that k-anonymity provides a formal means of generalizing this concept, as well as a measure of privacy protection by preventing re-identification of data to fewer than a group of k data items (Bayardo & Agrawal, 2005b; Campan & Truta, 2009; El Emam, et al., 2012; El Emam & Dankar, 2008b; El Emam, et al., 2009; Goryczka, et al.; Wei Jiang & Chris Clifton, 2006; Jurczyk & Xiong, 2009; LeFevre, et al., 2005; Parmar, et al., 2011; Sacharidis, et al., 2010; Sokolova, et al., 2012; Sweeney, 2002a, 2002c; Tassa & Gudes, 2012; Truta & Vinay, 2006). As stated in Samarati (2001) and Sweeney (2002b and 2002c), a data record is k-anonymous if and only if it is indistinguishable in its identifying information from at least k specific records or entities (Pierangela Samarati, 2001; Sweeney, 2002a, 2002c). The key step in making data anonymous is to generalize a specific value. Generalized data can be beneficial in many situations (Lei Chen, et al., 2012; W. Jiang & C. Clifton, 2006).

An anonymization operation comes in several forms, as mentioned in (B. Fung, et al., 2010). The healthcare sector adopts the generalization technique because it requires accurate, high quality data without any change of the data meaning (Lei Chen, et al., 2012; Sweeney, 2002b). The data related to the decisions of physicians affect the healthcare of patients. The generalization operation hides some details in the identifiers. For a categorical attribute, a specific value can be replaced with a general value according to a given taxonomy. Figure 2.7 shows that the parent node professional is more general than the child nodes, engineer and lawyer. The root node, ANY job, represents the most general value in jobs. For a numerical attribute, exact values can be replaced with an interval that includes exact values. If the taxonomy of intervals is given, the situation is similar to categorical attributes. More often, however, no predetermined taxonomy is given for a numerical attribute. Different classes of anonymization operations have different implications on privacy protection, data utility, and search space (B. C. M. Fung, et al., 2010). Many applications use generalized data in various areas, such as medical research, education studies, and targeted marketing, among others.

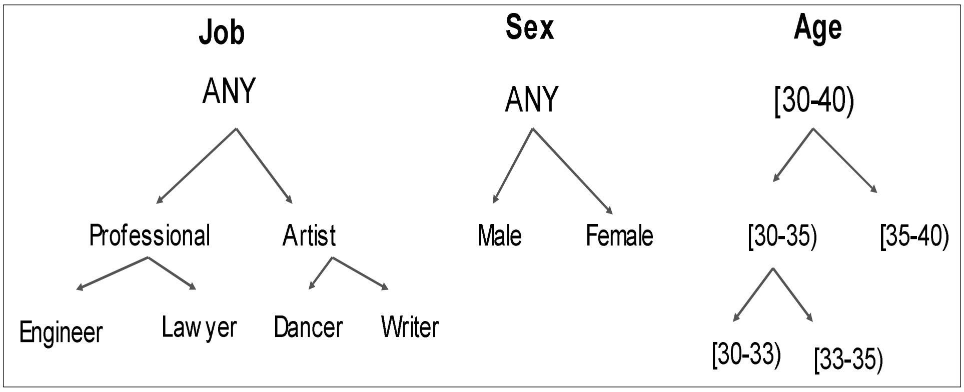


Figure 2.7: Taxonomy trees for Job, Sex, and Age

According to many studies, the k-anonymity characteristic is a simple and effective model that provides a measure of privacy protection by preventing re-identification of data to fewer than a group of k data items (Lei Chen, et al., 2012; Wei Jiang & Chris Clifton, 2006; Narayanan & Shmatikov, 2009; Sweeney, 2002c). K-anonymity provides a formal means to generalize this concept (Pierangela Samarati, 2001) because it maximizes data utility while limiting disclosure risk to an acceptable level (Morton, et al., 2012). The k-anonymity model is a simple and practical model for data privacy preservation (Chiu & Tsai, 2007), which guarantees that the data released is accurate (Barak, et al., 2007). Evidence from the literature reviewed in this section indicates that the k-anonymity model is appropriate for the healthcare field, especially privacy preservation before collaboration in sharing data to unknown parties. Moreover, the generalization technique adopted as the anonymize operation requires accurate and high quality data without any modification in the data meaning, such as data related to patient health and research findings. These findings address research question 3 to determine the characteristics required in the developed model to improve collaboration among specialists in the field of healthcare based on privacy preservation regarding the sharing of information.

2.7 Collaborative Healthcare Information Management Systems

Healthcare systems in many countries generally have distributed structures and consist of individual centres supported by autonomous HISs, such as hospitals. Cooperation among medical staff in such healthcare systems is an important issue in terms of sharing information and skills in patient treatment and improving healthcare research findings. HISs likewise serve as bases for exchanging healthcare information among physicians and provide integrated healthcare information for medical staff within a hospital or among different hospitals. Each HIS has the autonomy to process activities of patient treatment, but can likewise work cooperatively with other HISs to share healthcare information among physicians and provide quality care to patients. Therefore, a flexible cooperative approach to link HISs within a hospital and among different hospitals is necessary to provide an effective collaborative HISs environment.

Earlier studies (see Section 2.3.1) on developing cooperative HIS models focused on patient information and information relative to the provision of better services to patients. These models were aimed at improving healthcare management and physician activities. Most of the models have developed databases that contain integrated patient information into a centralized system to enable information sharing among the medical staff within the hospital. Several cooperative HISs models were developed to facilitate the sharing of healthcare information among practitioners at different locations in addition to the centralized system in order to concentrate on the problems of a particular patient. However, none of the earlier studies investigated the developing collaborative HIS models to improve collaboration among medical staff in healthcare research based on privacy preservation. Several significant factors affect collaboration among medical staff in sharing healthcare information using HISs within the hospital and in different hospitals. These factors are as follows:

1. Decentralized and autonomous units and lack of shared goals within healthcare systems; many HISs are isolated from one another because of the fragmented nature of healthcare systems (Fried, et al., 2011).
2. Lack of connectivity indicates the lack of HIS adoption in healthcare centres (K. M. Adams & Corrigan, 2003; Blumenthal, 2009).
3. Work style in the healthcare sector among medical staff (physicians, researchers) is characterized by independence (Blumenthal, 2009). These studies likewise indicate that working independently had an effect on collaboration in patient treatment and research findings (Blumenthal, 2009; Goldzweig, et al., 2009).
4. The physical work system indicates that most tasks in healthcare centres in many developing countries, such as Egypt, are paper based (Blaya, et al., 2010; Braa, et al., 2007; Fraser, et al., 2005; Gaboury, et al., 2009; Heeks, 2002; Mamlin, et al., 2006; Organization, 2010; Tierney, et al., 2010; VanVactor, 2012).
5. Issues of trust and its impact on collaboration among medical staff; recent studies indicate that security issues and privacy concerns raise the need for improved collaboration among medical staff through HISs. Effective

implementation of HISs requires trust from both the providers who use them and the patients they serve (Blumenthal, 2009; Lei Chen, et al., 2012; Goldzweig, et al., 2009).

6. Socio-technical challenges encountered by several health workers likewise have a role (Croll, 2009; Despont-Gros, et al., 2005; Gagnon, et al., 2003; R.J. Holden & Karsh, 2010; Moores, 2012; Succi & Walter, 1999; Zheng, et al., 2010).
7. Seventh, the logistics of implementation include low budget, low technology setting, and crowded and busy hospitals (Ahmad Samir AlFaar, 2014; Ezzat, 2014; Samir AlFaar, 2011).
8. Eighth, poor data management indicates a lack of high efficiency computer systems, lack of available high speed internet, absence of remote access to computers, and absence of institutional servers with automatic backups (Ahmad Samir AlFaar, 2014; Ezzat, 2014; Samir AlFaar, 2011).
9. Ninth, training issues: Obstacles exist, such as visa issues between different countries, and difficulty of agreeing on one place and time where collaborators leave their routine hospital work (Ahmad Samir AlFaar, 2014; Ezzat, 2014; Samir AlFaar, 2011).
10. Tenth, regulatory requirements: Difficulty in collecting approval from IRBs at different sites to conduct studies (Ahmad Samir AlFaar, 2014; Ezzat, 2014; Samir AlFaar, 2011).

In most developing countries, such as Egypt, collaboration among medical staff with regard to sharing information in healthcare research within the hospital setting is still very poor. Such poor collaboration can lead to insufficient outcomes, and research studies in hospitals can lead to harmful effects.

The socio-technical challenges faced by health workers, particularly clinicians, likewise serve a significant function. Therefore, to examine of the attitudes of clinicians toward

ICT is vital (Croll, 2009; Despont-Gros, et al., 2005; Gagnon, et al., 2003; R.J. Holden & Karsh, 2010; Moores, 2012; Succi & Walter, 1999; Zheng, et al., 2010) because clinicians have been shown to be non-receptive to ICT despite their awareness of its myriad of benefits. Research on the factors that affect attitudes of clinicians toward ICT have similarly been limited (Succi & Walter, 1999). HISs are implemented across the continuum of the healthcare environment to reduce healthcare costs. The attitudes of clinicians toward ICT will affect this situation because attitude is one of the determinants in TAM. Moreover, this study found a relationship between acceptance and success. Therefore, the nature of the clinician within the relatively fixed hierarchy in the healthcare delivery system should be considered as an important aspect of HIS usage when the acceptance of technology in the healthcare environment is scrutinized.

The literature review (see Section 2.4 and its sub-sections) has shown that health information privacy has received considerable attention in research communities. Preservation of the privacy of health information when reused in another field, such as collaborative medical research using HIS systems, has likewise been considered in previous studies. The addition to data utility is a very important issue in the implementation of data privacy protection. Sensitive information could be hidden through the insertion of false information into the database or by blocking data values. Although sample techniques do not modify the information stored in the database, they can reduce the value of information through the presentation of incomplete information. This reduction could have a negative effect in the medical field, considering the fact that medical staff requires clear data to arrive at transparent and evidence-based decisions to improve the healthcare system, as well as medical research findings.

In this context, research question 3 has been addressed. The effectiveness of the anonymization approach in privacy preservation has been shown in recent studies. The k-anonymization model, as mentioned in many studies (see section 2.6), is a simple and effective method that could maximize data utility while limiting the disclosure risk to an acceptable level, guaranteeing that the data released is accurate. Moreover, the generalization technique is adopted as the anonymize operation because of the accurate and high quality data requirement without any change in these data related to patient health and research findings.

The collaborative healthcare information management system, CHIMS, which was based on the k-anonymization model and generalization technique, was developed to achieve the objective of improving healthcare research collaboration and outcomes based on a privacy preservation approach. Figure 2.8 shows the conceptual framework of CHIMS.

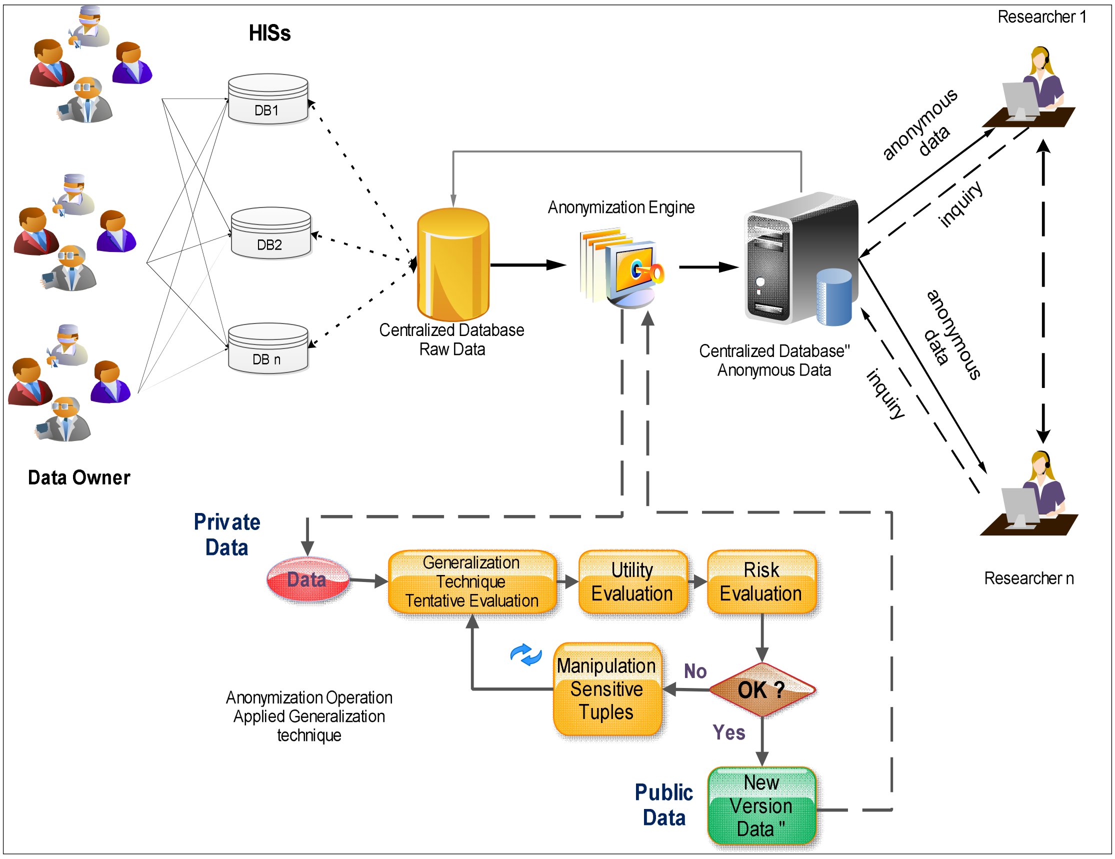


Figure 2.8: CHIMS using K-anonymization Model in Privacy Preservation Conceptual Framework

Recent studies have shown that the development of effective collaborative HISs to support collaborative work among medical staff, especially among physicians and researchers, requires the use of real data. This result is based on the fact that the collaborative HIS approach requires appropriate, flexible, and comprehensive healthcare information based on user (physicians or researchers) requirements (Kuziemsky, O'Sullivan, & Corneil, 2012; Kuziemsky & Varpio, 2011; Lezzar, et al., 2012; M. C. Reddy, et al., 2011; Ruxwana, et al., 2010; Scandurra, et al., 2008). Many studies mentioned the rising popularity of qualitative research in the last two decades. This method is becoming widely accepted across a wide range of medical and health disciplines, including health services research, health technology assessment, nursing, and allied health (Bradley, Curry, & Devers, 2007; Pope & Mays, 2008; Pope, Ziebland, & Mays, 2000; Robertson et al., 2010). A corresponding rise in the reporting of qualitative research studies in medical and health related journals has likewise been observed (Harding & Gantley, 1998). The development of a model for collaborative HISs among hospitals to improve healthcare information sharing among medical staff is a new research area in Egypt. Therefore, local literature on this particular subject is limited. This current study uses qualitative methods of research for data collection to address the research questions. Data collection was conducted in a selected Egyptian hospital as a case study. Collaborative HISs based on the k-anonymization approach and its features can provide an open, flexible, and collaborative system that can improve collaboration among medical staff in information sharing in healthcare research and future research findings.

2.8 Summary

This chapter provided an overview of ongoing and previous studies related to this current research. The chapter concentrated on analysing areas of collaboration among medical staff in healthcare research information sharing. The literature review identified several important studies on topics regarding the use of electronic HISs to meet the needs of physicians for cooperation in the hospital environment, enabling them to provide quality healthcare services and improve healthcare research findings. Many researchers in this area proposed healthcare system models for healthcare information sharing among medical staff, and few studies focused on the research on healthcare system and privacy preservation in the health sector. However, such models are not flexible in structure and are difficult to manage and control because of the enormous amount of data in complex healthcare systems. The literature review revealed the lack of collaboration among physicians because of significant factors (see section 2.7). The anonymization approach used to develop a CHIMS is described and obtained to overcome the factors that affect collaboration among physicians and develop effective collaborative HISs, thereby enhancing collaboration among medical staff and improving healthcare research findings. The next chapter will describe the methodology used in the current study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter details the research strategy and methods used in the data collection to achieve the objectives of this study. This chapter consists of two sections. In the first section, the methodology for the data collection procedures, including the description of the research strategies and the research paradigms, are outlined. The research theories, research methods, research design, case study, population and sample of the study, data collection plan, and research instruments are presented, along with a discussion of data collection techniques, as well as a description of the validity and reliability of the instruments and data analysis procedures. In the second section, the development of the collaborative healthcare information management system (CHIMS) model proposed in this study is detailed.

3.2 Methodology for the Data Collection Procedures

3.2.1 Research Strategy

The strategy of any research design is a set of procedures or methods used to conduct research. The three types of research strategies are quantitative, qualitative, and mixed methods (Mingers, 2001). These research strategies are based on underlying "paradigms", or philosophical assumptions that guide the research and identify the appropriate research methods. Taylor, Kermode, and Roberts (2006) defined a paradigm as "a broad view or perspective of something" (B. J. Taylor, Kermode, & Roberts, 2006). They also mentioned that several researchers refer to paradigm as "world view." According to Weaver and Olson (2006), the most commonly utilized paradigms in the healthcare field are positivist, post positivist, interpretive, and critical social theory (Weaver & Olson, 2006). Creswell (2009) proposed the conceptual framework components for any research design and explained the interconnection among these components, as depicted in Figure 3.1 (John W Creswell, 2009).

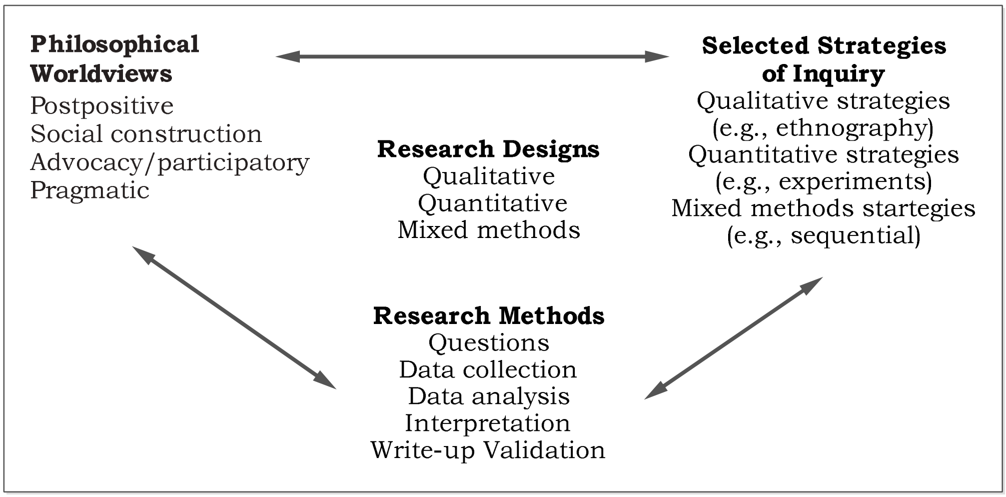


Figure 3.1: Framework for design: The interconnection of worldviews, strategies of inquiry, and research methods (John W Creswell, 2009)

Creswell (2009) focused on three research approaches, namely, quantitative, qualitative, and mixed methods (see Figure 3.1). The first two have been available for decades, and the last is new and continues to develop in form and substance.

The quantitative research approach is described in terms of "empiricism" (Leach, 1990) and "positivism" (M. E. Duffy, 1985). This research approach is a formal, objective, and deductive form of problem solving. The approach describes, tests, and examines cause-and-effect relationships (N. Burns & Susan, 2005) using a deductive process of knowledge attainment (M. E. Duffy, 1985). According to Gorman, Clayton, Rice-Lively, and Gorman (1997), quantitative research focuses more on numerical or statistical data (Gorman, Clayton, Rice-Lively, & Gorman, 1997). Fitzpatrick, Secrist, and Wright (1998) defined a quantitative technique as counting, scaling, and abstract reasoning (Fitzpatrick, Wright, & Secrist, 1998). Furthermore, quantitative methods focus on the strict quantification of observations and typically incorporate large-scale sampling procedures and the use of statistical tests to study group averages and variables. Quantitative research also aims to determine the relationship between one item (an independent variable) and another (a dependent or outcome variable) in a population (Kopala & Suzuki, 1999). Neuman (2007) mentioned that the experiments, surveys, content analyses, and existing statistics are the data collection techniques used in quantitative research to address research questions (Neuman, 2007).

The qualitative research approach is a form of scientific inquiry that spans different disciplines, fields, and subject matters, and comprises a number of varied approaches (Denzin & Lincoln, 2005). Qualitative methods can be used to understand complex social processes, capture the essential aspects of a phenomenon from the perspective of study participants (Malterud, 2001), and uncover beliefs, values, and motivations that underlie individual health behaviours (Berkwits & Inui, 1998; Crabtree & Miller, 1999). Such research can also illuminate the aspects of organizational context and healthcare delivery that influence organizational performance and the quality of care (Sofaer & Firminger, 2005). Qualitative studies are often exploratory in nature and seek to generate novel insights (Glaser & Strauss, 1967; M.Q. Patton, 1990; Pope & Mays, 1995; Silverman, 2009). Patton (2002) noted that qualitative approaches are characterized by three types, namely, in-depth, open-ended interviews, direct observation, and written documents (including program records and personal diaries or logs). Qualitative research strategies include grounded theory, ethnography, case study, and phenomenology (Patton, 2002). Each approach is uniquely suited for specific types of investigations, and the choice of design is determined by the aim of study (Patton, 2002). Patton (2002) stated that qualitative research provides an opportunity to “get close to the data,” and to observe and listen to the respondents express their thoughts in their own words (Patton, 2002). This approach provides an opportunity to draw insights and explanations from the respondents themselves. Thus, the researcher does not have to pre-determine the areas of response or study importance. According to Patton (1990) (M.Q. Patton, 1990), qualitative methodologies provide avenues that can uncover deeper levels of meaning.

The mixed methods approach is a combination of quantitative and qualitative research (Alan Bryman, 1998; Creswell, 1994). According to Creswell et al. (2003, 2007), "A mixed methods study involves the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given priority, and involves the integration of the data at one or more stages in the process of research." Pairing the quantitative and qualitative components of a larger study can achieve various aims, including corroborating findings, generating more complete data, and using results from one method to enhance the insights obtained using a complementary method (Creswell, Plano Clark, Gutmann, & Hanson, 2003; Tashakkori & Creswell, 2007). Approaches to mixed methods studies differ based on the sequence in which the components occur and the emphasis given to each component (Bergman, 2008; Creswell & Clark, 2007; Curry, Nembhard, & Bradley, 2009).

The researcher employed the qualitative research strategy due to several factors. The qualitative research assists the researcher study and gain in-depth information (Michael Quinn Patton, 1990). In addition, qualitative methods can be used to understand complex social processes, capture the essential aspects of a phenomenon from the perspective of study participants (Malterud, 2001), and uncover beliefs, values, and motivations that underlie individual health behaviours (Berkwits & Inui, 1998; Crabtree & Miller, 1999). Such research can also illuminate the aspects of organizational context and healthcare delivery that influence organizational performance and the quality of care (Sofaer & Firminger, 2005). In quantitative research, the researcher systematically identifies our participants and sites through random sampling; in qualitative research, the researcher identifies our participants and sites on purposeful sampling, based on places and people that can best help us understand our central phenomenon (J. W. Creswell, 2011b). Data is collected in a natural setting where the respondent feels comfortable and knowledgeable. When you collect data from a respondent in their natural surroundings, they are more likely to feel comfortable and thus, less likely to exude a bias of any sort (Creswell, 2013). In sum, qualitative research is now receiving recognition and is increasingly used in health care research with social and cultural dimensions. Unlike quantitative research, which is deductive and tends to analyse phenomena in terms of trends and frequencies, qualitative research seeks to determine the meaning of a phenomenon through description (Al-Busaidi, 2008). Qualitative research aims to develop concepts that aid in the understanding of natural phenomena with emphasis on the meaning, experiences and views of the participants.

3.2.2 Research Theories

HIS in the healthcare sector offers significant benefits for both medical treatment and scientific research to relevant sectors (Lei Chen, et al., 2012; Scott, 2007). According to Ammenwerth et al. (2003) and Lu et al. (2005), hospitals that do not adopt new information systems (IS) will become inefficient and lose the trust of their patients (E. Ammenwerth, et al., 2003; Lu, et al., 2005). A number of studies have proposed frameworks for building trustworthy IS solutions for the healthcare sector (see chapter 2 section 2.4.2).

Considering that most technical obstacles are gradually eliminated, the question that arises is whether people are willing to use these new technological achievements (see chapter 2 section 2.3.1). Therefore, a better understanding of how people confront the possibility of IS usage is required for the development of new implementation methods.

These methods must be able to identify user attitudes toward a system, thus helping developers improve and maximize the possible level of user acceptance (Aggelidis & Chatzoglou, 2009).

The current study uses the Technology Acceptance Model (TAM), an IS theory that models how users come to accept and use a technology (Fred D Davis, 1989). The model suggests that when users are presented with a new technology, a number of factors influence user decisions on how and when to use it. The most notable factors include perceived usefulness and perceived ease-of-use (F.D. Davis, et al., 1989). TAM assists in the identification of external factors and obstructions in the healthcare sector that affect the acceptance and adoption of technology for healthcare information sharing among medical staff using the HIS. Additional details are provided in Chapter 2, Section 2.4.1.

TAM has been applied in various fields, such as (1) computers (Igbaria, Parasuraman, & Baroudi, 1996; S. Taylor & P. Todd, 1995; S. Taylor & P. A. Todd, 1995), (2) business process applications (V. Venkatesh & Davis, 2000; Viswanath Venkatesh, et al., 2003), (3) communication and collaboration systems (Straub, Limayem, & Karahanna-Evaristo, 1995; Viswanath Venkatesh, et al., 2003), (4) system software (Guimaraes & Igbaria, 1997; V. Venkatesh & Davis, 2000), (5) World Wide Web/Internet (Gefen, et al., 2003), and (6) healthcare applications (Aggelidis & Chatzoglou, 2009; Lei Chen, et al., 2012; R.J. Holden & Karsh, 2010; P. J. Hu, P. Y. K. Chau, O. R. L. Sheng, & K. Y. Tam, 1999).

IS acceptance is a necessary precondition for success. According to Delone and McLean (2003, 2008), the IS success model has also been found to be a useful framework for organizing IS success measurements (William H. Delone & McLean, 2003; S. Petter, et al., 2008). The model has been widely used by IS researchers to understand and measure the dimensions of IS success. Furthermore, each of the variables that describes IS success is consistent with one or more of the six major success dimensions of the updated model, as mentioned in Chapter 2, section 2.4.3.

The present study used TAM based on the recommendations from recent studies regarding to TAM model benefits as the following. TAM (1989) is the most influential IT adoption model and is widely applied to explain the technology acceptance process in different contexts (Abu-Dalbouh, 2013; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010; Hossain & de Silva, 2009). Davis derived TAM from TRA (1975), mainly to explain technology use in various situations and cultures so that the user acceptance of systems would increase (Esmaeilzadeh & Sambasivan, 2012). Many studies note that the TAM theory is widely used in research contexts as well as with several types of technology applications (Abu-Dalbouh, 2013; Chau & Hu, 2001; S. M. Lee, et al., 2006; Raitoharju, 2007; Yarbrough & Smith, 2007). Another reason for the usefulness and popularity of TAM is its parsimony, simplicity, and understandability, which gives it the empirical support of a variety of user groups (Esmaeilzadeh & Sambasivan, 2012; Y.-S. Wang, et al., 2003). According to Abu-Dalbouh (2013), another reason is that the TAM uses factors of technology acceptance that are transferable to different user populations and different kinds of technologies. Many contexts and research constructions have confirmed the validity of the TAM model (Abu-Dalbouh, 2013; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010; King & He, 2006; Ma & Liu, 2004), including in the healthcare field (Abu-Dalbouh, 2013; Chau & Hu, 2002; Chismar & Wiley-Patton, 2003; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010). In sum, the available evidence suggests that TAM is appropriate for use in the healthcare field (Abu-Dalbouh, 2013; Ducey, 2013; Esmaeilzadeh & Sambasivan, 2012; R.J. Holden & Karsh, 2010; Ketikidis, et al., 2012). Specifically, perceived usefulness consistently predicted the adoption and use of health information technology by healthcare professionals. Moreover, perceived ease of use correlated with perceived usefulness in most studies. However, inconsistent results were obtained between PEOU and IT acceptance, possibly due to differences in intelligence, competence, and adaptability to new technologies, as well as the nature of the work between physicians and the general workforce (R.J. Holden & Karsh, 2010). According to Melas, Zampetakis, Dimopoulou, and Moustakis (2011), a strong need exists for developing and gaining empirical support for TAM within health organizations. More replication studies are required so that confidence will be gained on whether TAM is an appropriate theory for studies in the healthcare field (Melas, et al., 2011).

3.2.3 Research Methods

A research method is a plan that enables the researcher to generate answers for the research questions (Bradley, et al., 2007; Pope & Mays, 2008; Pope, et al., 2000; Robertson, et al., 2010). Thus, a research method weaves through the objectives, the research questions of the study, the data gathered to the conclusions, and recommendations drawn at the final stage of the study.

According to Mays and Pope (2000, 2009), qualitative research has increased in popularity during the previous two decades, and is becoming widely accepted across a wide range of medical and health disciplines, including health services research, health technology assessment, nursing, and allied health (Mays & Pope, 2000; Pope & Mays, 2008). The number of qualitative research studies in medical and health-related journals has likewise increased (Harding & Gantley, 1998).

Wong (2008) mentioned that the increasing popularity of qualitative methods is a result of the failure of quantitative methods to provide insight into in-depth information about the attitudes, beliefs, motives, or behaviours of people, such as understanding the emotions, perceptions, and actions of people who suffer from medical conditions (Wong, 2008). Qualitative methods explore the perspective and meaning of experiences, seek insights, and identify the social structures or processes that explain the behaviour of people. More importantly, according to (Mays & Pope, 2000; Pope & Mays, 1995), qualitative research relies on extensive interaction with the people being studied, and often enables researchers to uncover unexpected or unanticipated information, which is impossible when using quantitative methods. Holloway and Wheeler (2009) mentioned that the health behaviour studies in medical research, health, or education policies can be effectively developed if the reasons for behaviours observed or investigated using qualitative methods are clearly understood (Holloway & Wheeler, 2009).

Miles and Huberman (1994) claimed that qualitative research is a process that conducts research about “field” or “life” situations, implying that this process is concerned with practical situations. These situations are naturally reflective of the daily lives of individuals, groups, societies, and organizations (Miles & Huberman, 1994). Therefore, the qualitative researcher attempts to capture data on the perceptions of local actors “from the inside” through a process of deep concentration of empathetic understanding, and of suspending or “bracketing” presumptions about the topic under discussion (Miles & Huberman, 1994). The researcher is essentially the main measurement device in a qualitative study process (Charnkit, 2010).

The objective of qualitative research is to explicate the ways people in particular settings attempt to understand, give an explanation, take action, and manage their day-to-day situation (Charnkit, 2010).

The present research adopts the qualitative research approach and the case study method as part of its research components (B. L. Berg, 2004, 2007). A case study was conducted in an Egyptian hospital. Case study research is the most common qualitative method used to study IS (Alavi & Carlson, 1992; B. L. Berg, 2007; W. Orlikowski &

Baroudi, 1990), and is an increasingly popular approach among qualitative researchers (Hyett, Kenny, & Virginia Dickson-Swift, 2014; Thomas, 2011). According to Yin (2009), the case study is an empirical inquiry that "investigates a contemporary phenomenon within its real-life context" (R.K. Yin, 2009), especially when "the boundaries between phenomenon and context are not clearly evident" (Jemal et al., 2011). According to Davies and Beaumont (2007), the case study is a method that enables a researcher to learn and analyse a real situation and to develop a solution by applying theoretical concepts, experience, and observation by focusing on the conceptual issues of a case study (Davies & Beaumont, 2007). Through the case study, a researcher encounters new problems they might have never experienced before. The strength of a case study involves a detailed and holistic investigation of the conducted units. The researcher is not limited to any research method or instrument. Furthermore, the data collection of case studies can be conducted over a certain period. However, one of the main weaknesses of the case studies is related to the limited insights into relevant subjects. The results also cannot be generalized (Leary, 2012). The case study is detailed in section 3.2.5.

3.2.4 Research Design (RD)

Any successful attempt to integrate information communication technology (ICT) into existing institutional structures must begin with an evaluation of the current status of the institution, followed by a plan for improvement (Govender, 2011). Research design is the plan that is followed to conduct the research (B. L. Berg, 2004, 2007). According to Hevner and Chatterjee (2010), the design science research paradigm is highly relevant to information systems (IS) research because it directly addresses two of the key issues of the discipline (Hevner & Chatterjee, 2010): the central, albeit controversial, role of the IT artefact in IS research (Benbasat & Zmud, 2003; W. J. Orlikowski & Iacono, 2001; Weber, 1987) and the perceived lack of professional relevance of IS research (Benbasat & Zmud, 1999). Design science, as conceptualized by Simon (1996), supports a pragmatic research paradigm that calls for the creation of innovative artefacts to solve real-world problems (Simon, 1969). Thus, design science research combines a focus on the IT artefact with a high priority on relevance in the application domain. The design science paradigm has its roots in engineering and the sciences of the artificial (Simon, 1969). It is fundamentally a problem-solving paradigm. It seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, and use of information systems can be effectively and efficiently accomplished. Design science research in IS addresses what are considered to be wicked problems (Hevner & Chatterjee, 2010). That is, those problems characterized by: (1) unstable requirements and constraints based on ill-defined environmental contexts, (2) complex interactions among subcomponents of the problem, (3) inherent flexibility to change design processes as well as design artefacts (i.e., malleable processes and artefacts), (4) a critical dependence upon human cognitive abilities (e.g., creativity) to produce effective solutions, and (5) a critical dependence upon human social abilities (e.g., teamwork) to produce effective solutions.

The case study method is adopted in the current research, which aims to "illuminate the general by looking at the particular" (Denscombe, 2007). The purpose is not to over generalize an isolated investigation, but to gain some insights from which certain wider implications may be assumed. Case studies are the most common types of qualitative method used in information sciences and technologies research (B. L. Berg, 2004, 2007). Typically, the researcher studies a case or a variety of real-world organizations that utilize information sciences and technologies. Conclusions are then drawn regarding their impacts on the organizational context (B. L. Berg, 2004, 2007).

The concept of ontology was used to evaluate the current status of the institution. Ontology describes the nature of reality, followed by a plan for improvement according to the knowledge acquired from the study. Epistemology in research design (RD) involves learning through building and organizing steps and processes to improve performance (Creswell, 2007; Vaishnavi, et al., 2007). The successful integration of health information technology into hospitals ("health providers") will result in the early detection of infectious disease outbreaks around the country, improved tracking of chronic disease management, healthcare evaluation (Sinha, 2010; Wu, et al., 2006; Yusof, Kuljis, Papazafeiropoulou, & Stergioulas, 2008), and quality information that can be compared with "axiology," a philosophical perspective that studies values and value judgments (Creswell, 2007; Vaishnavi, et al., 2007).

This study adopts the qualitative research approach using case study. Data collection techniques, such as interview and observation, are also adopted. The need to use different techniques for data collection arises from the ethical need to confirm the validity and reliability of the processes (B. L. Berg, 2004, 2007), to ask subjects to identify factors that affect technology acceptance with regard to collaboration in sharing information among specialists within the selected Egyptian hospital, and to determine the main obstructions in technology adoption with regard to collaboration in sharing information among specialists. Furthermore, this study intends to develop a proposed CHIMS model (see Figure 2.8 in Chapter 2) to improve collaboration among specialists with regard to health information sharing in the hospital environment based on privacy preservation. Figure 3.2 shows the research science design framework.

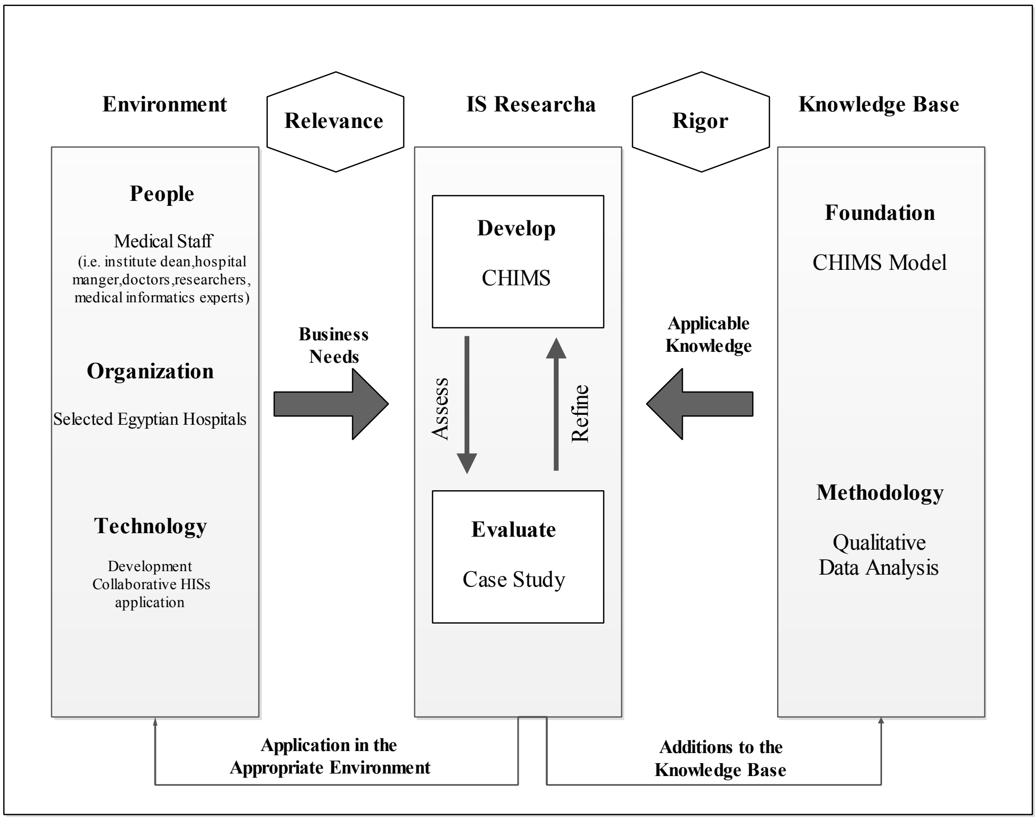


Figure 3.2: Research Science Design Framework

Figure 3.2 shows the research science design framework for this study. The research science design framework includes three stages: (1) the environment defines the problem space (Simon, 1969) in which the phenomena of interest resides. For IS research, it is composed of people, organizations, and their existing or planned technologies (Silver, Markus, & Beath, 1995). In it are the goals, tasks, problems, and opportunities that define business needs as they are perceived by people within the organization. Such perceptions are shaped by the roles, capabilities, and characteristics of people within the organization. Organization needs are assessed and evaluated within the context of organizational strategies, structure, culture, and existing business processes. They are positioned relative to existing technology infrastructure, applications, communication architectures, and development capabilities. Framing research activities to address organization needs assures research relevance (Hevner & Chatterjee, 2010). Design science addresses research through the building and evaluation of artefacts designed to meet the identified business need. The goal of design science research is utility. The knowledge base provides the raw materials from and through which IS research is accomplished. The knowledge base is composed of foundations and methodologies. Prior IS research and results from reference disciplines provide foundational theories, frameworks, instruments, constructs, models, methods, and instantiations used in the develop/build phase of a research study. Methodologies provide guidelines used in the evaluate phase. Rigor is achieved by appropriately applying existing foundations and methodologies. The following sections discuss the Research Science Design stages in detail.

3.2.5 Case Study

Case study research is the most common qualitative method used to study IS (Alavi & Carlson, 1992; B. L. Berg, 2007; W. Orlikowski & Baroudi, 1990). According to Yin (2009), the case study is an empirical inquiry that "investigates a contemporary phenomenon within its real-life context" (R.K. Yin, 2009), especially when "the boundaries between phenomenon and context are not clearly evident" (Jemal, et al., 2011). According to Davies and Beaumont (2007), the case study is a method that enables a researcher to learn and analyse a real situation and to develop a solution by applying theoretical concepts, experience, and observation by focusing on the conceptual issues of a case study (Davies & Beaumont, 2007). Through the case study, a researcher encounters new problems they might have never experienced before. The strength of a case study involves a detailed and holistic investigation of the conducted units. The researcher is not limited to any research method or instrument. Furthermore, the data collection of case studies can be conducted over a certain period. However, one of the main weaknesses of the case studies is related to limited insights into relevant subjects. The results also cannot be generalized (Leary, 2012).

Yin (1994, 2003) argued that the single case design is eminently justifiable under certain conditions, and the three key situations for choosing a single case study consist of critical, extreme, and revelatory cases (Robert K Yin, 2003; Yin Robert, 1994). This research employs the case study methodology to achieve the aims of the study, to propose and develop collaborative healthcare information management system (CHIMS) model, and to provide an integrated collaborative HIS environment. This model intends to improve collaboration among medical staff (i.e., physicians, researchers) in sharing healthcare information based on privacy preservation in the same and in different hospitals in order to enhance the medical research findings. In this study, two remote government hospitals (Egyptian Hospitals) are used as case studies because of the availability of cancer research centres in the hospitals. Furthermore, the selected Egyptian cancer hospital in Cairo City is considered to be the leading cancer centre in the Middle East and Africa. The hospital is also the largest and best facility for cancer treatment in Egypt. Various cancers are becoming an increasingly important cause of illness and death in developing countries. Fertility rates in less developed countries far exceed that of more developed countries (Dey & Soliman, 2010; JSH Ferlay, Bray, Forman, Mathers, & Parkin, 2010; E. Salim, 2010). The selected Egyptian hospital is located in Cairo City, Egypt. The profile, HISs, and activities of the Egyptian hospital, as well as the collaboration among medical staff of the hospital are detailed in Chapter 4.

The Egyptian hospitals were selected as subjects of this study for several reasons. First, one of the selected Egyptian hospitals is a main cancer centre in Egypt and includes six sub-centres in all regions of the country. Moreover, this hospital is a leading cancer centre in the Middle East and Africa (El Hattab, 2001; Inas. Elattar, 2005). Second, the lack of shared goals in and out of the healthcare organization regarding medical research indicates decentralized and autonomous units, which is common among HISs

(Fried, et al., 2011), and thereby leads to poor research findings. Third, cancer is a general health problem (E. Salim, 2010; E. I. Salim et al., 2009). Fourth, the selected Egyptian hospital is leading a national effort to reduce cancer morbidity and mortality by stimulating and supporting scientific discoveries through research, health information dissemination, basic and clinical biomedical research, and training. This hospital also conducts and supports programs that aim to understand the causes of cancer, prevent, detect, diagnose, treat, and control cancer, and disseminate information to practitioners, patients, and the public in general. These programs support research, health information dissemination, and training (El Hattab, 2001; Inas. Elattar, 2005). These factors served as a motivation to investigate the selected Egyptian hospital. To illustrate the obstacles in adopting collaborative HISs among medical staff in terms of sharing medical data based on privacy preservation, the responses should be from the physicians in the selected Egyptian hospital who use the HISs and are familiar with the system environment, as well as from medical informatics experts.

3.2.6 Population of the Study

The focus of this study is the issue of collaboration among medical staff in sharing healthcare information for health research based on preserving privacy. The population was comprised of 12 participants, including 10 physicians and 2 medical informatics experts. They included the institute dean, hospital manager, doctors, and two HIS experts. Hence, the adopted research strategy presents the findings of critical analyses from previous research discussed in Chapter 2, and supports these findings by adopting a case study in actual practice. Given that the adopted strategy is used to prove the credibility of the analysis results from previous research, these procedures typically involve observing the characteristics of the research respondents and how they conduct their work. Table 3.1 shows the profile of the population.

Table 3.1: Profile of the Population

Population Profile Attributes	Description
Hospital Name	Cancer Egyptian Hospital (Hospital A) Cancer Egyptian Hospital (Hospital B)
Hospital Specialization	General Hospital Teaching Hospital
Physicians	Institute Dean Hospital manager physicians
Interviewees No.	12 Participants including 10: Physicians (Hospital manager and heads of hospital departments) 2: Medical Informatics experts *Note: this number of physicians is change.
Biostatistics and Cancer Epidemiology Department	Biostatistics and research Cancer epidemiology Cancer prevention Computerized information system

Furthermore, considering the difficulty of studying the entire HIS in a hospital, the cancer research unit in Biostatistics and Cancer Epidemiology Department (BiOSCED) in the selected hospital was selected as a model to study the entire HIS. The hospital has a large number of units. Therefore, the connections between the information systems of these units are complex, and their establishment requires time (Al-Khawlani, 2009; Masaud-Wahaishi & Ghenniwa, 2009; H. Yang, et al., 2010) The following subsection discusses in detail the selection of sample for this study.

3.2.6.1 Selection of Sample

Choosing a sample group efficiently requires the researcher to match the sample with the main objective of the research topic. The selection is the main strategy of qualitative research, which is expected to assist the researcher in studying and gaining in-depth information (Michael Quinn Patton, 1990). Ryan, Coughlan, and Cronin (2007) mentioned that the qualitative examples are small and sourcing for information has no minimum limit (Ryan, Coughlan, & Cronin, 2007). Some groups might have 20 to 30 people or less (Paul Dellinger Leedy & Jeanne Ellis Ormrod, 2005).

In this study, the sample consisted of 12 participants, including the institute dean, hospital manager, and heads of departments who work closely on HISs in the selected Egyptian hospital. The selection was based on purposeful sampling (J. W. CRESWELL, 2011a; Creswell, 2012). Leary (2012) mentioned that in purposeful sampling, researchers can decide which participants to include in the sample. This sampling was done because they were the main actors in the selected Egyptian hospital.

The respondents were selected based on purposeful sampling (J. Creswell, 2011) because the data required for this research is from the standpoint of each sample within the HIS environment. The standard used to select the participants and sites is whether or not they are "information rich" (J. W. CRESWELL, 2011a; M.Q. Patton, 1990). Therefore, the research samples should be physicians and medical informatics experts within the selected Egyptian hospital who use the HIS and are familiar with the system environment. The Egyptian hospital was selected because of the reasons mentioned previously (see section 3.2.5). The 12 specialist physicians included the hospital manager, heads of departments, and medical informatics experts within the selected Egyptian hospital. They were asked to participate in the interview after they reviewed and approved the study proposal.

For the qualitative data collection, in-depth interviews were conducted with the 12 participants, including 10 physicians and 2 medical informatics experts. They included the institute dean, hospital managers, head of departments and doctors, and two HIS experts from the selected hospital for this study. Only 10 specialist physicians participated in interviews; some of the physicians refused to participate. Table 3.2 shows the number of participants and their profiles from selected Egyptian hospital.

Table 3.2: Number of Interview Conducted and their Profiles

Hospital Name	Number of Specialist participants	Interviewee Profile	Code of Interviewee	Gender	Educational Qualification	Date, Time
Selected Egyptian Hospitals	10 (Specialist physicians Interviewed)	Cancer Epidemiology	DNCI01	Female	PhD in Medicine	16/7/2011 10 am -11.15 am
		General Surgery	DNCI02	Male	PhD in Medicine	23/7/2011 12 am -1 pm
		Oncology	DNCI03	Female	PhD in Medicine	2/8/2011 1 pm -2.30 pm
		Pediatric Oncology	DNCI04	Male	PhD in Medicine	7/8/2011 12 am -1.30 pm
		Therapeutic Radiology	DNCI05	Male	PhD in Medicine	9/8/2011 10 am -12 am
		Surgical Pathology	DNCI06	Male	PhD in Medicine	17/8/2011 3 pm -4.30 pm
		clinical pathology	DNCI07	Male	PhD in Medicine	18/8/2011 10 am -11 am
		Anesthesiology	DNCI08	Male	PhD in Medicine	18/8/2011 1 pm -1.30 am
		Diagnostic Radiology	DNCI09	Male	PhD in Medicine	19/8/2011 10 am -10.45 am
		Tumor Biology	DNCI10	Male	PhD in Medicine	19/8/2011 12 am -1.30 pm
	2 Medical Informatics Experts	Information Technology Unit	MIENCI01	Male	Master in Information Systems	22/8/2011 11 am -1 pm
		Information Technology Unit	MIENCI02	Male	Master in Information Systems	22/8/2011 2 pm -3.30 pm

3.2.7 Data Collection Plan

Creating a data collection plan is an important step before collecting data to ensure the collection of correct data. The researcher should have a clear plan for data collection and decide on the type of study required (Al-Khawlani, 2009). According to Al-Khawlani (2009), the data collection plan ensures that all required information is going to be collected, and that no unnecessary data is collected. The data collection plan also ascertains that the data gathered contains real information that is useful to the improvement effort and prevents errors that commonly occur in the data collection process. Moreover, the data collection plan saves time and money that otherwise might be spent on repeated or failed attempts to collect useful data (Al-Khawlani, 2009).

Hence, the adoption of a data collection plan increased the reliability of the collected data and the credibility of this research. Initially, ethical approval to conduct this study was obtained from the national cancer institute, Cairo Governorate, Ministry of Health, Egypt. The approval was obtained before any information on the hospital selected for the case study was gathered. The researcher informed the institute dean and hospital manager about the upcoming study through a letter and personal visit. Official permission was obtained from the institute dean and the hospital manager. The letters of approval are shown in Appendix A. The researcher also used the same opportunity to explain the purpose of the study to the hospital manager. At the same time, the hospital manager was requested to explain the aims of the study to their staff members, especially those who were enlisted to participate in the study, based on the guidelines provided by the researcher. The data for the study were collected from the selected Egyptian hospital after carrying out the official steps to obtain permission to conduct the study. The observations and interviews were conducted during appointed times at different dates.

3.2.8 Research Instruments

Interactive qualitative inquiry is an in-depth study that uses the face-to-face technique to collect data from people in their natural settings (Creswell, 2007). Various data collection techniques were employed, as defined by (De Britto, Raj, & Chelliah, 2008). In the case study methodology, these techniques include observation and interviews. Recent studies indicate that the use of qualitative research methods (QRMs) is becoming increasingly widespread in medical informatics. QRMs are used to learn about the needs of users, their work, and the success or failure of IT applications in healthcare (M. Berg, Aarts, & van der Lei, 2003; Friedman & Wyatt, 1997, 2006; B. Kaplan, 2001; Weßel, Weymann, & Spreckelsen, 2006).

In the data collection stage of this study, data was primarily collected through observation and semi-structured interview instruments. An observation instrument was used as a method to easily collect qualitative data from respondents. The main advantage of the observation as mentioned in (J. W. CRESWELL, 2011a) is that the researcher can record information as it occurs in a research site and can examine behaviours that cannot be manipulated. The interview instrument was considerably more interactive, which allowed the researcher to clarify questions for the respondents and obtain valuable qualitative data from them (Alan Bryman, 2008; Bonnie Kaplan, Truex, & Wastell, 2004). This data collection procedure helped the researcher to clarify in-depth information and to extract the requirements needed to develop the proposed CHIMS model.

To compile, design, and develop the data collection instrument of this study (i.e., semi-structured interviews), a careful process of collecting and gathering the required information was conducted in a number of ways. On one hand, the research instruments were constructed after a thorough review of the available published literature, such as Samuel (2009), Shahmoradi et al. (2007), and Raddy and Jansen (2008) (M. C. Reddy & Jansen, 2008; Samuel, 2009; Shahmoradi, Ahmadi, & Haghani, 2007), consultation with local experienced physicians, and reflection upon the knowledge and professional experience of the researcher. On the other hand, the researcher conducted a thorough literature review to familiarize himself with the conceptual foundations. Recent literature reviews, such as Collins et al. (2011), Li and Yao (2006), and Reddy and Jansen (2008) addressed the issue of collaboration among medical staff (i.e., physicians) in sharing information using qualitative instruments (Collins, et al., 2011; K. Li & Yao, 2006; M. C. Reddy & Jansen, 2008). Furthermore, the research instruments were then tested to evaluate their validity and reliability through expert validation followed by a pilot test (Alan Bryman, 2008). The following subsections describe each technique that is most relevant to the case study.

3.2.8.1 Observation

Observation is the systematic documentation of nonverbal as well as verbal behaviour and communication. The key benefit of the observation technique is that the technique allows the recording of the behaviour without relying on reports from the respondents (Zikmund, 2003). Observation is the process of gathering open-ended and first-hand information by observing people and places at a research site. As a form of data collection, observation has advantages and disadvantages. Its advantages include the opportunity to record information as it occurs in a research site and examine behaviours that cannot be manipulated. Observation is a time-consuming technique; nevertheless, the information obtained is generally more accurate. According to (P.D. Leedy & J.E. Ormrod, 2005), observations, such as the observations made within the selected Egyptian hospital, can offer a tool to record information in great detail and capturing the numerous ways participants act and interact. This aspect will provide an integrated idea of how participants spend their time. According to Hannan (2006), the distinctive feature of observational techniques is their ability to record the flow of interaction or the dynamics of behaviour (Hannan, 2006). Behaviour in the selected Egyptian hospital was informally observed before conducting this study. This observation laid the groundwork for the study to access the selected Egyptian hospital before conducting this study. The researcher conducted a previous postgraduate study on medical informatics in the same Egyptian hospital from 2008 to 2010. The researcher visited the hospital numerous times to obtain medical data for the previous study. These visits provided the researcher a significant opportunity to observe the hospital environment of the selected hospital. This opportunity also enabled the opportunity to understand the culture of the medical staff using the HIS, as well as to determine some of the obstacles that the medical staff encounters in HIS adoption and management of patient information in the hospital environment.

Throughout the 2010-2011 academic year, the researcher began to undertake official steps to obtain permission to conduct the study in the selected Egyptian hospital. The routine procedures followed in the selected Egyptian hospital and the long waiting periods involved to obtain approvals required to conduct a study enabled the researcher to observe the environment of the selected Egyptian hospital. The researcher had an opportunity to understand the culture of the staff and the attitude of the administration regarding the use and adoption of the HIS, and to identify certain obstacles faced by medical staff and researchers. This informal observation also allowed for development of a more formal checklist to guide the observation during the actual study period in order to better understand medical staff behaviours. The main themes identified for the formal observation during the study included (1) the nature work among specialists within selected hospital (collaboration), (2) how HIS is used in the selected hospital with regard to the sharing of healthcare information (technology acceptance), (3) identifying the factors and obstructions that affect the HIS adoption in this environment, (4) researchers activity, and (5) the CHIMS requirements needed in the selected hospital from the user perspective.

3.2.8.2 Interview

Interviews offer a means to record the responses of research participants of open-ended questions. The interview is a verbal questionnaire. The researcher can ask questions, listen to the responses, observe behaviour, and record responses, allowing for "nuanced and rich data" (Creswell, 2005), especially when the interview occurs in a one-to-one situation in which the researcher asks questions and records answers from only one participant (Creswell, 2005). Interviews are used to interactively collect data from the subjects. In the present study, interviews were conducted individually and in the Arabic language. The information was recorded on individual copies of the interview form for each interviewee.

This research employed a semi-structured format for the interview because the outcomes (both attitudes and ideas) are obtained from the perspective of the interviewee, which will assist the researcher to set new questions during the interview session (Yin Robert, 1994). Moreover, semi-structured interviews have an open format that compels the participants to reveal the truth, as they cannot predict questions beforehand and will be unable to formulate answers in advance. Therefore, a semi-structured interview is an important instrument in qualitative research.

All of the interviews were conducted by the researcher to maintain consistency of responses. The researcher conducted the in-depth interviews with 12 participants, including 10 physicians and two medical informatics experts from selected hospital for this study (see Table 3.2). The in-depth interviews were useful to study the issues comprehensively. The researcher used a guide to conduct the interviews. The interview guide is a set of interview questions developed based on the objectives of the study and observation findings. The open-ended questions used during the interview process were based on recommendations from existing literature, anecdotal information, and conversations with the expert cancer colleagues of the researcher (Alan Bryman, 2008). Overall, 20 questions were asked during the interviews, and each interview session took approximately one to two hours. The Arabic and English languages were used in the interviews (see Appendix B).

The interviews continued until data saturation was achieved (i.e., no new opinions were raised) (Alan Bryman, 2008). Data was recorded, written, and summarized with the permission of the participants. This data was then translated into English, transcribed, and analysed based on themes (Miles & Huberman, 1994). The transcription process involved the transfer of the recorded interview files from the voice recorder to the personal computer of the researcher. This procedure was followed by the word-by-word transcription of the interviewee data. The transcription process was then followed by the subsequent data reduction in an Excel format. In this context, the issues were classified based on the codes of the participants, as shown in Table 3.2. This approach assisted the researcher to sort the data easily, transcribe, and display the data in accordance with themes depending on the objectives of the study.

Participants were also informed of the recording of the interviews. During the interview, the researcher took notes as the interviewees talked. A brief explanation was introduced first to ensure a clear understanding of the research aim, research question, and confidentiality of their identities. Finally, to maintain confidentiality, this research used code names to replace all the names of the people and the organization. To keep an informal conversational atmosphere, the researcher agreed to whatever the interviewees said.

3.2.8.3 Documents

A valuable source of information in qualitative research can be documents. Documents consist of public and private records that qualitative researchers obtain about a site or participants in a study, and they can include newspapers, minutes of meetings, personal journals, and letters. These sources provide valuable information in helping researchers understand the central phenomena in qualitative studies (J. W. Creswell, 2011b). Documents represent a good source for text (word) data for a qualitative study. They provide the advantage of being in the language and words of the participants, who have usually given thoughtful attention to them. They are also ready for analysis without the necessary transcription that is required with observational or interview data (J. W. Creswell, 2011b).

The researcher used document analysis for data collection in order to answer the research questions, the main themes identified from the documents during the study included, the nature of work among specialists within the selected hospital (collaboration), how HIS is used in the selected hospital with regard to sharing of healthcare information technology acceptance based on privacy preservation, identify the factors and obstructions that affect the HIS adoption in this environment, researchers activity, and the CHIMS requirements needed in selected hospital to improve the collaboration in sharing healthcare information using HIS based on privacy preservation. The researcher used materials such as web site data to illustrate both public and private documents included the hospital research department publications, and they represent a growing data source for qualitative researchers (J. W. Creswell, 2011b).

The researcher adopted the Creswell (2011) guideline procedures for collecting useful documents (J. W. Creswell, 2011b), which are as follows: (1) Identify the types of documents that can provide useful information to answer research questions, (2) seek permission to use documents from the appropriate individuals in charge of the materials, (3) Examine documents for accuracy, completeness, and usefulness in answering the research questions in your study. Additionally, record information from the documents. This process can take several forms, including taking notes about the documents or scanning documents to form a qualitative text database.

3.2.9 Validity and Reliability of Instruments

All studies must be concerned with issues of validity and reliability. Establishing the trustworthiness of methods to produce credible and accurate findings is important. According to (Baxter & Babbie, 2004), ensuring validity and reliability in qualitative and quantitative research involves conducting the investigation in an ethical manner. To ensure that the items developed in the research instruments (interview guide) were reasonably appropriate, the instruments were tested for validity and reliability. Reliability and validity tests of the instrument used in this study are described in the subsequent sections.

3.2.9.1 Validity

The validity criterion, which establishes the credibility of the qualitative research, results from the perspective of the research participant. The purpose of qualitative research is to describe or understand the phenomenon of interest from the viewpoint of participants because they are the only ones who can legitimately judge the credibility of the results (Lincoln & Guba, 1985).

Burns (2000) mentioned that the validity assesses whether the test measures what it claims to measure (R. B. Burns & Bursn, 2000). Thus, validity is concerned with the extent to which an indicator accurately measures the concept (Best & Kahn, 2006). According to Bernard (2000, 2012), validity is a crucial element in research because it addresses the accuracy and trustworthiness of instruments, data, and findings (H Russell Bernard, 2000; Bernard & Bernard, 2012).

Content validity is achieved when an instrument has appropriate content to measure a complex concept or construct (H Russell Bernard, 2000). The research instruments of this study were revised and sent to selected professionals in the area of study to check the validity of the instruments, review, and comment on the instruments used. The professionals were able to validate the instrument before the pilot study was conducted. They also evaluated the appropriateness of the contents of the research instruments. The professionals selected for this purpose include three lecturers from the IS sector in Sadat Academy for Management Sciences, Egypt and two health IS professionals from the National Cancer Institute, Egypt. They were chosen based on their sound knowledge in this field, and were considered to possess the insights to evaluate the instruments of this study. The pilot study was conducted in a research laboratory at the department of information systems of Sadat Academy for Management Sciences, Egypt. Based on the feedback, the instrument was revised and amended to ensure that the questions were relevant, and easy to understand and answer. The amendments included the interview layout, type of responses, and clarity of the questions.

The member check technique establishes validity achieved during the interviews. The researcher uses this technique to improve the validity of the instrument (John W Creswell, 2009; Jones, Torres, & Arminio, 2006). The member check is executed during the interviews. The researcher will restate or summarize information, and then question the participant to determine accuracy (The information was sent back to the interviewees in order to check its correctness or "accuracy"). This process is important in qualitative research (Patton, 2002). Moreover, to establish validity, the original participants were asked to review the interpretations and descriptions of the experience for accuracy. The participants either affirm that the summaries reflect their views and experiences or they do not. If the participants affirm the accuracy and completeness, then the study is said to have validity.

3.2.9.2 Reliability

Creswell (2009) argued that qualitative reliability should be consistent across different researchers and different projects (J.W. Creswell, 2009). One type of the reliability procedure was used to check transcripts for errors. The researcher edited the data by checking the spelling, recovering the missing words, and correcting the errors with the assistance of a native English speaker. This reliability procedure checks the transcripts for errors. Meanwhile, Leary (2012) mentioned that higher reliability can be achieved in the interview by asking the questions as they were worded to all respondents. The reliability of open-ended questions used during the interview process was achieved through asking the same questions for each interviewee (Leary, 2012).

3.2.10 Data Analysis Procedure

Qualitative Data Analysis (QDA) is the range of processes and procedures whereby we move from the qualitative data that has been collected into some form of explanation, understanding or interpretation of the people and situations we are investigating. QDA is usually based on an interpretative philosophy. The idea is to examine the meaningful and symbolic content of qualitative data (Ann Lewins, 2010; Coffey, Holbrook, & Atkinson, 1996; Seidel & Kelle, 1995; C. Taylor & Gibbs, 2010). Creswell (2011) mentioned that the qualitative researchers first collect data and then prepare it for data analysis. This analysis initially consists of developing a general sense of the data, and then coding description and themes about the central phenomenon (J. W. Creswell, 2011b) . Figure 3.3 shows the qualitative process of data analysis.

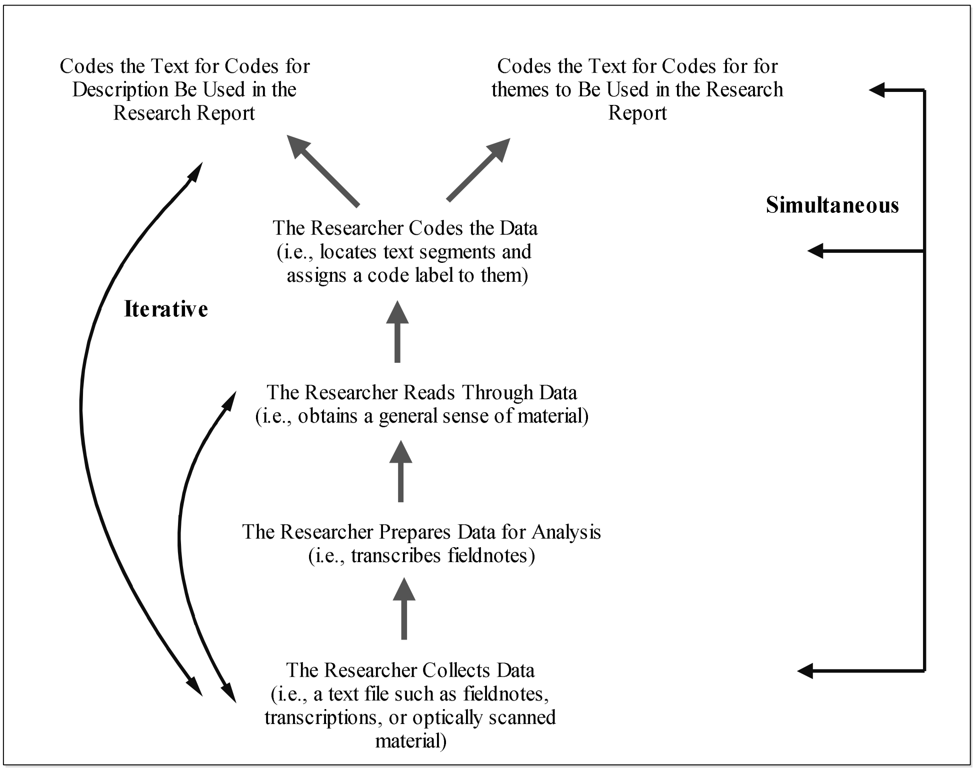


Figure 3.3: Qualitative Process of Data Analysis (J. W. Creswell, 2011b)

After every interview session, the researcher wrote down comments as a pre-analysis of the interview, a process called prompt analysis. Prompt analysis was undertaken because we thought of the existing data (the completed interviews) when iterating the same questions as we conducted the new interview sessions. Miles and Huberman (1994) emphasized that this procedure is part of prompt analysis (Miles & Huberman, 1994). This approach enables us to focus on the new points and skip the less significant issues in order to save time in the new interviews. This iteration also facilitates pre-defining codes, which are used to analyse the interviews in the future. The semi-structured interviews are flexible in design. Thus, we modify the interview questions while conducting new interviews iteratively.

The transcribed materials consisted of only seven interviews from six specialist physicians and one medical informatics expert. The researcher selected only seven interviews because of data saturation (Alan Bryman, 2008; Fontanella, Ricas, & Turato, 2008). The materials comprised 101 pages, 73,034 words, and approximately 12.30 hours of audio recording. Approval was obtained from the Research Ethics Committee of Health before any information was gathered from the participants (see section 3.2.7). Harteny (2012) mentioned that the data analysis cannot be automatically performed. Humans have both domain expertise and the uniquely human capabilities of organization, breakdown, creation, generalization, induction, intention, inference, deduction, thought, and rationalization. These abilities can be applied to data to acquire information and knowledge. Moreover, these tools can facilitate the analysis of the obtained data (Hartney, 2012). Miles and Huberman (1994) suggested a number of ways that utilize computer software to aid qualitative research as shown in Table 3.2.

Table 3.3: Uses of Computer Software in Qualitative Studies (Miles & Huberman, 1994)

	Use of Computer software in qualitative studies
a	Making note in the field.
b	Writing up or transcribing field notes.
c	Editing: correcting, extending or revising field notes.
d	Coding: attaching key words or tags to segments of text to permit later retrieval.
e	Storage: keeping text in an organised database.
f	Search and retrieval: locating relevant segments of text and making them available for inspection.
g	Data "linking": connecting relevant data segments with each other, forming categories, clusters or networks of information.
h	Memoing: writing reflective commentaries on some aspect of the data, as a basic for deeper analysis.
i	Content analysis: counting frequencies, sequence or location of words and phrases.
j	Data display: placing selected or reduced data in a condensed, organised format, such as a matrix or network, for inspection.
K	Conclusion drawing and verification: aiding the analyst to interpret displayed data and to test or confirm findings.
l	Theory building: developing systematic, conceptually coherent explanations of Findings: testing hypotheses.
m	Graphic mapping: creating diagrams that depict findings or theories.
n	Preparing interim and final reports.

According to Miles and Huberman (1994), qualitative data can be divided into three activity flows, namely, data reduction, data display, and conclusion drawing/verification. These three activities also show each of the themes in greater depth. Data reduction is a process of selecting, focusing, simplifying, abstracting, and transforming the data that appears in written field notes or transcriptions.

The transcribed materials were stored in digital format. Then, the researcher edited the data by checking the spelling, recovering the missing words, and correcting the errors with the assistance of a native English speaker. The transcription process was followed by the subsequent data reduction in an Excel format. In this context, the issues were classified based on the codes of the participants. Johnson and Christensen (2008) defined coding as marking the segments of data with symbols, descriptive words, or category names (Johnson & Christensen, 2008). The researcher followed the coding manual as mentioned in Saldaña (2012). Coding is just one way of analysing qualitative data (Johnson & Christensen, 2008). Figure 3.4 shows the procedures of the qualitative data analysis (Saldaña, 2012). The researcher began to analyse the textual data by grouping quotes under the predefined codes. Unsurprisingly, more data and information were discovered in the transcripts. However, as a rule of thumb for developing coding schemes, no coding will ever be perfect (Willms & Johnson, 1993), and not every piece of the note must be coded (Miles & Huberman, 1994). Hence, we limited the coding to build a balance between covering adequate details to contribute to our research and avoiding excessive details on a particular IS. Analysis of the interviews enabled the modification of the additional codes that appeared.

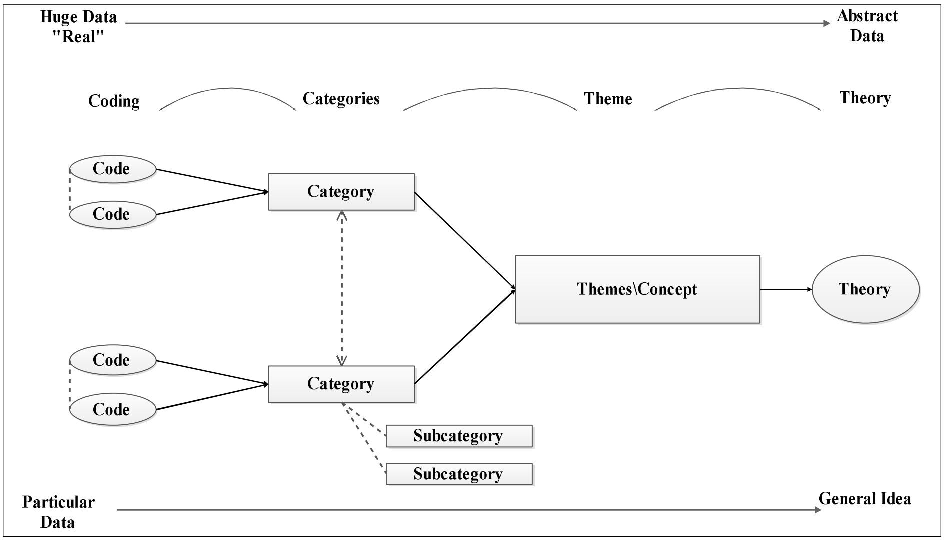


Figure 3.4: Procedures of the Qualitative Data Analysing (Saldaña, 2012)

Meanwhile, the researcher used the Statistical Package for Social Sciences (SPSS) to analyse the demographic data of the participant. The SPSS program provides a wide range of statistical analyses to obtain the most accurate responses for different data types. This study uses SPSS version 18.0 to analyse data, specifically for the descriptive analysis, testing the differences, and measuring associations results (Carver & Nash, 2011; Pallant, 2010).

3.3 Methodology for Developing the CHIMS System

The second part of chapter 3 describes the CHIMS development based on privacy preservation. System development is the methodology of developing a system based on measures and rules (W. S. Davis & Yen, 1998). In this study, the CHIMS model (see Figure 2.8 in Chapter 2) is proposed to provide an integrated collaborative HIS environment to improve collaboration among medical staff in sharing information in medical research based on privacy preservation. This model is developed based on the K-anonymization model, including the generalization technique for privacy preservation. The K-anonymity was selected because it is a simple and effective model that provides a measure of privacy protection by preventing re-identification of data to fewer than a group of k data items (see Chapter 2 Section 2.5). The functions of these modules are discussed in detail in Chapter 6.

The functional requirements for the CHIMS are based on the K-anonymization features and participant (medical staff) requirements. These requirements are presented in Chapter 5. Aside from the functional requirements, other non-functional requirements have to be considered, such as the integrity, security, flexibility, and maintainability of the system. The CHIMS requirements are explained in Chapter 6.

The CHIMS structure was developed using the following web-based application tools:

1. CHIMS Programming Language: The CHIMS system was programmed using ASP.NET, a web application framework developed and marketed by Microsoft that enables programmers to build dynamic web sites. ASP.NET is used to create web pages and web technologies, and is an integral part of the .NET framework vision by Microsoft. As a member of the .NET framework, ASP.NET is an extremely valuable tool for programmers and developers because it allows them to build dynamic, rich websites and web applications using compiled languages such as VB and C#. In this study, we used the C# language (MacDonald & Szpuszta, 2007). In addition, the various benefits of working with ASP.NET reinforced the decision to use the program for this study.
2. CHIMS Database: For this study, the researcher chose MySQL, an open-source program supported by Oracle/Sun Microsystems. According to DMW Technologies (2008), MySQL is "a powerful free SQL database, and PHP provides a comprehensive set of functions for working with it." MySQL is generally considered better than other web database options because this option is a true relational database, as well as the most widely used and best supported

database (Pros, 2008). This description implies that "[MySQL] stores data in separate tables rather than putting all the data in one big area. This adds flexibility, as well as speed" (Softpedia, 2008).

3. CHIMS Server: The CHIMS prototype also required web server technology. The researcher chose to use the Windows 2008 Server because it is "now the most-used web server in the world, and ASP.NET can be compiled as a Windows 2008 Server" (Dewson, 2008). In sum, the combination of Windows 2008 Server, MySQL, and ASP.NET is unbeatable, and thus provides a solid, stable, and flexible infrastructure for CHIMS.

CHIMS was initially put through a testing procedure, and then evaluated by potential users. Testing was necessary to control the quality of the system and determine whether the system can handle real applications. The primary purpose of testing was to ensure that the program and its resulting components fulfilled the requirements specification and eliminated the errors (Kit & Finzi, 1995). Given that a field test was conducted and the questionnaire was developed specifically for this study, only content validity was assessed (3.2.9.1), and scale reliability using Cronbach's alpha coefficient was 0.85. The reliability score shows a high internal reliability. The reliability of open-ended questions used during the interview process was achieved by asking the same questions for each participant. According to Leary (2012), the higher reliability can be achieved in the interview by asking questions as they are worded to all respondents.

The CHIMS evaluation, carried out using the quantitative approach and a questionnaire, is utilized for the purpose of meeting the objective of the study. The researcher selected a quantitative approach to evaluate CHIMS, as it helps to provide a description of the trends in a population or a description of the relationships among its variables (J. W. Creswell, 2011b). In addition to this advantage, a quantitative approach is also inexpensive to be conducted and it is less time consuming as it enables the researcher to acquire both quantitative scale and qualitative data from a large research sample (Abu-Dalbouh, 2013).

This approach was used mainly to answer a research question (i.e., to evaluate the rate of the use of CHIMS in improved collaboration with regard to sharing health information among specialists based on privacy preservation). The HISs, particularly in the evaluation process, and the projects required substantial investments to predict the impact of the outcomes of such systems in the real domain (Al-Yaseen, Al-Jaghoub, Al-Shorbaji, & Salim, 2010; Mbananga, Madale, & Becker, 2002). The questionnaire was developed specifically for this study; the questions used during the evaluation process were based on recommendations from existing literature for the HISs based on privacy preservation to improve collaboration among specialists that will lead to acceptance and successful technology (Armstrong, Fogarty, Dingsdag, & Dimbleby, 2005; Fred D Davis, 1989; William H. Delone & McLean, 2003; Hsu & Lee, 2013). Moreover, a Likert Scale is applied for each set of questionnaires. The Likert scale is designed to examine how strongly subjects agree or disagree with statements on a five-point scale with the following anchors: (1) Strongly disagree, (2) Disagree, (3) Somewhat agree, (4) Agree, (5) Strongly agree (Chomeya, 2010).

To ensure that the questions developed in the questionnaire instrument were reasonably appropriate, the instruments were tested for validity and reliability before conducting the pilot study. The assessed content validity is achieved when an instrument has appropriate content for measuring a complex concept or construct (H Russel Bernard, 2000). The questionnaire instrument of this study was revised and sent to selected professionals in the area of study to check the validity of the instruments, reviewing and commenting on the instruments used. The professionals were able to validate the instrument for validity. The professionals selected for this purpose were three lecturers from the Faculty of Information Science and Technology of the Universiti Kebangsaan

Malaysia in Selangor, Malaysia. Additionally, one lecturer from the Faculty of Computer Science and Information Technology of the University of Malaya in Kuala Lumpur, Malaysia was included in the process. They were chosen based on their sound knowledge in this field, and were considered to possess the insight to evaluate the instruments of this study. Based on the feedback, revisions and amendments were made to the questionnaire to ensure that the questions were relevant and easy to understand and answer.

Reliability of instruments deals with the consistency of a measure of a concept to consider whether a measure is reliable. Reliability addresses the ability of a measuring tool to provide the same result on repeated occasions. One way of leading this is the test/re-test method. This method addresses the question of consistent answers from multiple occasions of use (A. Bryman, Becker, & Sempik, 2008). To address the issue of questionnaire reliability in this study, the test/re-test method of reliability testing was used. According to Robson (2002), researchers studying fixed design should conduct a pilot study to sort out any technical issues in the data collection method (Robson, 2002).

In this study, the data was collected through a questionnaire instrument. The research questions in the system evaluation examined one macro variable, namely, using CHIMS in improved collaboration among specialists regarding the sharing of healthcare information based on privacy preservation, which would lead to acceptance and success of technology in healthcare sector. This macro variable was measured by a set of specific questions, using the five-point Likert scales as mentioned earlier. The intent of the field test was to analyse the operational aspects of the questionnaire, such as content and flow, and to question ambiguity, completion time, and the reliability and validity of the questions. The scale reliability was measured with the Cronbach's alpha coefficient; moreover, items were removed as deemed necessary to purify the scales, as shown in Table 3.4.

Table 3.4: Reliability Coefficients of Scale for Study Variable

Variable	Populations	Items	Cronbach's Alpha
Evaluation Rate of the Collaboration among Physicians in sharing healthcare information among specialists based on privacy preservation	50	25	0.85

The information in Table 3.4 indicates the interval scale variable that was used in this study. The entire variable shows a high internal reliability of 0.85. The reliability presented in Table 3.4 suggests that the indicators are sufficient for use because the values are higher than the reliability indicator provided by (Nunnally, 1978).

The participants were selected from the same population in the selected Egyptian hospitals that actually used the system (see subsection 3.2.6.1). A total of 60 respondents participated in the evaluation. A structured questionnaire was developed to include the evaluation of the CHIMS in practice. This questionnaire has four main sections (refer Appendix F).

1. Section A contains eight items of demographic information about the respondents, including email address, personal information, organization, gender, age, educational background, experience with computers, and perceived experience.
2. Section B contained the evaluation rate of the collaboration of physicians in sharing healthcare information among specialists based on privacy preservation. This section comprises 25 questions for the evaluation rate for the using CHIMS in improved collaboration in sharing healthcare information among specialists based on privacy preservation. This section could be grouped into the following general themes: perceived usefulness (PU), perceived ease of use (PEOU), information quality, privacy preservation, system quality, and services quality. In

this section, information on the use and evaluation rate of CHIMS in improved collaboration in sharing healthcare information among specialists based on privacy preservation were extracted from the responses of the respondents on a five-point Likert scale: (1) Strongly disagree, (2) Disagree, (3) Somewhat agree, (4) Agree, (5) Strongly agree.

3. Section C contained the use of the system. This section aimed to evaluate functionality of the CHIMS modules. This section used CHIMS with the responses provided on a five-point Likert scale: (1) very poor, (2) poor, (3) satisfactory, (4) good, (5) Excellent.
4. Section D has four open-ended questions, which allows the respondents to express their ideas, opinions, and suggestions on methods to enhance CHIMS functionality in healthcare research and services in the selected hospital.

3.4 Summary

This chapter discussed the adopted research design to accomplish the research effort and addressed the research question in two stages. In the first stage, this study employed a qualitative approach using observation and semi-structured interviews that included open-ended questions. In addition, in-depth interviews with 12 participants were conducted. The development of the proposed CHIMS model was outlined. In the second stage, the CHIMS was evaluated using a questionnaire survey involving 60 participants. The reasons for using the aforementioned instruments were outlined, and their reliability and validity were explained. The summary of the research design undertaken in the study is presented in Figure 3.2. The qualitative methods of data analysis employed in the study were also highlighted in this chapter. The case study on the selected Egyptian hospital used in this research is detailed in the next chapter.

CHAPTER 4

CASE STUDY OF THE RESEARCH

4.1 Introduction

Two Egyptian cancer hospitals from Cairo City are selected as case studies to address the research question, develop a CHIMS system, and determine convenient solutions for the research problem.

This chapter begins with an introduction on cancer disease and its evolution, globally and in the Arab region. This introduction follows the in-depth details related to the description of participant hospitals, HIS used in selected hospitals, the activities of the hospitals, and the collaboration among medical staff (physicians, researchers) in sharing information in healthcare research in/out of the hospital environment.

4.2 Cancer Disease: Introduction

This section includes the definition and evolution of cancer disease globally and the real magnitude of the problem. Then, we focus on cancer disease control and care in the Arab region, especially in Egypt.

4.2.1 Definition and Evolution of Cancer Disease

Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells. A spread that is not controlled could cause death. Cancer is caused by both external (tobacco, chemicals, radiation, and infectious organisms) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism). These causal factors may act together or in sequence to initiate or promote carcinogenesis (De Britto, et al., 2008). Cancer is the second most frequent cause of death in the majority of developed countries (J. Ferlay, et al., 2010). The disease is emerging as a major public health problem in developing countries, as reported by the International Agency for Research on Cancer (IARC).

The global rate of cancer is increasing, and nearly 70% of cancer cases are found in low- and middle-income countries (LMICs). The Middle East and Asia account for two-thirds of the world population and the largest regional concentration of LMICs (Dey & Soliman, 2010). Cancer mortality is projected to substantially increase in these populations because of massive demographic and epidemiologic transitions (Dey & Soliman, 2010). Lung cancer among men and breast cancer among women are the most prominent cancer sites in both the Middle East and Asia. Enhanced tobacco control and managing obesity are the most important measures for the effective control of most cancers. However, detailed research is required within each population to best identify risk factors and develop evidence-based methods for cancer prevention.

Dey and Soliman (2010) stated that forging collaborations is an essential step to facilitate cancer disease control. Collaborations can improve cancer registries, create robust infrastructure, improve the skills of personnel, and enhance cancer control and prevention (Dey & Soliman, 2010).

Christensen and Larson (1993) and O'Daniel and Rosenstein (2008) emphasized that collaboration among medical staff increases the awareness of each other's type of knowledge and skills, and thus continually improves decision making (Christensen & Larson, 1993; O'Daniel & Rosenstein, 2008). Figure 4.1 shows the world cancer map as presented by the IARC (Boyle & Levin, 2008).

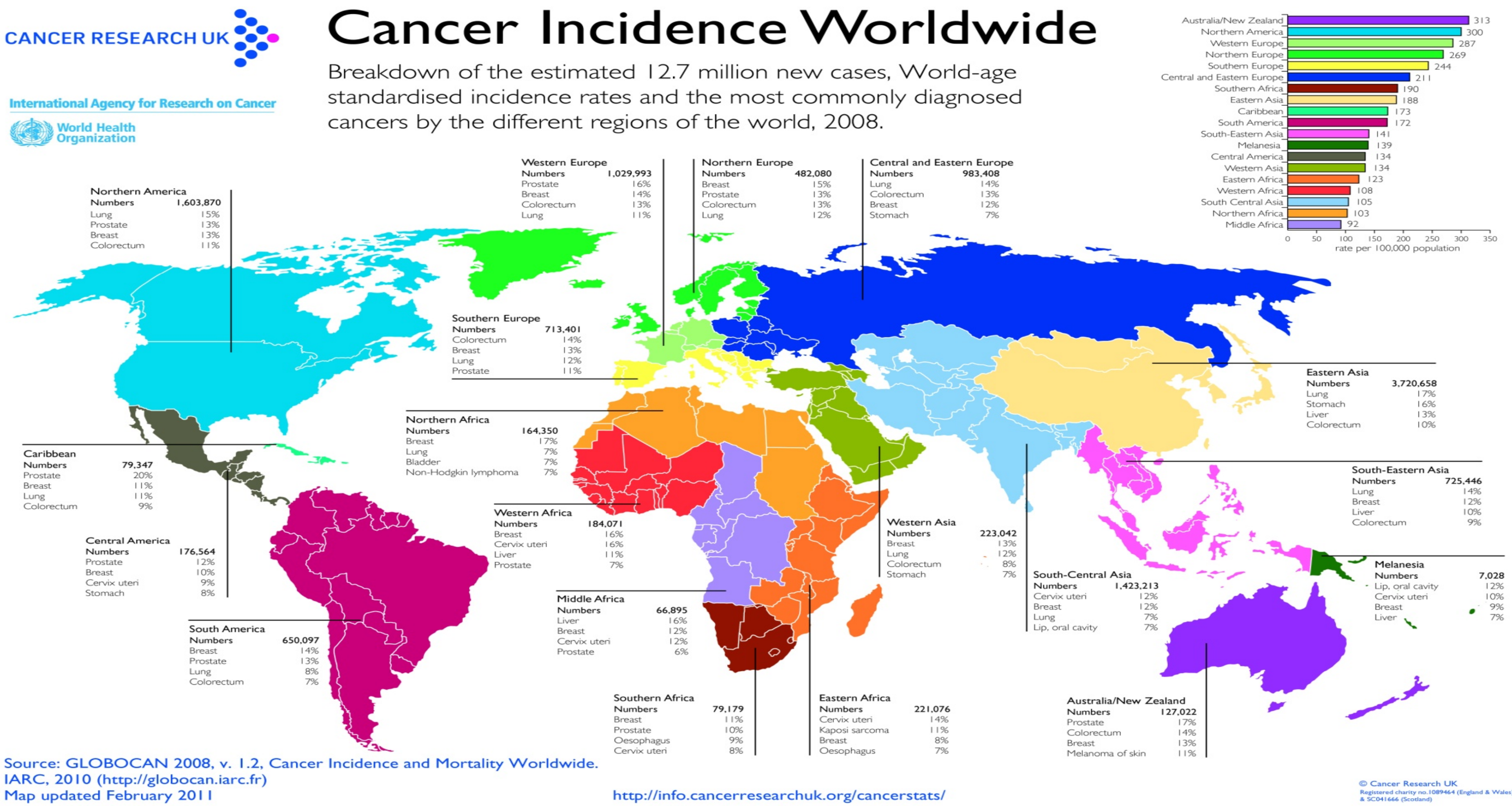


Figure 4.1: World Cancer Map (Boyle & Levin, 2008)

4.2.2 Cancer Disease in the Arab World: Magnitude of the Problem

The Arab region includes 22 countries with a total population of roughly 300 million. The urban/rural population ratio is approximately 49.7% urban and 50.3% rural. Several studies indicate that cancer is a major problem, and the problem will worsen over time (Dey & Soliman, 2010; Inas. Elattar, 2005; Labib & Malek, 2005). Elattar (2005) and Salim et al. (2010) presented the cancer registry database status in the Arab world. This map is classified into three categories, namely, national cancer registry, regional cancer registry, and non-registry (Inas. Elattar, 2005; E. I. Salim, et al., 2009). Figure 4.2 shows the status of the cancer registry database in the Arab region.

Figure 4.2: Arab World Map: Status of the Cancer Registry Database

Figure 4.2 shows that only four countries- Saudi Arabia, Oman, and United Arab Emirates, and Jordan- have a national cancer registry. Two countries, Egypt and Algeria, have a regional cancer registry, and the remaining 16 countries in the Arab region have no cancer registry database systems. A number of studies (Blaya, et al., 2010; Braa, et al., 2007; Fraser, et al., 2005; Gaboury, et al., 2009; Heeks, 2002; Mamlin, et al., 2006; Tierney, et al., 2010; VanVactor, 2012) reported that numerous developing countries continue to use manual and stand-alone systems in their hospitals.

These studies also indicated that using manual and individual systems has resulted in insufficient collaboration among medical staff. Furthermore, several hospitals currently use both manual and computerized systems because of the complexity of the healthcare system environment.

However, detailed research is required within each population to best identify risk factors and develop evidence-based methods for cancer care and prevention. Moreover, international collaborations in cancer care and prevention, as well as a planning strategy among healthcare organizations and research institutes are lacking. International collaborations in cancer care and prevention are essential steps to facilitate this process. Such collaborations can improve cancer registries, create robust infrastructure, improve the skills of personnel, and enhance cancer control and prevention.

Salim (2010) described the cancer care and control in the Arab region, as well as the action steps (E. Salim, 2010). The steps in cancer care and control were presented through the Arab World Cancer Declaration at the Inaugural Conference on the "Initiative to Improve Cancer Care in the Arab World" (ICCAW), held in Riyadh, Kingdom of Saudi Arabia, in 2010. The conference was organized by the National Guard Health Affairs and Arab Medical Association against Cancer, and numerous regional and international experts and organizations participated in the conference. These steps are expected to be implemented between 2010 and 2020. Figure 4.3 describes the taxonomy for comprehensive cancer care and control in the Arab world.

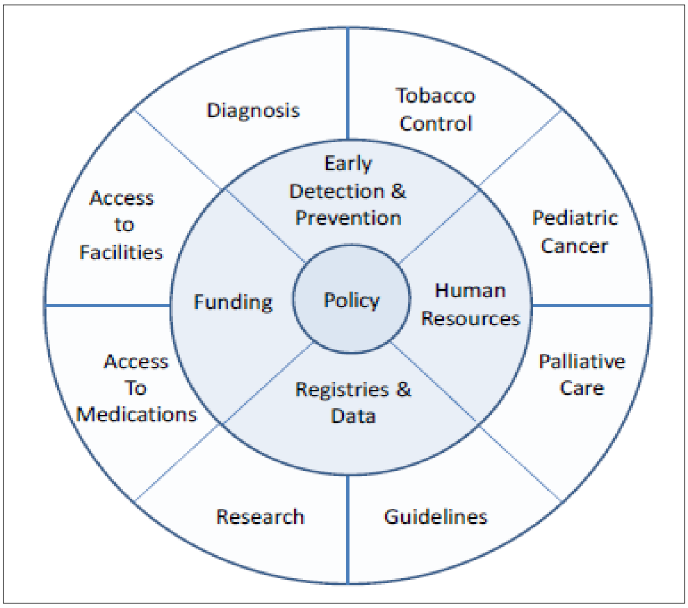


Figure 4.3: Taxonomy for Comprehensive Cancer Care and Control
in the Arab World (E. Salim, 2010)

Cancer care and control in the Arab region as highlighted in the ICCAW (2010) (E. Salim, 2010) has 13 priority objectives: Objective 1 (policy): implement a national cancer control plan in each country; Objective 2 (funding): establish reliable and sustainable fund-raising strategies for each country, utilizing existing effective fund-raising models tailored to meet the needs and capacity of that country; Objective 3 (early detection and prevention): establish accessible and effective national screening and early detection programs in each country; Objective 4 (tobacco control): decrease all forms of tobacco consumption in all Arab countries (as an additional key component of prevention); Objective 5 (human resources): substantially improve human resource capacities in all professions aligned to supporting goals for comprehensive cancer care; Objective 6 (registries and data): establish a pan-Arab automated cancer registry network that meets current international standards, and develop at least minimum epidemiology and related data across the Arab region; Objective 7 (research): initiate and conduct rigorous, collaborative cancer research activities in all Arab countries, according to resource availability; Objective 8 (guidelines): ensure that the standards of care and management of the majority of cancer patients in Arab countries are based on evidence-derived guidelines; Objective 9 (diagnosis): ensure all cancer diagnostic testing in the Arab region follows the highest international standards and quality control regulations; Objective 10 (access to facilities): identify inequities in cancer care facilities to service cancer detection and management needs and resource allocation in all Arab countries; Objective 11 (access to medications): ensure that adequate access to cancer medications for cancer patients is thoroughly studied, lobbied, and applied based upon scientific evidence; Objective 12 (palliative care): promote the integration of comprehensive palliative care for all cancer patients throughout the Arab region; and Objective 13 (paediatric cancer): reduce morbidity and mortality of paediatric cancer patients in the Arab region.

The Arab Region Cancer Declaration recommended these objectives to achieve collaborative associations with regional governmental and non-governmental organizations, academic institutions, and concerned individuals, as well as form partnerships with international organizations, institutions, industry, and experts. These objectives promote cooperation and medical data sharing between healthcare organizations and research institutions.

Through the Arab World Cancer Declaration (2010), the collaboration in healthcare fields, especially among physicians in sharing information in cancer research activities, is extremely poor because of the lack of HIS to register patient data. This study focuses on collaborative HIS in terms of shared healthcare data in cancer healthcare research based on privacy preservation, using the k-anonymization model to develop HISs that effectively provide accurate and clear data (refer to Chapter 2, section 2.7).

In sum, cancer is currently one of the most common causes of morbidity and mortality. The Arab region lacks HIS adoption in the healthcare field, especially in cancer hospitals. This deficiency indicates poor medical data in cancer research because of the lack of HIS to register the patient data, as mentioned in the Arab World Cancer Declaration (2010). The researcher selected the Egyptian hospital because it is a leading cancer centre in the Middle East and Africa. The selected Egyptian hospital is the main hospital for cancer treatment and research centre in cancer studies, with six sub-centres distributed in Egypt. The next section describes the case study on the selected Egyptian hospital.

4.3 Case Study 1 (Hospital A)

This case study, which was conducted in Hospital A, focused on the systems used for managing and controlling healthcare information, such as information on patients and medical staff (i.e., physicians and researchers). Furthermore, this case study focused on collaborative ways to share healthcare information using HISs based on privacy preservation, in order to improve the collaboration among researchers. The activities used to improve the quality of healthcare in the hospital were also identified, such as sharing healthcare information among medical staff in collaborative healthcare research in the hospital environment.

Hospital A in Cairo City is considered to be the leading cancer centre in the Middle East and Africa. Hospital A is also the largest and best hospital in cancer treatment in Egypt. Egypt is one of the most populous countries in Africa and the Middle East. A large majority of its over 82 million people live near the banks of the Nile River, in an area of approximately 40,000 square kilometres. The main goal of Hospital A is to control cancer in Egypt through developing and maintaining integrated quality programs in patient care, research, education, and prevention based on cooperation rather than competition. Figure 4.4 shows the map of the Arab Republic of Egypt and depicts the densely populated centres.

Figure 4.4: Map of the Arab Republic of Egypt

Hospital A started operating in 1969, with 270 beds. Manpower included 40 medical staff members, as well as 150 supporting and nursing staff members, serving approximately 5,700 new cases and 8,000 outpatient visits in its first year of operation. Over a 23-year period (1970 to 1993), approximately 1,057,733 patients availed of the services; among these patients, 122,099 were new cancer patients, 50,399 were admitted patients, and 935,634 were outpatients. Approximately 38% of patients came from the Cairo metropolitan area, 40% from Lower Egypt, and 22% from Upper Egypt. Roughly 65% of patients are treated free of charge, and private patients generally have health insurance that covers their medical expenses. Today, the selected Egyptian hospital provides 550 beds, developed in stages, including 369 beds free of charge. The hospital is now the largest cancer facility in the Middle East (Inas. Elattar, 2005; I. A. Elattar et al., 2002). Figure 4.5 shows the structure of the Hospital A.

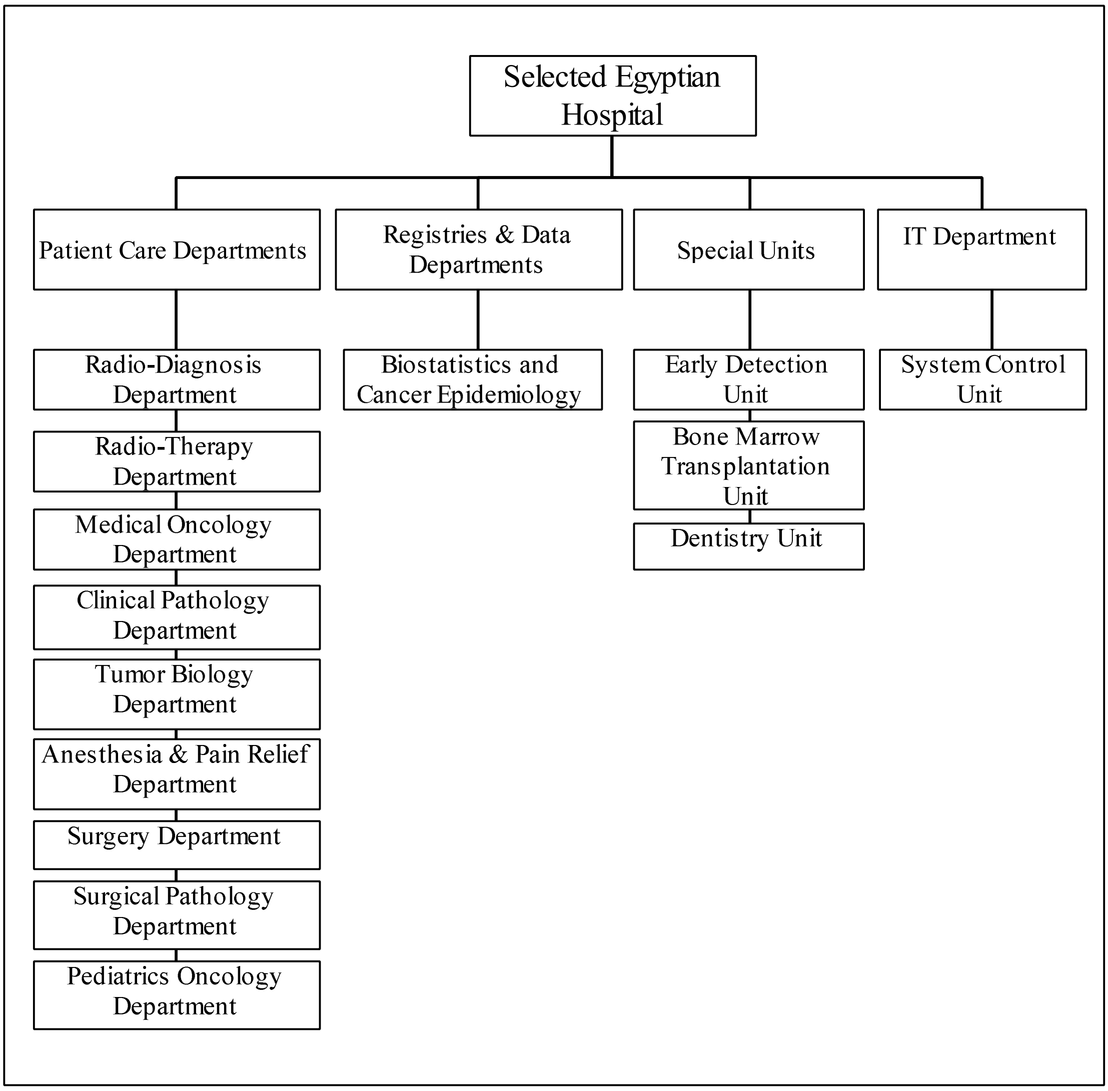


Figure 4.5: Structure of the Hospital A

Figure 4.5 depicts the structure of the Hospital A, which comprises four main units: patient care departments (including 10 department specialists for patient treatment), a registries and data department (including the biostatistics and cancer epidemiology department [BiOSCED]), special units (including early detection unit, bone marrow transplantation unit, and dentistry unit), and the Information Technology Department (including a system control unit).

The researcher selected Hospital A as the case study because of many factors. First, the selected hospital is a leading comprehensive cancer centre in Egypt, as well as the only academic institution in the Arab region specializing in all types of cancers. Moreover, this hospital is the main centre and it has expanded into six sub centres throughout Egypt in recent years. In addition to these cancer centres, six university-based clinical oncology departments operate in various parts of Egypt. Also, the selected hospital is the largest hospital, providing cancer treatment for more than 65% of patients free of charge. Third, the selected hospital is a teaching hospital with a cancer research centre. Fourth, Hospital A employs HIS in the management and treatment of patients.

This study focused on the system for managing and controlling healthcare information in Hospital A, such as information on patients and medical staff in research studies, and collaborative ways for medical staff and physicians in to share healthcare information based on privacy preservation using HISs. Figure 4.6 shows Hospital A and the related sub-centres in various parts of Egypt.

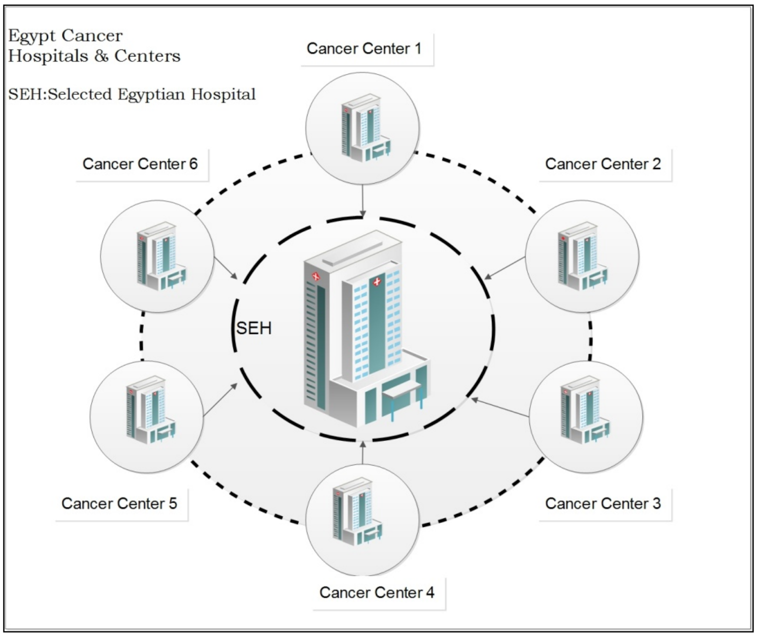


Figure 4.6: Case Study of the Hospital A

Hospital A provides numerous healthcare services that are discussed in detail in the following subsections.

4.3.1 HIS in the Hospital A

Hospital A has a hospital management information system (HMIS). The HMIS was completed and became operational in 1992 through a United Nations Development Programme (UNDP) grant. At that time, the HMIS was the largest and most comprehensive medically oriented system in Egypt. The HMIS is composed of hardware, network, and software; the hardware system consists of roughly 120 PCs. HMIS is composed of several administrative, clinical, and financial applications (El Hattab, 2001). The software has been translated in part into the Arabic language to fit the needs of the hospital. The development and Arabization of HIMS were done by an in-house development team.

Hospital A owns a set of HIS to manage patient information and hospital activities. However, the system was not easy to use and the process was complex for the medical staff to manage the patient information, which consequently affected the HIS adoption in hospital environment as observed by the researcher (Appendix D shows the snapshots of the systems used). These systems are based on decentralized database (El Hattab, 2001).

The HMIS has the following modules (El Hattab, 2001): (1) patient registration, admission, discharge, and transfer system, (2) scheduling system for outpatients and services, (3) surgery module, which is an operating room management system that also handles anaesthesia and non-operating room procedures, (4) laboratory system that covers chemistry, haematology, blood banking, anatomic pathology, and cytology, (5) radiology system that covers conventional ultrasonography and CT scans, as well as nuclear medicine, (6) outpatient and inpatient pharmacy systems, (7) patient billing system, (8) imaging system (picture archiving and communication system or PACS) that covers images, slides, and films in the different departments of the hospital, including radiology, radiotherapy, pathology, and endoscopy (Peer, Vogl, Peer, & Jaschke, 1999), (9) nursing system, (10) equipment and preventive maintenance system, and (11) other financial and administrative systems, such as payroll, personnel, general ledger, fixed assets, and inventory.

Furthermore, the HMIS was implemented to achieve the following objectives:

1) To improve patient care,
2) To support and improve hospital management, and
3) To support research.

Members of the medical staff, such as physicians, work on the HIS to manage patient information and allow tasks to be accomplished more quickly. However, the use of such system is ignored by numerous physicians and nurses because of the time factor, large number of patients, and poor management of patient information. Appendix E shows some pictures of the situation in the selected hospital.

Currently, the HIMS is used only by the department of the biostatistics and cancer epidemiology (BiOSCED) to collect patient medical records. Some patient information entered by associate employees in this department is incomplete based on data coming from different departments and in different formats. Each department in the hospital has its own type of medical report. The recording of this data is a complex process. Other patient information is recorded in the manual system and saved in the statistics department to manage the patient information. This aspect causes difficulty in managing the data and in utilizing the data for secondary purposes such as research. Figures 4.7 and 4.8 show the sample of the patient file. BiOSCED is responsible for the provision of data for research after the researcher obtained the permission of the hospital manager to conduct research. The BiOSCED provided the required data to the researcher as a hard copy. This procedure is for data protection. The researcher waited in BiOSCED, spent a long time to read the data, and worked independently. Using the data from the hard copy directly in the research activities by researchers affected data privacy. No system was available to manage the research activities, such as data sharing, which leads to poor collaboration in the research environment among the medical staff. Moreover, using the manual system to manage the healthcare information is difficult, as mentioned by the World Health Organization (2006) (Organization, 2006). Consequently, the medical staff experienced more complications because different systems were used to manage patient information. These systems are based on a decentralized database (does not imply sharing by communication network) and affect the perceived usefulness and intention of the system. The lack of HIS in Hospital A also resulted in poor collaboration among medical staff in such an environment.

Figure 4.7: Biostatistics and Cancer Epidemiology Department: Data Store

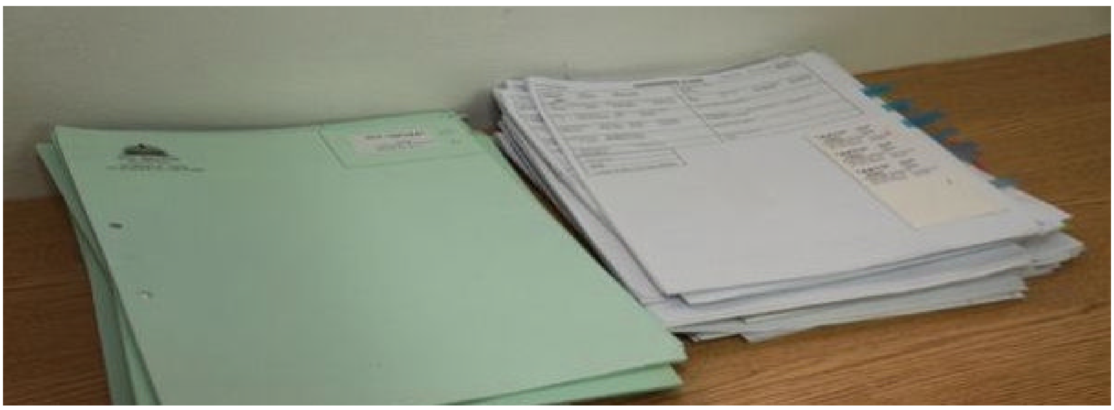


Figure 4.8: Sample of Patient Medical File in the Selected Hospital

Aside from HIS, other manual systems are used to manage various forms of information related to Hospital A, such as pharmacy, payment, and medical staff systems. The observations and interviews with physicians revealed that the physician writes a prescription and the patient bring the prescription to the pharmacy. A pharmacist occasionally retains these pieces of paper or records the information in the pharmacy system without indicating for whom the medicine was prescribed. To pay for the healthcare services, the patient has to go to the accounting department. The payment is also recorded using the manual system.

In sum, almost the entire healthcare system in Hospital A is based on the manual system. This system is used to manage and control patient information, medical staff information, and other activities related to the hospital. The HIS is no longer used by other hospital units. Only BiOSCED used HIS to collect the medical records of patients from all hospital departments. This data is used in statistics issues and only general information is shared. Other data is kept as a hard copy and these copies can be accessed by the researcher using the manual process. HIS is used to manage and control patient information efficiently and safely. However, a number of physicians discontinued its use because it insufficiently managed patient information. The healthcare data analysis and information flow based on the manual system in any hospital are extremely difficult to manage. The manual system causes harm because physicians have inadequate information to make decisions. The lack of computerized systems in the hospital environment also causes poor collaboration among medical staff in such an environment. Moreover, data for the research is unclear and inaccurate, which could affect the healthcare research findings. No available system manages the research activities among researchers, and the direct use of the data by researchers violates privacy laws, as mentioned in Chapter 2.

4.4 Case Study 2 (Hospital B)

This case study, which was conducted in Hospital B, focused on the systems used for managing and controlling healthcare information, such as information on patients and medical staff (i.e., physicians and researchers). Furthermore, this case study aims to improve collaboration in sharing healthcare information using HISs based on privacy preservation, in order to improve the collaboration among researchers and healthcare services in the hospital environment.

Hospital B is the largest children's cancer hospital in the Egypt. Hospital B is leading the way in healthcare in Egypt and is a model of what people can do when they work together for the benefit of mankind. Hospital B was established in 2007, with a vision of "Challenging the frontiers of cure for our kids with cancer by providing the highest standards of care while being an inspiring model of charity". Hospital B currently has a capacity of 185 beds. It is the largest facility in the world offering treatment for children with cancer, and annually receives about 1300 new patients, with ongoing expansion plans. Since its establishment, Hospital B has pursued three main pillars in the hospital's activities in order to achieve the hospital's vision. These pillars are: quality, education, and research (Ahmad Samir AlFaar, 2014; Ezzat, 2014). Following initial success and improvements at Hospital A, the group started to develop an ambitious plan to build an innovative, new hospital: the first in Egypt to be devoted solely to the treatment of children with cancer. Hospital B is a non-profit, nongovernmental organization. It consists of a group of Hospital A physicians, and prominent businessmen and women, dedicated to raising funds to advance the quality of cancer care in Egypt and to help develop Hospital A's services (Ahmad Samir AlFaar, 2014; Ezzat, 2014; Systems, 2008).

Hospital B was founded on a vision for connected healthcare; using the power of technology to improve clinical efficiency and effectiveness, make better use of scarce resources, and remove the limitations presented by geographical boundaries. In addition, it is free of charge for all, regardless of ability to pay (Systems, 2008).

The mission of Hospital B is to achieve cure and to improve the quality of life for all children with cancer regardless of race, creed, or ability to pay (Samir AlFaar, 2011). Hospital B will achieve this by: (1) Caring for children with cancer and their families with compassion, innovation and passion. (2) Serving as an international magnet of care by providing effective clinical and management systems in treatment, education and research. Hospital B will share the knowledge gained with other healthcare centres nationally and internationally. (3) Being committed to research that will seek to understand the epidemiology of paediatric cancer, and improve prevention, early diagnosis, and treatment effectiveness for the ultimate objective of cure without long term physical and psychological adverse effects. (4) Recognizing that achieving the goal of providing superior services depends upon a dedicated and highly trained staff; we place the highest priority on supporting personal and professional growth, and fostering a team environment. We regard our staff as the essence of our humanitarian effort. (5) Utilizing information & communication technology as an integral component of our patient care, research, and outreach programs. (6) Ensuring that the Administration and Board of Directors of the Children's Cancer Hospital Egypt and the Children's Cancer Hospital Foundation Board of Governors work in alliance to develop a financially responsible strategy for the sustainability of the hospital and fostering accountability to the hospital stakeholders and our generous donors, ensuring the best use of their contributions. (7) Recognizing that our roots stem from Hospital A. Hospital B will continue a strong alliance and affiliation with Hospital A by sharing services, clinical expertise, research, knowledge, and a vision of quality cancer care for all patients. (8)

Serving our community by being a good employer, leading in public health education and environmental issues and caring for our neighbourhood. Figure 4.9 show the structure of Hospital B.

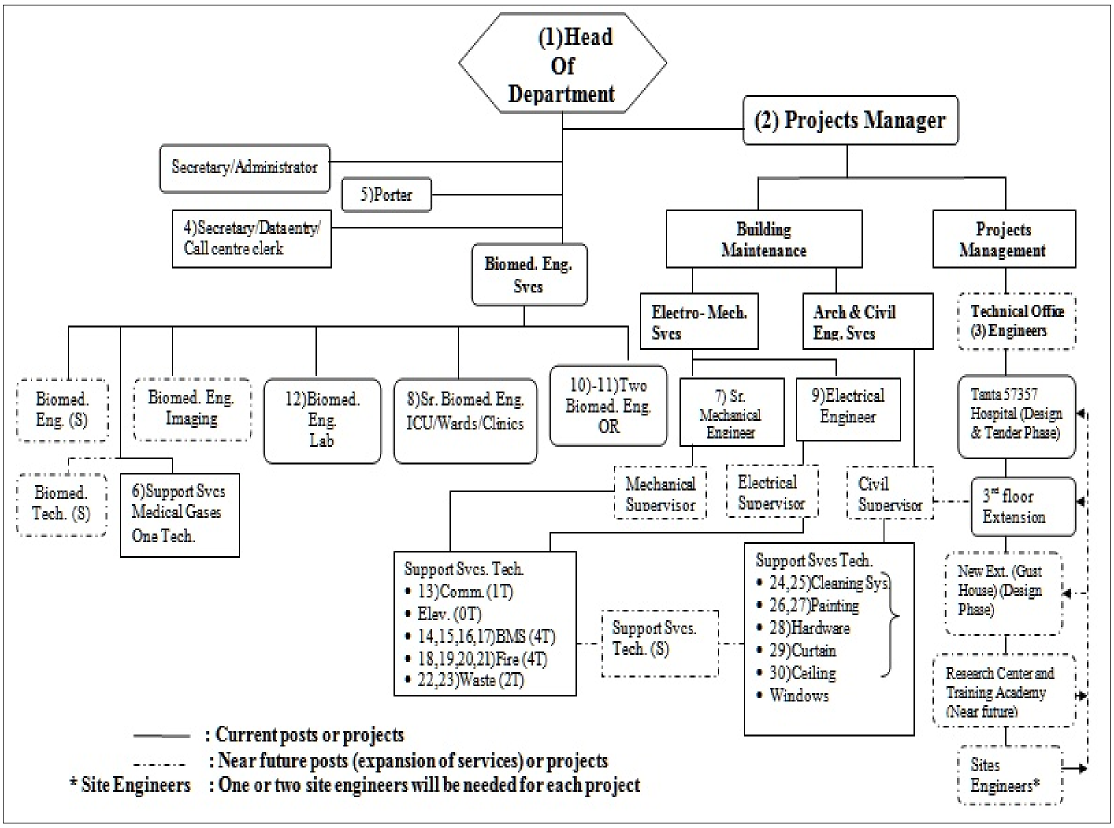


Figure 4.9: Hospital B Structure (Children's Cancer Hospital Egypt, 2014).

Hospital B has all the necessary medical and healthcare specialties to provide children with cancer the best access to care in Egypt. Hospital B consists of the anaesthesia and pain management department, diagnostic imaging services department, nursing department, nuclear medicine department, paediatric oncology department, pathology department, pharmaceutical services department, psychosocial oncology department, radiation oncology department, surgery department, and research department.

The researcher selected Hospital B as the case study because of many factors. First, the selected Hospital B is the first in Egypt to be devoted solely to the treatment of children with cancer, and Hospital B is related to Hospital A. The roots of Hospital B stem from the Hospital A. Hospital B will continue a strong alliance and affiliation with the Hospital A by sharing services, clinical expertise, research, knowledge and a vision of quality cancer care for all patients. Second, Hospital B is a teaching hospital with a cancer research department. Hospital B believes that research is a key to eliminating cancer, finding the best treatments, and reducing side effects. The clinical team has integrated research into their practice. Third, Hospital B employs HIS in the management and treatment of patients. In sum, this case study focused on the system for managing and controlling healthcare information in Hospital B, such as information on patients and medical staff in research studies, and collaborative ways for medical staff and physicians to share healthcare information based on privacy preservation using HISs. Subsection 4.4.1 explains the HIS in Hospital B.

4.4.1 HIS in Hospital B

From the beginning of the planning in 1999, Hospital B's vision for information systems was to have a hospital that would be competitive with the leading systems in the West, but that might not necessarily be at the leading edge of technology. Since then, it has recognized that it is important to achieve a fully automated hospital with the best programs and technologies available. The administration of Hospital B believes that timely and easy access to information is critical to the pursuit of excellence in all clinical, academic, research and administrative matters. The tender was divided into six distinct packages: Health Information Systems, Enterprise Resource Planning (ERP), Security, Picture and Archiving Communication System (PACS), Voice over Internet Protocol (VOIP), and Hardware. After 2 years of planning and implementation, Hospital B went live in November 2009 with the Cerner HIS system and is now operational, bringing to completion all above mentioned packages (Children's Cancer Hospital Egypt, 2014).

The Hospital B Foundation (CCHF) has selected Kansas-based IT healthcare specialist Cerner Corporation as their system provider. The hospital will implement multiple Cerner Millennium systems to provide its clinicians with unified patient health records available throughout its facilities. The new system will be used to automate nursing communications, intensive care unit operation, clinician documentation, image management, pharmacy and laboratory operations, medication administration processes, patient accounting, and surgery operations (Children's Cancer Hospital Egypt, 2014).

Hospital B will also use Cerner Knowledge systems to provide clinicians with access to knowledge-based and patient-specific information. According to Dr. Sherif Aboulnaga, professor of paediatric oncology and vice president of academic affairs, research and outreach, “Children’s Cancer Hospital Egypt is focused on meeting the unique needs of each child and leveraging medical findings to help children in the whole community. We have partnered with Cerner to implement technology that will help us ensure safety and reliability in the delicate process of caring and paediatric cancer patients,” (Children's Cancer Hospital Egypt, 2014).

Hospital B created strategies to address the following areas of information technology support, which are critical to fulfilling the mission. (1) Relationships: recognizing that the IT department’s mission is only successful if end users are compliant, knowledgeable and satisfied with the service, and that Hospital B’s mission is to encourage teamwork and collaboration within the hospital system, the IT will build strong collaborative relationships throughout the hospital. The following initiatives will be done. (2) Business processes and coordination: the IT department will be an integral component for the hospital to manage its business processes efficiently. This will be done through evaluation and solution-oriented approaches to abort any problems quickly. (3) Research technologies: ensuring that the system will be able to handle the complex needs of research by identifying and utilizing the most appropriate, cost effective applications. (4) Learning technologies: ensuring that the system meets the various educational requirements for the employees. (5) Clinical technologies: ensuring that the system meets the clinical requirements of all departments. (6) Marketing and communication: it is envisioned that the Hospital B IT program will share its expertise with other centres throughout the region. (7) Fundraising: ensuring that the CCHF and Hospital B have the most efficient technology to monitor their fundraising strategies and financial planning by providing the ERP modules of Customer Relations Management, Financial Management, Human Resources, and E-Payment (managed by Hospital B Information technology department) (Children's Cancer Hospital Egypt, 2014).

Benefits and results with the Cerner system in place, Hospital B clinicians ensure they are providing high quality, safe care for their patients, and the entire organization can communicate and share information from a single patient health record. Specifically, Cerner technology enables the hospital to:

1) Ensure medication safety: When prescribing medications, physicians can access the patient’s medical history, including allergies and diagnostic results, along with medication dosing guidelines based on age and weight to ensure accurate medication administration.
2) Reduce medical errors: If a physician inadvertently prescribes an adult dose of medication to a child, the system’s decision support features automatically alert him or her of the potential overdose as well us drug interactions and alternatives.

3) Provide quality care: The use of standardized treatment guidelines promotes evidence-based, effective, and consistent care for every patient, while enabling quality improvement and operational efficiency.
4) Reduce transcription errors: All care is documented electronically, virtually eliminating the possibility of errors due to illegible handwriting.
5) Improve access to information: Clinicians have instant access to patient information when and where they need it, and no longer have to spend time searching for misplaced paper charts.

Hospital B believes that research is the foundation for healthcare and society advancement, with its research mission statement declaring, “Through fostering innovation, creation and teamwork we will integrate research in all our activities”. This has led to the development of a Scientific Medical Advisory Committee, Internal Review Board, a Research Department Handbook, a new profession in Egypt known as Clinical Research Associates, and several publications from the disease strategy groups. Hospital B administration and staff are proud that research is an integral part of the hospital strategy and work. The areas of activities are paediatric cancer, epidemiology, molecular biology, pathology, and pharmaco-kinetics, and the hope is to expand into healthcare policy, healthcare management, nursing, and translational research. Long-term strategy includes the construction of a research institute where Hospital B staff and researchers can conduct their activities with optimum conditions for optimum results (Children’s Cancer Hospital Egypt, 2014).

The mission of the Hospital B research department is to conduct, facilitate, and support innovative & quality research for the prevention and cure of cancer in children. We will also integrate research culture & its practices in all hospital activities (Children’s Cancer Hospital Egypt, 2014). Hospital B will accomplish this mission by:

1. Conducting fundamental research to discover causes of cancer, translating basic research findings into effective medical practice, and generating new scientific discoveries.
2. Developing and implementing best operational practices and quality measurement to maximize quality of data and outcome when applying Standard treatment protocols.
3. Facilitating teamwork amongst all disciplines, including patients & their families, to encourage passion for research. We believe that the richness of our data has the power to change cancer treatment throughout the world and enable Hospital B to be an international leader in research.
4. Supporting investigators and research teams by providing advanced research technologies and providing the means for effective communication.
5. Pursuing and organizing collaborative research activities with local, regional and international organizations with adherence to Hospital B and national and international research regulations, policies, and standards.
6. Prevention, patient education, & public awareness are a major adjunct to improve results & increase patient survival.

In sum, Hospital B used HIS to manage and control patient information, medical staff information, and other activities related to the hospital. The information system in the research department in Hospital B is not available, but there is a plan to implement the Research Electronic Data Capture Software (REDCap), aiming at harmonization, standardization, and centralization of clinical research data and integrating this application with Cerner (The hospital HIS system) through InfoView (Children's Cancer Hospital Egypt, 2014). In this context, using data as the hard copy directly or soft copy collected from current HISs in Hospital B within the research activities by researchers affected data privacy, and the direct use of the data by researchers violates privacy laws as mentioned in Chapter 2. No system was available to manage the research activities, such as data sharing, which leads to poor collaboration in the research environment among the medical staff. Moreover, using the manual system to manage the healthcare research is difficult, as mentioned by the World Health Organization (2006) (Organization, 2006).

4.5 Summary

Two healthcare centres, Hospital A and Hospital B, were included in this study as case studies. These two case studies significantly address the research question (as real-life situations), to develop a CHIMS system, and to find useful solutions to the research problem. Conducting these two case studies involved management and control of the HIS used in a hospital environment. These case studies were concerned with improving collaboration among physicians in sharing healthcare information using an HIS system, based on privacy preservation.

At Hospital A, almost the entire healthcare system in this Egyptian hospital is based on a manual system. The hospital lacks a centralized database (or integrated system) to collect healthcare data. The available systems are based on a decentralized database (which does not imply sharing by a communication network), and the management and control of healthcare information are deficient. Consequently, the lack of data sharing among medical staff negatively affects collaborative research. The manual healthcare information handling system causes poor collaboration in healthcare research. Moreover, the use of healthcare data, available as hard copy, violates privacy laws; and thus, the collaboration among medical staff in the use of HIS for data sharing in healthcare research is impeded. In this context, Hospital B used HIS to manage and control patient information, medical staff information, and other hospital related activities. An information system, in the research department of Hospital B, was not available. However, there was a plan to implement the Research Electronic Data Capture Software (REDCap) at Hospital B, aimed at harmonization, standardization, and centralization of clinical research data. This application is to be integrated with Cerner (the hospital's HIS system) through InfoView. They would then use this data as a hard copy directly or as a soft copy, collected from current HISs in Hospital B, within research activities by researchers. The direct use of this data by researchers violates privacy laws (as mentioned in Chapter 2). Consequently, a lack of data sharing, based on privacy preservation among medical staff, negatively affects collaborative research.

In conclusion, this research project is concerned with two real hospital case studies (i.e., Hospital A and Hospital B), as well as the data collection instruments used. Healthcare information systems in research are lacking within these two hospitals, with regards to sharing healthcare information using HISs based on privacy preservation. Physicians in Hospital A are therefore forced to work individually in this particular hospital environment. There is evidence of poor collaboration among physicians in sharing research information using HISs within parent and different hospitals.

The next chapter will detail the data analysis and the findings of empirical data obtained from the data collection instruments used in first stage of this study.

CHAPTER 5

DATA ANALYSIS AND FINDINGS

5.1 Introduction

This chapter begins with a description of the instruments used to collect data for this study and the response rates on these instruments. In this study, two government hospitals (selected Egyptian hospitals) in Cairo City, Egypt were selected as the subject of case studies to address the research objectives, specifically the first and second objectives: (i) identify factors that affect technology acceptance with regard to collaboration among specialists within selected Egyptian hospitals in information sharing based on privacy preservation, and (ii) determine the key obstructions in the adoption of technology with regard to collaboration among specialists within the selected Egyptian hospitals in information sharing based on privacy preservation. The system requirements from the perspective of participants should be collected in the CHIMS system.

This chapter analyses the data collected from two data collection methods, namely, observation and interview. The researcher employed a coding process to analyse data (Chapter 3 Section 3.2.10). The data code was organized for each participant. According to the research objectives, the qualitative raw data was grouped into categories and themes. This chapter discusses the data analysis and findings of this study based on the objectives, which respond to the first and second research questions. Then, the discussion of findings followed to address the research problem and find convenient solutions.

5.2 Data Collection and Response Rate

In this study, the participants included the institute dean, hospital manager, and heads of departments from the selected Egyptian hospital (Chapter 3 Sub-Section 3.2.6.1). The observation and semi-structured interview techniques were used to collect the data.

The researcher observed the selected Egyptian hospital to lay the groundwork for the study and gain access to the selected hospital before conducting this study. Consequently, this observation assisted the in-depth understanding of the selected hospital environment. Moreover, this informal observation also allowed the development of a more formal checklist to guide the observation during the actual study period in order to understand medical staff behaviours. Hence the researcher conducted in-depth interviews with 12 participants, including 10 physicians and 2 medical informatics experts from the selected hospital for this study (refer to Chapter 3; Table 3.2 shows the profiles of participants). The researcher selected only seven interviews, including those from six specialist physicians and one medical informatics expert because of data saturation. The response rate was seven out of 12 interviews.

The first level of analysis examines the demographics of the respondents to obtain a better understanding of their nature, and to provide a point of comparison for future studies. Table 5.1 shows the demographic characteristics of the interviewees, including gender, academic qualifications, year of employment, experience with computers, and perceived experience of the respondents.

Table 5.1: Demographic Characteristics of Respondents (N=7)

Demographic Variables	Frequency (Person)	Percent (%)
Gender		
Male	5	71.4
Female	2	28.6
Age		
40-50	2	28.6
≥51	5	71.4
Qualification		
Master	1	14.3
PhD	6	85.7
Personal		
Medical	6	85.7
IS & HISs	1	14.3
Year of Employee		
less than 10 :New Employee	3	42.9
More than 10: Experienced Employees	4	57.1
Experience with Computers		
More than 6 years	2	28.57
Between 4 to 6	3	42.86
Between 1 to 3	2	28.57
Perceived Experience		
Low	2	28.57
Mediocre	3	42.86
High	2	28.57

Table 5.1 shows the demographic characteristics of the seven participants. Among the participants, five (71.4%) are male and two (28.6%) are female. As to the age of the participants, two were between 40 and 45 years old and five were more than 51 years old. The mean age of the group was 55 years, indicating a long career in the medical field, especially in cancer treatment. The academic qualifications of the respondents are one participant (14.3%) with a Master's degree and six (85.7%) with PhDs in medicine, implying a significant number of professional physicians work in the healthcare centres of Egypt, especially the selected Egyptian hospital of this study. Establishing cooperation among them in medical research will lead to important and effective findings in the treatment of cancer patients. Distribution of participants in the selected

hospital is six individuals with medical backgrounds and one expert in health information systems. These results indicate the lack of specialists in the HIS in the selected hospital environment. This finding was confirmed from the observation of the researcher. As to the years of employment, three respondents (42.9%) had less than 10 years and four (57.1%) had more than 10 years of employment, indicating a long career in the medical field. Regarding the years of experience in computer usage, two respondents (28.57%) had more than six years, three respondents (42.86%) had between two and six years, and two respondents (28.57%) had between one and three years of experience in computer usage. The perceived experiences of the respondents are as follows: two (28.57%) with low levels, three (42.86%) with mediocre levels, and two (28.57%) with high levels of perceived experience. The in-depth interviews were crucial and assist in the investigation of issues in a more comprehensive manner.

The data obtained through observation and interviews were combined and presented to identify factors that affect technology acceptance with regard to information sharing among specialists within the selected Egyptian hospital, and determine the main obstructions in technology adoption. Moreover, this study intends to develop a proposed CHIMS model based on the K-anonymization model and the requirements of participants to improve collaboration among medical staff in sharing healthcare information based on privacy preservation within the hospital environment in the selected Egyptian hospital.

5.3 Factors that Affect Technology Acceptance Among Specialists in the Selected Egyptian Hospital Based on Privacy Preservation

This study investigated the factors that affect technology acceptance within the selected Egyptian hospital with regard to information sharing among specialists. This section aims to answer research question 1 (RQ1). To answer RQ1, the researcher employed the qualitative data collection techniques, such as observations and semi-structured interviews (Chapter 3 Section 3.2.8). This study adopts the qualitative approach; thus, the results were not presented in a quantitative style (i.e., the results were presented as the individual attitudes of respondents). In this study, the influence of all factors on technology acceptance in an organization cannot be ascertained; however, the findings can guide other researchers to identify the key impacts and problems of using the quantitative approach.

5.3.1 Results from Observations

The researcher visited the Egyptian hospital frequently in the 2010 – 2011 academic year to obtain permission to conduct this study. The researcher had an opportunity to understand the culture of the staff and the attitude of the administration regarding the use and adoption of the HIS in sharing healthcare information (refer to Chapter 3 Sub-Section 3.2.8.1). Figure 5.1 summarizes a checklist to guide these observations.

The Researcher's Observational Checklist

1. The nature of work among specialists within the selected hospital (collaboration).
2. How to use HISs in the selected hospital; with regards to sharing healthcare information (technology acceptance, data privacy).
3. Identify the factors and obstructions that affect HISs adoption in this environment.
4. Researchers' activity.
5. What are the CHIMS requirements needed in the selected hospital; from the user's perspective?

Figure 5.1: Summary of a Checklist to Guide Observations

The researcher observed that the selected Egyptian hospital relied on the paper based systems. The specialists worked independently and individually because of the time factor and poor HIS in their hospital environment. A manual system is used in healthcare management, thereby making paper-based information difficult to manage, control, and share. Consequently, healthcare information sharing among specialists using HIS is weak.

The researcher also noted the lack of HIS adoption. A set of different systems is used to manage patient information. Most of these systems are difficult to use, indicating poor computer based systems and inadequate technology infrastructure support. Most data stored in the systems was incomplete because it was recorded by the staff assistants or administrative staffs who do not have medical backgrounds. In addition, the patient medical file consists of a large number of reports compiled from more than one medical department (Chapter 3 Section 4.5.1). Consequently, healthcare information sharing among specialists is poor, and information sharing using a hard copy is a difficult process. The lack of shared information resulted in poor collaboration among medical staff in the hospital. Most of these results were also confirmed in previous studies in Chapter 2.

The observational data was extracted from the field notes of the researcher during visits to the selected hospital in Egypt (narrative type). Figure 5.2 shows the observation data.

Researcher Observation

Located: Selected Egyptian Hospital

Date: 2010–2011 Academic Year

The medical staff including physicians' poor skill in HISs used, due to the poor of the technology background with regard to HISs in hospital.

Lack of the workshops and training in HISs used.

Set of different systems to manage patients' information (decentralized systems). Most systems are difficult and not easy to use from specialists' perspective. Consequently; lead to poor collaboration. Not ease of use this main factor in technology acceptance

Lack collaboration among physicians' using HISs

Limited HISs functionality

Time factor, was noted the overload tasks for physicians and huge number of patients lead to physicians adopt the paper based systems for quick processing.

Most physicians responsible for the main departments in the selected Egyptian hospital the age more than 50 years old, and do not want\like to use technology in their work, due to the weakness of technological culture, as well as consider that these tasks of assistant staff .

The researcher observe, found out that the selected Egyptian hospital does not have a separate research unit to manage the researches activities. The department of the biostatistics and cancer epidemiology (BiOSCED) is responsible for researches activities.

The researchers waits in BiOSCED, spent long time to collect medical data for own research, and independently work. The researcher used these data as the hard copy directly hacked data, rules privacy.

Absence of a web based system available to manage the research activities such as sharing data this lead to poor collaboration in research environment among the medical staff in/out hospital environment, due to security and privacy concerns in the selected hospital.

The physicians and researchers need to collaborative HISs to support collaborative work in sharing data in research studies based on privacy preservation. Collaborative HISs requires appropriate, flexible, and comprehensive healthcare information (integration systems).

Figure 5.2: Researcher Observation Data

To identify the factors that affect technology acceptance with regard to healthcare information sharing among specialists in the selected Egyptian hospital, the researcher coded the observation data and organized it into categories, as shown in Table 5.2.

Table 5.2: Categorization of Observation Data

Categories	Codes
Ability and Skill	Physicians' poor skill in HISs used Poor of the technology background Lack of adopt HISs
Management Issues	Poor of the technology background in HISs used Independently and individually Poor collaboration Lack of the workshops and training in HISs used Overload tasks for physicians Patients information register by non medical staffs Does not have a separate research unit Security and privacy concerns
Time	Physicians adopt the paper based systems for quick processing Spent long time to collect medical data for own research
Age	Most ages of head of departments more than 50 years old
Culture	Most physicians do not like to use technology in their work Weakness of technological culture Patients information register by assistant staffs Lack of adopt HISs Independently work
Poor Technology Infrastructure	Most systems are difficult and not easy Lack of adopt HISs Absence of a web based system Absence of a sharing data using HISs Manual system of healthcare management Security and privacy concerns Poor technology adoption Limited HISs functionality Sharing information as the hard copy, process difficult Lack collaboration among physicians using HISs Poor collaboration among specialists using HISs in sharing data

Findings from the observation data analysis indicated the set of factors that affect technology acceptance among specialists in the selected hospital, such as ability and skill, management, time, age, culture, and poor technological infrastructure. Moreover, these factors might also directly or indirectly affect the hospital environment.

5.3.2 Results from Interviews

The researcher conducted semi-structured interviews with 12 participants, including 10 physicians and 2 medical informatics experts in the selected Egyptian hospital during the 2010 – 2011 academic year (Chapter 3 Sub-Sections 3.2.6.1 and 3.2.8.2). The researcher selected only seven interviews, from six specialist physicians and one medical informatics expert, because of data saturation (Appendix C shows the in-depth interview data).

After a review and immersion in the data (i.e., extensive reading and re-reading of the transcripts and repeated listening to recorded interviews), the researcher integrated, analysed, and categorized the results according to the issue of health information technology acceptance with regard to collaboration in sharing information among specialists and identifying factors that might affect technology acceptance (using HIS).

The first section of the interview consisted of the technology background related to the HIS use in hospital. Some items in this section indicated the level of HIS acceptance and use in addition to the factors that might have effects on HISs acceptance among specialists in sharing healthcare information. The interviews yielded useful information regarding the factors that affect technology acceptance among specialists in sharing information using HISs.

In the context of the technology acceptance and level of HIS use in the selected hospital, the majority of the participants indicated that the HIS technology in hospitals is important, but the adoption of these systems is poor because of many factors, such as weak technology background, poor computer based systems, and paper based systems. Regarding the acceptance of HIS in the hospital, one of the interviewees indicated that, "The HIS in the hospital is important….."(DNCI03). Another observed that, "HIS is a necessity in the healthcare field…" (DNCI02). A third respondent agreed that, "HIS facilitates the data storage and retrieval processes…" (DNCI05). The majority of the respondents admitted that their technology backgrounds in HIS usage are weak because of many factors. One respondent narrated that, "My experience is weak in HIS activities; due to poor technological infrastructure and time factor in our hospital"

(DNCI01). Another one observed that, “Health information systems are important in the health sector. If there is an appropriate environment of medical staff intern on the use and the presence of experts from the medical informatics, these systems are helpful in carrying out a lot of functions. However, due to the limitations of the data storage, we are forced to use a set of systems on different locations of the institute, which makes it too difficult to deal with the data, where the medical staff treated with these regimes have weak abilities. This is due to the weak technological background, lack of time, lack training, systems complexity, and lack of medical informatics staff” (DNCI02). A third respondent noted that, “Generally the HIS use among the physicians is very weak due to the lack of training and technological knowhow, and don't forget the age effect for technology acceptance” (DNCI04).

In summary, the results indicated that certain factors affect technology acceptance and use in the selected Egyptian hospital. These factors include the (1) lack of experience, (2) weak technological infrastructure, (3) distributed systems, (4) lack of appropriate environment, (5) limited functionality of HIS, (6) lack of training, (7) system complexity, (8) time, (9) lack of medical informatics staff (experts), (10) age, (11) using paper based system for quick process, (12) task overloads for physicians, and (13) poor computer based systems. Consequently, these factors might have direct or indirect contributions to the lack of HIS adoption among specialists in sharing healthcare information in research. The subsequent paragraphs discuss this issue more comprehensively.

The first section of the interview also consisted of the factors that might have effects on HIS adoption among specialists in sharing healthcare information. Using HIS to share healthcare information, especially in medical research, is vital to improve the delivery of healthcare services and medical research findings.

The researcher observed that the selected hospital does not have a research unit. Moreover, the BiOSCED is responsible for research activities and provides medical data to researchers to conduct their studies. In this context, one of the interviewees mentioned that, “BiOSCED collects data from hospital departments to conduct medical statistics and medical research” (DNCI02). Another respondent noted that, “BiOSCED collects data from different NCI departments, and store to use for other purposes, such as medical research” (DNCI03). A third respondent observed that the, “BiOSCED’s objectives include collection of medical data from different NCI departments and using it for other purposes, such as biostatistics and research” (DNCI03).

In sum, the BiOSCED collected medical data from all the departments of the selected Egyptian hospital, and stored the hard copy in the archive unit to be used as medical data for secondary purposes, such as providing statistics on the medical progress of cancer, prevention, and early detection of the disease, and providing researchers with medical data for their studies.

The majority of participants in the interview cited noted the lack of a system to manage research activities and provide medical data for research in BiOSCED. Consequently, the selected hospital environment has weak collaboration among experts in sharing healthcare data because of the absence of a research system to manage the research activities. Moreover, the BiOSCED provides data to researchers in hard copy. In this context, one of the interviewees noted that,” No information system is available to manage and control the medical research unit; hence, the process of sharing medical data is very weak” (DNCI01). Another one mentioned that, “No system is available to provide medical data and we have a lack of accuracy in the medical data” (DNCI02). The majority of the participants in the interview noted the lack of a system to manage research activities and to provide medical data for research. This deficiency results in weak research activities for the hospital environment and lack of collaboration among medical staff (i.e., physicians and researchers).

The majority of the participants attributed the lack of HIS adoption and poor collaboration among physicians in sharing healthcare information using HIS to the paper based systems in the hospital, poor computer based systems, time factors, and related factors. HIS was only used in BiOSCED to collect data from patient files (hard copy), which results in difficult data analysis and the slow flow of information. In this context, one of the interviewees observed that, "BiOSCED provides statistics for the medical progress of cancer, and to make plans and to provide strategies for future work, but frankly weak potential technology weakens the work of this section, which makes it very difficult to implement the above activities" (DNCI02).

All respondents agreed that the use of HIS in research in the hospital is important to enhance the collaboration among researchers by sharing data to improve the research findings in the healthcare sector. One interviewee noted the "Necessity to have the medical research based on information system to manage and control medical data. This system stores accurate data, helps in scientific research, and raises the level of public health" (DNCI02). Another observed that, "The presence of these systems in health institutions is very useful, because it helps to strengthen the cooperative relations between the members of a single institution at all levels and to provide a single source of data in one. They help to take medical procedures quickly and effectively" (DNCI06).

Improvements in research activities and data sharing using HIS in the selected hospital enhance healthcare services, thereby increasing the reliability of services. The respondents also indicated that the best means to enhance healthcare services in hospitals is to deploy a mechanism to enable rapid information sharing among medical staff. One interviewee observed that, “Research systems are useful to conduct medical research in order to improve patients’ treatment” (DNCI06).

In this context, the majority of participants concurred that HIS in the research unit of the hospital is important in order to enhance the collaboration among researchers by sharing data. However, this system must be based on the privacy preservation of patient data. One interviewee noted the “Privacy for use the medical data is absent…” (DNCI01). Another respondent observed that, ‶There are no protocol agreements to maintain the confidentiality and privacy of data, and this one of the most important factors in the lack of participation, whether at the level of treatment or medical research or expertise” (DNCI01). One interviewee aptly observed that, “There is no law or convention for the protection of medical data for patients and medical staff. Consequently, there is lack of trust in using these systems” (DNCI03). Another likewise mentioned that, “There is no protocol to protect the security and privacy when using medical information systems” (DNCI05). Finally, another respondent mentioned that, “No privacy protocol is available to manage the collaborative activities” (MIENCI 01).

In this context, the researcher asked participants to describe the data privacy concerns. All respondents indicated some privacy concerns. One interviewee mentioned that, “The weakness in security might lead to the misuse of personal and official records” (DNCI01). Another observed that, “The data privacy is affected by a misuse of the system by unauthorized parties” (DNCI02). The same interviewee said, “Lack of control in managing the HISs indicates poor computer based systems.” One respondent indicated that, “Privacy concerns of medical data using data in purposes not related to medical treatment and scientific research” (DNCI03). Another respondent said, “The use of medical data and personal data available for non-scientific purposes is the one of the biggest issues for data privacy” (DNCI05). Based on the responses of the participants, privacy preservation is an important factor to improve collaboration among physicians in sharing healthcare information using HIS.

In summary, the results indicated a set of factors that might have effects in technology acceptance among medical staff with regard to the use of HIS in research to collaborate and share healthcare information. Table 5.3 shows these factors as an unordered list of responses to the open-ended questions.

Table 5.3: Factors that Affect Technology Acceptance Among Specialists in the Selected Hospital: Participants Responses in Interviews

Participants Responses
Lack of experience Weak technological infrastructure Distributed systems Lack appropriate environment HISs has a limited functionality Lack training Systems complexity Time Lack of medical informatics staff (experts) Age Paper based system for quick process Overload tasks for physician. Poor computer based systems lack of a system for managing research lack of accuracy in the medical data difficult to implement the BiOSCED activities Poor technology expertise lead to wary to use the technology, misuse the technology activities. Misuse of personal and official records. Refrain from recording and sharing details in HIS Untrusted parties share the data Lack of law or convention for the protection of medical data. Lack of confidence in using health information systems (HISs) Lack protocol to protect the confidentiality and privacy when using medical data systems a violation of personal data. Lack of rules in use and sharing medical data. Ensure confidentiality and privacy of data and staff. The use of medical data and personal data available through HISs for non-scientific purposes is most important issues of data privacy Lack of control in managing the HISs" this indicate to poor computer based systems Systems security

To identify the factors that affect technology acceptance among specialists with regard to sharing healthcare information in the selected Egyptian hospital, the researcher coded the interview data and organized the data into categories as shown in Table 5.4. The researcher followed the same process used to analyse observation data.

Table 5.4: Categorization of Interviews Data

Categories	Codes
Ability and Skill	Lack of experience Lack training
Management Issues	Lack appropriate environment Lack training Lack of medical informatics staff (experts) Overload tasks for physician
Time	Time Paper based system for quick process
Age	don't forget the age effect for technology acceptance
Culture	Paper based system for quick process Independently work Weakness of technological culture
Poor Technology Infrastructure	Weak technological infrastructure Distributed systems Systems complexity Poor computer based systems lack of a system for managing research lack of accuracy in the medical data difficult to implement the BiOSCED activities
Perceived Usefulness PU	HISs has a limited functionality Poor computer based systems lack of accuracy in the medical data HISs in research unit in the hospital important in order to enhance the collaboration this system store accurate data helps in scientific research provide a single source of data in one, they help to take medical procedures quickly and effectively
Perceived Ease of Use PEOU	Systems complexity Systems not ease to use difficult to implement the BiOSCED activities
Privacy Concerns	Poor technology expertise lead to wary to use the technology, misuse the technology activities. Misuse of personal and official records. Refrain from recording and sharing details in HIS Untrusted parties share the data. Lack of law or convention for the protection of medical data. Lack of confidence in using health information systems (HISs). Lack protocol to protect the confidentiality and privacy when using medical data systems a violation of personal data. Lack of rules in use and sharing medical data. Ensure confidentiality and privacy of data and staff. The use of medical data and personal data available through HISs for non-scientific purposes is most important issues of data privacy
Security Concern	Ensure confidentiality and privacy of data and staff. Lack of control in managing the HISs" this indicate to poor computer based systems

In summary, there are factors that might have an effect on technology acceptance with regard to collaboration in sharing healthcare information among specialists in the selected Egyptian hospital. The researcher conducted a summary of these factors from observations and interviews, as shown in Table 5.5.

Table 5.5: Summary of the Factors that Affect the Technology Acceptance

Factors That Affect on Technology Acceptance with Regard to Collaboration in Sharing Healthcare Information	**Data Collection Instruments**
Ability and Skill	Observations, Interviews
Management Issues	Observations, Interviews
Time	Observations, Interviews
Age	Observations, Interviews
Culture	Observations, Interviews
Poor Technology Infrastructure	Observations, Interviews
Perceived Usefulness (PU)	Interviews
Perceived Ease of Use (PEOU)	Interviews
Privacy Concerns	Observations, Interviews
Security Concerns	Interviews

5.3.3 Results from Documents

The researcher examined and analysed documents collected from the Hospital B site. These documents provide information on the following:

1. The nature of work among specialists within the selected hospital regarding collaboration among physicians in sharing healthcare information using HISs based on privacy preservation in hospital activities such as research,
2. Identifying the factors and obstructions that affect the HIS adoption in this environment, researchers activity, and

3. The CHIMS requirements needed in the selected hospital to improve the collaboration in sharing healthcare information using HIS based on privacy preservation.

The researcher analysed the documents collected from Hospital B. The findings from these documents refer to Hospital B using HIS to manage and control patient information, medical staff information, and other activities related to the hospital. The information system in the research department in Hospital B is not available, but there is a plan to implement the Research Electronic Data Capture Software (REDCap) at the hospital, aiming at harmonization, standardization, and centralization of clinical research data and integrating this application with Cerner (The hospital HIS system) through InfoView. In this context, using the data as the hard copy directly or soft copy collected from current HISs in Hospital B within the research activities by researchers affected data privacy, and the direct use of the data by researchers violates privacy laws, as mentioned in Chapter 2. No system was available to manage the research activities, such as data sharing, which leads to poor collaboration in the research environment among the medical staff. Moreover, using the manual system to manage the healthcare research is difficult.

In this context, the directors of the research department in Hospital B published on the official website the main challenges of establishment collaboration of case-control study and conducting epidemiologic studies of cancer in middle- and low-income countries, including Hospital B in Egypt. These challenges as follows:

1. Recruitment of cases:
    a. Selection of study sites to recruit enough sample size.
    b. There is no enough cooperation between centres.
    c. Lack of interest among study clinicians.

    d. Variety of patient backgrounds.
    e. Increased number of participating centres requires adjustment of the study procedures to suit each centre.

2. Confirmation of cases:
    a. Standardizing the diagnosis of a disease that has a clinical component.
    b. Diseases with clinical diagnosis can be independent.
    c. Identifying study subjects with a specific disease before treatment is initiated among many patients seen at study hospitals.
    d. All confirmation is based on different lab criteria.
3. Recruitment of Controls:
    a. Convincing the study collaborators that recruiting controls is as important as recruiting cases.
    b. Finding interviewers who are available during visiting hours.
    c. Finding visitors meeting the matching criteria for age and geographic residence.
    d. Orthopaedic controls.
    e. Not matching the residence.
    f. Other hospital controls.
    g. Population controls.
4. Logistics of implementation:
    a. Low budget.
    b. Low technology setting.
    c. Crowded and busy hospitals.
5. Difficulties conducting the Questionnaires and Interviews:

a. Patients may come from different countries or different areas (rural and urban).
b. Specific cultural sensitivities.
c. Different languages (different dialects of Arabic).
d. Translating questionnaires to standard Arabic where most have a different spoken Arabic dialect.
e. Consenting, as some people don't have this type of culture.

6. Biologic Specimens:
    a. Ensuring that the method of fixation is standardized between different centres.
    b. Obtaining sufficient tumour tissue.
    c. Obtaining tumour tissues for cases diagnosed outside the participating hospitals.
    d. Reluctance of collaborators and patients to share their tissue outside the home country.
7. Data Management, include
    a. Lack of high efficiency computer systems.
    b. Lack of available high speed internet.
    c. Absence or remote access to computers.
    d. Absence of institutional servers with automatic backups.
8. Training:
    a. Visa issues between different countries.
    b. Difficulty of agreeing on one place and time where collaborators can leave their routine hospital work.
9. Regulatory Requirements:
    a. Approval from the institutional review board (IRBs) at different sites.

b. IRB committees don't meet until they have a sufficient number of protocols to review.
c. Not all collaborators check their mail regularly, so they miss notifications that registrations need to be renewed.

Findings from the document analysis indicated the set of factors that affect technology acceptance among specialists in the selected hospital regarding collaboration in sharing HISs, such as:

1. Management issues:
    a. Lack of collaboration among healthcare staff in the same or different sites using HIS.
    b. Logistics of implementation include low budget, low technology setting, crowded and busy hospitals, and regulatory requirements.
2. Culture.
3. Training.
4. Poor Technological Infrastructure:
    a. Lack of high efficiency computer systems.
    b. Lack of available high speed internet.
    c. Absence of remote access to computers.
    d. Absence of institutional servers with automatic backups.

This is a summary of the factors that might have an effect on technology acceptance with regard to collaboration in sharing healthcare information among specialists in the selected Egyptian hospital. The majority of the factors identified in observations and interviews further confirm that these factors affect technology acceptance among specialists in the selected hospital regarding collaboration in sharing HISs.

5.4 Key Obstacles that Affect the Collaboration among Specialists in the Selected Egyptian Hospital based on Privacy Preservation

The issue of key obstructions that might have an effect on technology acceptance among specialists in the selected hospital with regard to collaboration in sharing healthcare information among specialists is revealed after analysing the data of the interviews in which the interviewees mentioned these issues frequently. Key obstructions consist of several points.

Poor technological infrastructure, including attitudes toward the perceived usefulness (PU) and perceived ease of use (PEOU) of technology, management issues, privacy concerns and culture that influence the behaviour of people (participants) in the organization (selected hospital) and their attitudes (see Tables 5.2 and 5.3) were mentioned by most of the respondents. Table 5.6 shows the levels of key obstructions in the selected Egyptian hospital as stated in observations and interviews.

Table 5.6: Key Obstacles Affecting Technology Acceptance in the Selected Egyptian Hospital

	Key obstructions	**Data Collection Instruments**		
		Observations	**Interviews**	**Documents**
1	Poor Technology Infrastructure (PU,PEOU)	observe	DNCI01, DNCI02, DNCI03, DNCI04, DNCI05, DNCI06, MIENCI 01	confirmed
2	Management Issues	observe	DNCI01, DNCI02, DNCI03, DNCI04, DNCI05, DNCI06, MIENCI 01	confirmed
3	Privacy Concerns	observe	DNCI01, DNCI02, DNCI03, DNCI04, DNCI05, DNCI06, MIENCI 01	confirmed
4	Culture	observe	DNCI01, DNCI03, DNCI04, DNCI05, DNCI06	confirmed

The results show that poor technological infrastructure, including attitudes on technology (PU and PEOU), is a key obstruction in technology acceptance with regard to collaboration in sharing healthcare information. Table 5.7 shows the responses to the poor technological infrastructure (observations, interviews, and documents).

Table 5.7: The Responses to the Poor Technological Infrastructure

Responses
Most systems are difficult and not easy to use. Lack of adopt HISs. Absence of a web based system. Absence of a sharing data using HISs. Manual system of healthcare management. Security and privacy concerns. Poor technology adoption. Sharing information as the hard copy, process difficult. Sharing information as the hard copy direct hacked patients' privacy. Lack collaboration among physicians using HISs. Poor collaboration among specialists using HISs in sharing data. Weak technological infrastructure. Distributed systems. Systems complexity. Poor computer based systems. Lack of a system for managing research. Lack of accuracy in the medical data. Difficult to implement the BiOSCED activities including research. HISs has a limited functionality. Poor computer based systems. Lack of accuracy in the medical data. HISs in research unit in the hospital important in order to enhance the collaboration This system store accurate data helps in scientific research. Provide a single source of data; they help to take medical procedures quickly and effectively.

The researcher collected the responses to the management issues from observations and interviews. The responses were confined to the following points: (1) poor technological background in HIS used, (2) working independently and individually, (3) poor collaboration among medical staff, (4) lack of workshops and training in HIS used, (5) task overload for physicians, (6) patients information registered by non-medical staffs, (7) no separate healthcare research unit, (8) lacks appropriate environment, and (9) lacks medical informatics staff (experts).

In addition, the researcher collected responses to the privacy concerns from observations and interviews. Consequently, the responses were confined to the following points: (1) poor technological expertise lead to wary use of technology and misuse of technology activities, (2) misuse of personal and official records, (3) refraining from recording and sharing details in HISs, (4) untrustworthy parties sharing the data, (5) lack of law or convention to protect medical data, (6) lack of confidence in using HIS, (7) lack of protocol to protect the confidentiality and privacy when using medical data systems, which violates the privacy of personal data, (8) lack of rules in the use and sharing of medical data, (9) lack of measures to ensure confidentiality and privacy of data and staff, and (10) the use of medical data using HIS for non-scientific purposes is the most important issue of data privacy.

The responses to the cultural issue were confined to the following points: (1) paper based system for quick process, (2) independent work, (3) weakness of technological culture, (4) most physicians do not like to use technology in their work, (5) weakness of technological culture, (6) patient information is registered by assistant staffs, and (7) lack of HIS adoption.

The remaining factors, such as ability and skill, time, age, and security issues indicate the limitation and barriers that might have effects on technology acceptance with regard to collaboration in sharing healthcare information using HIS.

As mentioned in Sub-Section 5.3.2, all respondents agreed that the use of HIS in the research unit in the hospital is important in order to enhance the collaboration among researchers by sharing data to improve the research findings in the healthcare sector. The improvements in research activities, data sharing, and findings enhance healthcare services in the selected hospital. To increase the reliability of services, the respondents also indicated that the best means to enhance healthcare services in hospitals is to deploy a mechanism to rapidly share information among physicians. In this context, the researcher extracted the factors that might improve the collaboration among physicians with regard to sharing health information using HIS.

The majority of the participants in interviews mentioned the PU to improve technology acceptance in sharing healthcare information using HISs. For instance, one of interviewees said, “Using HISs can manage and control the medical data for research” (DNCI01). The same interviewee also said, “Using HIS lead to enhance the quality of healthcare raises the level and efficacy of scientific research, and improved decision-making processes”. Another interviewee observed that, “HIS is helpful in carrying out a lot of functions” (DNCI02). The same interviewee said, “HIS improves quality in work, tasks can be completed in less time, and HISs improve the healthcare services and medical research studies.” Another respondent mentioned that “HIS helps in management medical data” (DNCI04). One other interviewee observed that “HIS improves medical procedures quickly and effectively...” (DNCI06).

In summary, the results indicated the PU factor including a set of criteria that might improve the technology acceptance in sharing healthcare information using HISs. The following is the random list of responses to PU factors extracted from the interviews: (1) increases work quality, (2) promotes greater control over work, (3) increases quality of care, (4) improves work efficiency, (5) enables decisions based on better evidence, (6) allows tasks to be completed more accurately, (7) increases productivity, (8) allows tasks to be accomplished more quickly, (9) enhances work effectiveness, (10) improves job performance, (11) increases the possibility of receiving a raise, and (12) improves patient care and management.

All participants indicated that privacy might improve technology acceptance in sharing healthcare information using HIS. Moreover, the system quality might also improve technology acceptance, as stated by the majority of the participants. One interviewee observed that “HIS can provide the necessary data” (DNCI01). The same interviewee also said, “HIS, if used right, can provide reliable data.” Another interviewee mentioned that “HIS provides centralized database storage…” (DNCI02). Another respondent said, “HIS provides important information for the future vision” (DNCI05).

In summary, the results indicated the system quality factors, including a set of criteria. The researcher collected these criteria, such as (1) availability, (2) reliability, (3) integration, (4) ease of use, (5) system accuracy, and (6) flexibility.

The majority of the participants indicated the use of PEOU to improve technology acceptance. An interviewee indicated, “We need a system that is simple and uncomplicated” (DNCI01). Another interviewee observed, “HIS can provide a complete database ...” (DNCI02). The same interviewee also said, “HISs assist in conducting research with less time and effort.” Another interviewee mentioned that “HIS is used to store, organize, and retrieve data” (DNCI04). Another interviewee said, “HISs stored data in an orderly manner, and we can retrieve this data when needed” (MIENCI 01).

In summary, the results indicated the PEOU factor, including a set of criteria. The researcher collected these criteria, which were (1) easy to use, (2) clear and understandable, (3) flexible to use, (4) easy to navigate, and (5) easy to understand.

The majority of the participants indicated the importance of information quality to improve technology acceptance. One respondent mentioned, “Collaborative HISs provide complete medical information” (DNCI01). Another interviewee observed the “need to clear information...” (DNCI02). In summary, the results indicated the importance of information quality as a factor, including a set of criteria, such as completeness and ease of understanding.

The majority of the participants pointed to the quality of services as a factor to improve technology acceptance. One interviewee commented that “HISs provide the necessary data” (DNCI01). Another interviewee noted that “HISs allow tasks to be accomplished more quickly” (DNCI02). Another respondent said, “HISs can provide clear data” (DNCI04). In summary, the results showed the quality of services to be a factor including a set of criteria, such as assurance, reliable service, clear data, and promptness.

The majority of the participants indicated that the net benefits might improve technology acceptance in sharing healthcare information using HIS. In this context, one of interviewees said, “We need to a lot of procedures to obtain data” (DNCI05). Another interviewee said, “We need a web based system.” (DNCI06). In summary, the results indicated the net benefits as a factor, including a set of criteria, such as time savings and cost savings.

In summary, these factors might affect the improvement in technology acceptance among specialists in the selected hospital with regard to collaboration in sharing healthcare information using HIS. This study cannot determine these factors, because entire solutions are necessary for technology adoption in the selected Egyptian hospital. Furthermore, this study only suggests some issues that the healthcare organization should consider, in particular, the technology acceptance among specialists regarding the use of HIS in sharing healthcare information. Table 5.8 shows a summary of these factors extracted from the responses in the interviews.

5.5 Collaborative HIS in Hospital Environment

The collaboration among specialists using HIS within the hospital environment is an important issue in healthcare information. Sharing provides accurate information to support the right medical decision, and consequently improves healthcare services such as healthcare research. This study aims to improve the technology acceptance among specialists on the use of HIS in healthcare information sharing and medical research based on privacy preservation using the K-anonymization model. This aim can be achieved by developing an integrated, collaborative HIS that supports the sharing of appropriate information based on the K-anonymization model. The decision to select the K-anonymization model to preserve privacy for sharing healthcare information with untrustworthy parties was mainly based on the K-anonymization features. The K-anonymization model is a simple and effective model, which provides a measure of privacy protection by preventing re-identification of data. In addition, the K-anonymity model is a simple and practical model for data privacy preservation, which guarantees that the data released is accurate (see Section 2.6 in Chapter 2).

Given that the healthcare organization system contains individual centres supported by autonomous HISs, such as hospitals, the collaborative HIS environment can be developed into an integrated system that supports sharing information based on privacy preservation in a research community in order to improve research findings, thereby improving healthcare services and patient treatment. In this context, all participants indicated that the selected Egyptian hospital had decentralized, autonomous departments, and the connection among these systems was not available. Consequently, collaboration among specialists in the selected hospital using HIS to share healthcare information is absent. One interviewee mentioned, “There are no connections available among HISs in own hospital. There is a need for a system to collect data from different hospitals” (DNCI01). Another mentioned, “There is no connection among the hospital departments. Each department works independently and individually, even though all these departments have the same goal, especially in providing patient treatment” (DNCI02). A third respondent said, “No connection is available among the systems in our own hospital, where the systems are not based on a network" (DNCI03). A fourth respondent noted, "Every department in our own hospital works individually. We need a new system to connect all hospital departments in order to provide complete patient information and used it for research studies" (DNCI06).

In summary, all participants concurred that the appropriate option to improve healthcare services in the hospital was to establish a connection between hospital departments to enable to medical staff to share healthcare information with each other or an integrated healthcare system. In addition, all respondents agreed that the use of HIS in the research unit of the hospital is important in order to enhance the collaboration among researchers by sharing data to improve the research findings in the healthcare sector. Establishing a collaborative healthcare system in order to share healthcare information in research and connect all hospital departments could be beneficial to improve collaboration among specialist and research findings.

In this context, the researcher asked the participants to describe the collaboration among medical staff in order to gather the collaboration benefits in the hospital environment. All participants agreed that collaboration among medical staff is helpful to improve patient treatment and research findings. One respondent observed that, "The collaboration among physicians from same/different organizations is a crucial issue. The collaboration among physicians improves the quality of service in patient treatment, research, and performance. One respondent said, "Besides, HIS assists in the organizing of research activities" (DNCI01). Another respondent noted, "Medical cooperation in itself is a great benefit in the medical sector and public health, as it will enable us to develop plans and strategies in the management of diseases in the country. All of this will have an impact on the early detection and prevention, while raising the level of public health and reliable results in scientific research" (DNCI02). A third respondent mentioned, "Collaboration among physicians supports the right medical decisions in order to improve the patients' treatment. Moreover, the collaboration is helpful in enhancing the quality of services and management of healthcare activities" (DNCI04). The collaboration among physicians is an important issue and has a positive effect on the hospital environment, especially in patient treatment and healthcare research findings. In addition, the HIS in the hospital environment is dynamic and requires a flexible information system that can adapt quickly to any changes to gather and share information among the same/different hospitals based on privacy preservation. This issue is crucial in order to achieve the collaboration benefits.

In conclusion, the development of CHIMS is based on privacy preservation. These issues have been investigated in the collaborative HIS environment from the perspective of specialists of the selected hospital in Egypt. The goal of this investigation was to gather the requirement of flexible collaborative HIS to improve collaboration among physicians in sharing information in the hospital environment.

This improved collaboration could lead to the enhancement of healthcare services in patient treatment and research findings. Some functional requirements of the development of the CHIMS were extracted from the viewpoints of the participants. The following subsections discuss the details of these requirements.

5.5.1 Functional Requirements of the Participants for the CHIMS

System analysis aims to determine the requirements of the proposed system. System analysis should establish the parameters in which the system should perform, rather than how the system performs. The requirements of the proposed system were derived through the observation of existing systems (see Section 2.3.1 in Chapter 2) and from the data collected through a study. This phase of software development is important because inaccurate requirement specifications will cause errors in the requirements to be propagated to the system design and implementation, consequently resulting in user dissatisfaction. If inaccuracy is discovered at a later phase, correcting the problem to fulfil the requirements is expensive.

System requirements consist of two categories, namely, functional and non-functional requirements. Functional requirements define the services that the system should provide and the behaviour of the system under certain circumstances (Sommerville & Kotonya, 1998). They are often referred to as system functionalities. All services required by the user should be defined under functional requirements. Sommerville and Kotonys (1998) defined the non-functional requirements as the constraints on the service or functions offered by a system. This section shows the functional requirements that describe what a proposed system should do based on perspectives of the participants from the selected Egyptian hospital.

The functional requirements of the proposed CHIMS were extracted from the perspectives of the interview participants. The interview questions, such as interview questions 17 and 18 (refer Appendix B) regarding the CHIMS requirements, provide the background information related to the HIS within the selected hospital. Several items of these questions were extracted from the requirements to overcome the healthcare system problems from the perspective of the respondents. To identify the requirements in an HIS environment, the majority of participants stated that overcoming the current problems in the existing systems is necessary. In this context, all respondents agreed that the hospital will require more healthcare services, especially in scientific research (Sub-Sections 5.3.1 and 5.3.2). To improve these services, all respondents agreed that the appropriate way to improve healthcare services in the hospital was to establish a connection between hospital departments to share healthcare information among medical staff or an integrated healthcare system. Moreover, all respondents agreed that the use of HIS for research in the hospital environment is important in order to enhance the collaboration among researchers by sharing data to improve the research findings in the healthcare sector (refer to Section 5.5).

The majority of participants indicated that a web based system might improve sharing healthcare information using HIS to facilitate the navigation among selected Egyptian systems in order to know the research activities in different departments, and to save on time and money.

The idea of the web based system based on privacy preservation was accepted by the majority of the participants. Furthermore, CHIMS connects all hospital systems. Moreover, sharing healthcare information in/out of the hospital environment is based on privacy preservation using the K-anonymization model. In this context, the majority of the respondents stated that this system might improve the reliability among specialists in healthcare sector, especially in scientific research.

The comprehensive understanding of the content of the functional requirements can be investigated based on the participant responses in the interviews. The participants answered several questions related to this issue. The first question was: What kind of information do you need store and share in the research system in order to improve collaboration among specialists and research findings? This question aimed to identify the elements of the database system for collaborative research. One interviewee said, “We need to collect medical data from all hospital departments, including the patient’s information, medical departments, treatments, medical staff, and administrative information. Moreover, if this information is stored, a research system will be helpful to improve healthcare services” (DNCI01). Another respondent observed, “We need all of the information related to patients, medical staff available, medical specialties available, and medical devices available. This data will be helpful to improve patients’ treatment and scientific research” (DNCI03). A third respondent noted, “Medical information is needed for patients, medical staff available, lab, and medicines as well as medical devices in various scientific departments” (DNCI05). A fourth respondent commented, “Comprehensive patient, physician, and hospital information might be useful in patients’ treatment and medical research” (MIENCI01).

The next question was: If you have a research system in your own hospital, what are the functions that you need from the system? This question aimed to determine the functions of the research system in order to improve collaboration among specialists and research findings. In this context, one of the interviewees said, “We need a system that provides a search function for the information with regard to patient information, medical staff available, the scientific expertise available to them, and the areas of their jurisdiction minute” (DNCI01). The same interviewee also mentioned, “We need a system that provides a database of graduate students and research areas available based on Web applications” (DNCI01), indicating the export of data and use in their research. Another respondent said, “The most important functions of scientific research management systems is to provide a database of patients, medical staff and administrative information, treatment, medications used in the treatment, and medical expertise available. Moreover, we need to generate reports based on our own needs in treatment or research” (DNCI03).

The final question on this issue was: why do researchers need to use and have access to the research database of the hospital that contains the patient information and the hospital activities? This question aimed to determine the necessity of navigating the HIS to obtain useful and necessary information. In this context, one interviewee said, “We need a search about the patient information by departments or physicians” (DNCI03). Another one said, “In my work, I need integrated information for the patients’ case, which leads to an improved decision for treatment. The case is the same for if I conduct research study” (DNCI05). A third respondent said, “Collect patients information from different departments in less time and cost” (DNCI06).

The functional requirements of CHIMS proposed in this study have been extracted from the viewpoints of the physicians who participated in the study. These functional requirements include the creation of a good HIS for the research in the hospital to collect and record patient information, physician information, related hospital information, and activities, and connecting this HIS among hospital departments based on a web based system and privacy preservation. This idea was found satisfactory by the majority of the participants. The research system in the hospital can manage and control research activities, especially the activities of physicians in patient treatment and common research area, as indicated by the majority of the participants. Furthermore, sharing healthcare information is based on privacy preservation. Therefore, the connection among hospital departments can disseminate these activities among physicians to improve collaboration in sharing information based on privacy preservation to improve their knowledge on patient treatment and research findings. In addition, the elements of the HIS required by physicians were patient information (i.e., personal information, examinations, diagnosis, and treatment), physician information (i.e., personal information and research area), and hospital information. The information among researchers required by the physicians included the activities of physicians in patient treatment (i.e., patient details, examination results, and diagnosis) and hospital characteristics, such as units, treatments, and available devices. Generally, the goal of these requirements was focused on the issue of collaboration among researchers (i.e., physicians) in sharing information within the same/different hospital departments to improve the patient treatment and research findings.

In conclusion, the results of the development of collaboration in the HIS environment based on privacy preservation using the K-anonymization model indicated the following points:

1. Developing an online collaborative process requires the provision of a centralized database to collect data from the departments of the selected Egyptian hospital based on privacy preservation using the k-anonymization model. Such a system has a flexible and collaborative structure to improve collaboration among physicians in sharing information within the hospital environment.
2. The functional requirements of the CHIMS proposed in this study were extracted from the viewpoints of participants. The CHIMS connects the hospital departments and shares information among them in a timely manner. The information included patient data, activities of physician in patient treatment, and hospital characteristics, such as units, treatments, and available devices. This work could improve the research findings in patient treatment. The following are some of the system activities:
    a. **Authentication, Authorization, Access Control and Identification**
        i. Ability to control system authentication, authorization and access by role or individual that is consistent with organizational policy and/or professional scope of practice.
        ii. Appropriate permissions for access to audit log information and reports.
        iii. Authorization and access management, which is related to the authorization of users and the verification of their access rights for the use of patient data, hospital information, and medical staff.
        iv. Ability to support data retention (keep, update, and merge a record), and prevent destruction.

b. Reporting and Queries

i. Provides a variety of reports that can create any required new report.

ii. Ability to view multiple levels of data (for example, log view versus readable view using categories selected).

iii. Ability to provide patient and/or population outcome data or query results to appropriate organizations (for example, create new versions of data based on privacy preservation).

iv. Ability to check extracted data to be used for secondary purposes, for missing data fields, or to provide an appropriate audit trail for deletions or changes in the data fields.

v. Provides an easy-to-use report builder module to enable the system administrator to create/edit any report according to the hospital requirements.

vi. Offers a wide variety of queries to facilitate and speed up the work cycle and provides an ability to inquire about healthcare information via different methods, such as physician's name, disease, department, patient age, location, patient sex, research area, and other information.

vii. Ability to list all clinicians and/or providers directory or registry within and outside the centre for transmitting or mailing of notes/clinical summary.

viii. Ability to demonstrate flexibility of a built-in reporting tool from writing simple queries to constructing complex reports.

ix. Ability to share and incorporate reports with others users for secondary purposes, such as research.

x. CHIMS is able to import and export patient information from a personal health record.

c. Integration

i. Ability to integrate with a hospital department's database that is in accordance with the established standards (for example, collect data from the departments of the selected Egyptian hospital based on privacy preservation using the k-anonymization model).

ii. Ability to integrate secure communication/messaging services for users of CHIMS to facilitate collaboration.

iii. Ability to synchronize patient demographic, scheduling, and resource utilization information across multiple systems. When an update of information is made in one system, then the corresponding table in the second system is automatically updated.

iv. Ability to provide clinicians an improved capability to manage complete medication profiles through the CHIMS system.

v. Ability to support secure data exchange and routing (for example, sending data over a secured connection).

vi. Ability to accept or view data and documentation from a patient originated source.

vii. Ability to access and integrate standards, protocols, and best practice documentation from external sources based on privacy preservation.

d. Audit Logs and Monitoring of Workarounds

i. Ability to audit records through audit trails that include the following information: date and time recorded for each entry, and any change or updating in recorded information.

ii. Ability to aggregate log data to provide meaningful information. Regular review and analysis of log data should be done to identify system performance, trends, and identify issues early so they can be addressed.

iii. CHIMS provides retrieval, updates, and storage of data from multiple input locations, including, but not limited to, hospital workstations and physician workstations.

iv. CHIMS provides retrieval and sorting of medical record information and allows for screening, printing, and/or exporting the output of said information.

v. Ability to maintain and organize user data such as users' personal data, research area, and research data.

e. Personal Health Information, Patient Privacy and Confidentiality

i. Ability to control access to personal health information to comply with information safety, security, and privacy legislation, including the use of secure passwords.

ii. Ability to demonstrate the purposes of data collection with other systems using system rules that have clear rationales. For example, collection of additional personal information as part of clinical trials must provide explanatory statements for the collection of such in the user screen, which the clinician can immediately access.

iii. Ability to support patient privacy, confidentiality, and log privacy breach for internal monitoring and evaluation.

The researcher employed the IEEE software requirements specification (SRS) in order to explain the CHIMS requirements (A. Davis et al., 1993). For more details, refer to Appendix G.

5.5.2 Non- Functional Requirements of the Participants for the CHIMS

Non-functional requirements pertain to how well the system provides the functional requirements. Non-functional requirements are as important as functional requirements and must be complied with to ensure the proper operation of the system. The non-functional requirements established for the proposed system are as follows:

a) Security: A security process of the system is important to prevent unauthorized users from accessing any part of the system. An authorized person (administrator) provided system users with usernames and passwords to enable them to access the system. Furthermore, each user has a special privilege based on job level (admin, doctor, researcher, and so on) and authorized information flows.

b) Contents: The system contains only two types of information about the selected Egyptian hospital. The first comprises general information about the selected Egyptian hospital, including the departments, education, journal, mission, vision, and contacts, which could be obtained from the website of the hospital. The second type of information includes administrator and researcher information.

c) Usability: Usability implies that the system should be convenient and practical to use. Ease-of-use requirements address the factors that constitute the capacity of the software to be understood, learned, and used by its intended users.

d) Flexibility: This process is essential to the CHIMS system development based on environmental requirements, especially the requirements of physicians on the collaboration issues. Therefore, such a system can increase or extend the functionality of the software based on new requirements.

Table 5.8 shows the summaries of the CHIMS functional and non- functional requirements.

Table 5.8: CHIMS Functional and Non- Functional Requirements

Collaborative Healthcare Information Management System (CHIMS) Requirements	
Functional Requirements	Non- Functional Requirements
a) Developing an online collaborative process requires the provision of a centralized database to collect data from the departments of the selected Egyptian hospital based on privacy preservation using k-anonymization model.	a) Security: A security process of the system is important to prevent unauthorized users from accessing any part of the system. An authorized person (administrator) provided system users with usernames and passwords to enable them to access the system. Furthermore, each user has a special privilege based on job level (admin, doctor, researcher, and so on) and authorized information flows.
b) The CHIMS connects the hospital departments and shares information among them in a timely manner. The information included patient data, activities of physician in patient treatment, and hospital characteristics, such as units, treatments, and available devices. This work could improve the research findings in patient treatment.	b) Contents: The system contains only two types of information about the selected Egyptian hospitals. The first comprises general information about the selected Egyptian hospital, including the departments, education, journal, mission, vision, and contacts, which could be obtained from the website of the hospital. The second type of information includes administrator and researcher information.
c) The following are some of the CHIMS activities: 1- Authentication, Authorization, Access Control and Identification. 2- Reporting and Queries. 3- Integration. 4- Audit Logs and Monitoring of Workarounds. 5- Personal Health Information, Patient Privacy and Confidentiality.	c) Usability: Usability implies that the system should be convenient and practical to use. Ease-of-use requirements address the factors that constitute the capacity of the software to be understood, learned, and used by its intended users. d) Flexibility: This process is essential to CHIMS system development based on environmental requirements, especially the requirements of physicians on the collaboration issues. Therefore, such a system can be increase or extend the functionality of the software based on new requirements.

5.6 Discussion of Findings

Conducting research in Egypt was characterized by the deterioration of the situation in the country, as illustrated by the high population density, poor financial situation, low level of education especially in rural areas, as well as the spread of cancer and its late discovery in this country. Compared to most Arab countries, research expenditure in Egypt is extremely low, and investment on student education is low as well.

The findings of the observation and interviews in this study indicated poor collaboration among physicians in sharing healthcare information using HIS in the selected Egyptian hospital. Furthermore, most of the work in the selected Egyptian hospital employed paper based systems. The hospital specialists worked independently because of the time factor and the poor HIS in their hospital environment. A manual system is used in healthcare management, thereby making paper-based information difficult to manage, control, and share. Consequently, all these reasons might have effects on the collaboration among specialists regarding healthcare information sharing using HIS.

The interview findings in this study indicated that the use of HIS in research in the hospital is important in order to enhance the collaboration among researchers by sharing healthcare information to improve patient treatments and research findings. In this context, the majority of the participants in the interviews agreed that HIS in hospitals is necessary. Moreover, the improvement of research activities and sharing of data using HIS to enhance healthcare services in the selected hospital could increase the reliability of services.

Nevertheless, the adoption of these systems in the selected hospital is weak in healthcare information sharing among specialists because of many factors, such as the ability and skill, management issues, time, age, culture, poor technology infrastructure, PU, PEOU, and privacy and security concerns. These factors were extracted from the responses of the participants (see Table 5.5.).

The collaboration in healthcare information sharing in the research activities that use HIS is weak in the selected Egyptian hospital environment. In this context, the majority of the respondents in the interview stated the lack of a system to manage research activities and provide medical data for research. Consequently, the selected hospital environment has weak collaboration in healthcare data sharing because of the absence of a research system to manage the research activities (see Sub-Section 5.3.2). Furthermore, the findings of this study on the role of the research system in the hospital environment indicated the importance of improving the collaboration among physicians to enhance healthcare services through a collaborative healthcare information management system, thereby controlling the research activities and data sharing to catalyse collaborative research and improve the research findings in the health sector. Therefore, the improvement of a research system based on a good system to control research activities and share data based on privacy preservation will improve the collaboration among physicians in the Egyptian hospital environment (see Section 5.5).

In conclusion, this study identified the key obstructions that might affect the technology acceptance with regard to collaboration in sharing healthcare information among specialists in the selected Egyptian hospital. Key obstructions consist of several points. These obstructions include the poor technology infrastructure regarding PU and PEOU of technology, management issues, privacy concerns, and cultural behaviour of people (participants) in the organization (selected hospital) and their attitudes (see Table 5.6). Moreover, the remaining factors, such as ability and skill, time, age, and security issues indicate the limitation and barriers that might affect technology acceptance regarding the collaboration in healthcare information sharing using HIS.

In sum, the collaboration improves the qualifications of medical staff (i.e., physicians and researchers) by sharing data in a similar research area in a rapid manner and satisfies system requirements. Therefore, participating healthcare professionals strongly believe that developing a collaborative HIS based on the privacy preservation potential can provide numerous benefits to healthcare centres, such as increased cooperation among physicians in sharing information. This cooperation, in turn, improves the experiences of physicians and the satisfaction of most system requirements through the information sharing among physicians and researchers based on a research system that preserves privacy. The improvement of research findings also enhances healthcare services.

5.7 Summary

This chapter presented the data analysis and findings of data collected via observations interviews, and documents. This chapter also presented the answers to research questions 1, 2, and 4, with regard to the factors that affect technology acceptance and adoption in the selected Egyptian hospital, and identified the key obstructions that affect the collaboration among physicians with regard to information sharing for health research in the selected Egyptian hospital. Discussion and summary of the findings were later provided. The steps in developing and evaluating the proposed CHIMS model are discussed in greater detail in Chapter 6.

CHAPTER 6

SYSTEM DEVELOPMENT AND EVALUATION

6.1 Introduction

This chapter addresses the collaborative healthcare information management system (CHIMS) model in three parts. The first part presents the design and implementation of the CHIMS model, including a description of the development platform and the use of various modules. In the second part, the CHIMS is evaluated by a testing procedure and then by potential users, followed by an analysis of the questionnaire and responses of selected participants who have tried out the CHIMS. The last part presents the results of the analysis, and suggests appropriate actions for fine-tuning the CHIMS.

6.2 HISs at the Selected Egyptian Hospital

Hospital A is a leading cancer centre in the Middle East and Africa, as mentioned in Chapter 4. The implementation of its hospital management information system (HMIS) was completed, and the system became operational in 1992 through a grant from the United Nations Development Programme. At that time, the system was the largest and most comprehensive medically oriented HMIS in Egypt (El Hattab, 2001). Although different modules were added to the HMIS, the core of the system has never been changed or updated (El Hattab, 2001; Inas. Elattar, 2005).

Hospital A installed the HMIS to achieve the following objectives: (1) to improve patient care, (2) to support and improve hospital management, and (3) to support research. The HMIS requires regular updating and frequent modifications and fine-tuning. Modern hospitals significantly change every few years due to the introduction and use of new equipment, change in the standard management of diseases, and the introduction of modern procedures (Bakker & Leguit, 1999). Moreover, hardware and networks technology have considerably developed in the past decade. Although attempting to keep up with the competition in hardware and network development is difficult and uneconomical for a hospital, updating its system every few years is critically important. Changes in economics, pricing, and budget are also reflected on hospital operations and management, which in return, is reflected on the HMISs. Another important factor is that the drop in the prices of computer and network components sometimes promotes a more economical approach, that is, the replacement of old expensive technologies with cheap and up-to-date ones is more cost effective than the maintenance of old equipment (Sailors & East, 1999).

As previously mentioned, the HMISs are important for hospitals in developing countries; the development, customization, and maintenance should be done locally, by local manpower with suitable and continuous training. The HMIS are dynamic, and require continuous updating, fine-tuning, and additions (El Hattab, 2001). The HMIS also need to be affordable for many countries, and should include indicators for measuring the quality of system operations (D. W. Bates et al., 1998).

Hospital A has an HIMS; however, the system lacks adoption in work by the medical staff due to several factors, as presented in Chapter 5 (Section 5.3 and related Sub-Sections). Hospital A has numerous systems for managing its activities. As observed in the selected hospital, the absence of a research system to manage the research activities results in the collaboration in sharing healthcare information within the selected hospital environment being weak. Most of the work in Hospital A is based on paper-based systems. A manual system of healthcare management is used, thus making paper-based information difficult to manage, control, and share.

Hospital B used HIS to manage and control patient information, medical staff information, and other activities related to the hospital. The information system in research department in Hospital B not available, but there is a plan to implement the Research Electronic Data Capture Software (REDCap), aiming at harmonization, standardization, and centralization of clinical research data and integrating this application with Cerner (The hospital HIS system) through InfoView (Children's Cancer Hospital Egypt, 2014). In this context, using data as the hard copy directly or the soft copy collected from current HISs in Hospital B within the research activities by researchers affected data privacy, and the direct use of the data by researchers violates privacy laws, as mentioned in Chapter 2. No system was available to manage the research activities, such as data sharing, which leads to poor collaboration in the research environment among the medical staff. Moreover, using the manual system to manage the healthcare research is difficult, as mentioned by the World Health Organization (2006) (Organization, 2006).

In this context, research activities use a paper-based system and patient files, a process that is difficult, complicated, and requires time and cost to extract medical data used in research and data collection. In addition, routine procedures in obtaining approval to conduct research and use the data requires a long time. Additional use of the data by researchers violates privacy laws. Therefore, HISs in hospital are necessary; especially in research activities in order to improve the sharing of data and collaboration among specialists. Accordingly, using HISs in hospitals enhances healthcare services in the selected hospital, thus increasing the reliability of services.

Therefore, there is a need to develop collaborative healthcare information management systems in order to improve sharing healthcare information in research activities based on requirements of the participants in this study. The following sections present the development platform of the CHIMS model.

6.3 Development Platform of the CHIMS

The CHIMS model is proposed to provide an integrated collaborative HIS environment for improving collaboration among specialists in sharing healthcare information using HISs based on privacy preservation, and in collaborative research in the selected Egyptian hospital environment. This model also aims to improve collaboration among medical staff in sharing healthcare information in hospital services, such as providing healthcare information for researchers based on privacy preservation in order to improve the research findings. The CHIMS model is developed based on the anonymization model and its features, as mentioned in (Chapter 2, Section 2.5). This system is selected to provide an open and flexible collaborative HIS to improve collaboration among physicians in sharing information in the hospital environment. The CHIMS consists of centralized and anonymization process units using the generalization technique, which retrieves data and provides necessary information to researchers. Therefore, the CHIMS is designed based on Web applications for managing and controlling healthcare information, and quickly and accurately disseminating this information among researchers within the same hospital and between different ones.

6.3.1 Design of CHIMS

The system design takes place after the system requirements have been determined. System design is a creative process that transforms problems into solutions by building the architecture for software. Pressman (2001) asserted that system design covers several processes, such as identifying the software architecture (major components of the system), detailing what they are to accomplish, establishing the interfaces among those components, and designing the data for the system to satisfy specified requirements (RS, 2001). The design of the CHIMS is based on the anonymization model and its features, such as preserving privacy, maintaining data utility, and accurately sharing data, as mentioned in (Chapter 2, Section 2.6). This system consists of a centralized database and anonymization process that collects and updates data of the selected Egyptian hospital systems in order to provide the necessary data for research. The system design includes the system architecture, which deals with the decomposition of a system into a couple of interacting modules or components. The subsequent sections explain the system construction and implementation to develop the proposed system.

6.3.1.1 Construction of the CHIMS

The development of integrated HIS applications was conducted with a Web-based application to easily manage and control the healthcare information, and allow users to access their information based on user privileges (Rodrigues, 2009). Given that a Web-based application is a tool for aggregating applications online, it typically offers a wide range of information content, applications, and services, integrated into a single-theme interface that is easy to navigate, reflects the interest of different users, and enables them to access information from multiple sources. The CHIMS was designed based on Web applications to manage and control healthcare information, and quickly and accurately disseminate this information among medical staff, especially researchers. The construction of the CHIMS is shown in Figure 6.1.

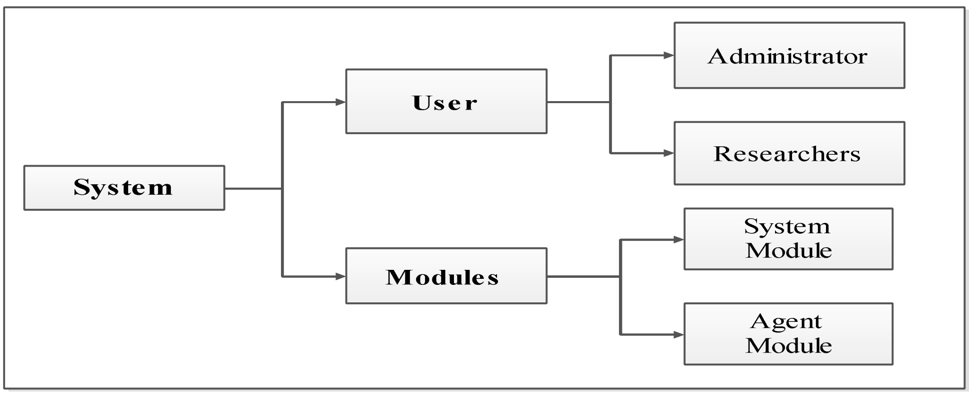


Figure 6.1: Construction of the CHIMS

Figure 6.1 illustrates the CHIMS major components, which involves modules and users. Agent modules are used in creating and storing data, and in disseminating the data among the researchers to facilitate the research. The system modules are used for data entry, providing information, and for users in interfaces; the users are administrators, researchers, and individuals who have the responsibility and privilege to enter and view healthcare information.

The CHIMS defines a set of tasks that support research in a formal and collaborative manner. These tasks provide separate utilities for the stakeholders, namely, the administrator and the researcher.

1. Researcher Module: The researcher initially logs in to his account, types his user number and password, and then clicks Enter to navigate the next Web page. Once the researcher has logged in, he selects the required type of resource and starts to search the CHIMS database by entering the keywords of his choice as they relate to his research and research area in the selected Egyptian hospital. Then, the researcher clicks on Search to start the function. The resource type is set on All Types by default; the researcher may also choose a specific resource type. The researcher then types in keywords appropriate to his search, and the CHIMS searches the database to retrieve files that match the keyword and the resource type the researcher has requested. The keyword field has a built-in automatic completion function; the auto-search function completes the word for him by retrieving information from the resources stored in the CHIMS database after the applied generalization technique in anonymization engine (refer Figure 2.8). When the researcher completes the search function based on keywords or research area, he can export the data in a private storage, reuse the data in his research, or share the data.

2. Administrator Module: The administrator has several screens in common with the researchers, including login and resource search functions. The administrator also has a range of unique functions, including the ability to add a new department, a new specialist, a new researcher, a new research area, a new staff member, and a new patient.

Choices for tracking statistics on individual researcher are available, including a researcher's use of all resources and use of any given particular source. The statistical function page allows for entering the researcher number and type of statistics to track statistics for aggregate groups. Class statistics can be tracked for use of all resources and use of particular resources. Table 6.1 shows a comparison of the two modules.

Table 6.1: Comparison of the Users Modules

Researcher	**Administrator**
Browse e- resource on hospitals and export data	Assign the researcher username and password. Add e-resources to the system
Request for additional information	Cooperate with physicians by sending notice to approve the acquisition.
Receive notice, that the request information (data, research area) has been added.	Send notice to researcher that the request information has been added.
View the system instruction, how to search in it.	Monitor the usage of available e-resources as browsed by researcher

The CHIMS system architecture comprises four phases. The first phase involves collecting data from different HISs, and then sending the data to a central database. The second phase involves data pre-processing, such as missing values, inconsistent data, data integration, data selection, and data transformation. The third phase involves processing data based on the anonymization engine, which applies the anonymization operation based on the data generalization technique; this phase involves "a strategy for protecting individual privacy in released microdata records", as mentioned in (Chapter 2 section 2.6) The fourth phase involves sharing data among researchers based on privacy preservation, as shown in Figure 6.2.

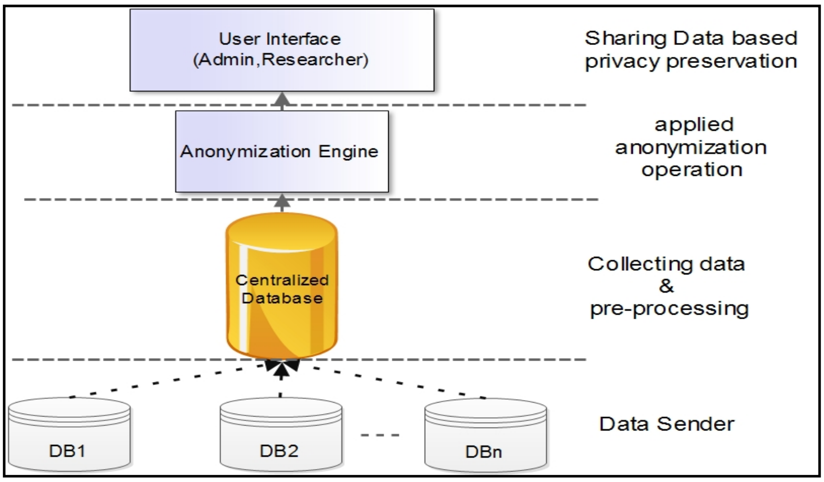


Figure 6.2: CHIMS System Architecture

The idea is that by reconstructing a more "general" and semantically consistent domain for the attributes and transforming its values to this domain, identifying individuals by linking this attribute with external data would be much more difficult. From the perspective of information communication technology (ICT), the CHIMS construction was developed on the basis of an agent-based technique for linking the CHIMS units in different departments at hospitals using Web-based application tools; in this stage collecting healthcare data from different HISs departments, and then sending the data to a central database. In the second stage of pre-processing data in this study, the researcher assumes the collected data of hospital departments is clear. In stage three, collected healthcare data is sent to an anonymization engine in order to ensure privacy preservation; to anonymize data was an applied generalization, which transforms attribute values of non-sensitive attributes in the data into values ranges, so as to prevent an adversary from identifying individuals by linking these attributes with public available information (refer to Chapter 2, Section 2.7). In hospital environments, the collaboration among medical staff increases the awareness of team members regarding their respective knowledge and skills, which leads to further improvements in decision making and improves the research findings in the healthcare sector. Consequently, collaboration is an important requirement in health information systems (HISs) because it produces reliable and rigorous evidence that can inform critical decisions related to healthcare services. It aids in the provision of proper, fast treatment to patients, and healthcare information for research. However, this study is primarily concerned with the collaboration among specialists in the selected Egyptian hospital, such as physicians and researchers. The collaboration occurs when sharing healthcare information using HISs among researchers for patient's treatment and research studies based on privacy preservation within the same hospital departments and/or among different hospitals. It aims to improve this collaboration among medical staff to enhance healthcare services and research findings. This aim can be achieved by developing an integrated collaborative HIS that supports the sharing of appropriate and relevant healthcare information based on the requirements of specialists. The final stage is the new version of the anonymize data stored in the database, and sharing this healthcare data among specialists, such as physicians and researchers, based on privacy preservation. The general structure of the CHIMS is shown in Figure 6.3.

In this study, healthcare information related to the selected hospital departments, which includes the patients' healthcare information on treatment activities of physician information, is reviewed to create data entities (i.e., tables) of the database module. The MySQL database management system is used to manage these entities successfully as a relational database as mentioned in (Chapter 3, Section 3.3). An entity relationship diagram (ERD) of a data model is a detailed logical representation of data for a database in a system. The ERD model is expressed in terms of entities in an environment and the relationship among the entities, as well as their attributes. The conversion of a logical data model to a physical data model is called a database schema (Satzinger, Jackson, & Burd, 2011; Talla & Valverde, 2012). Figure 6.4 shows the ERD of the database schema for the DB.

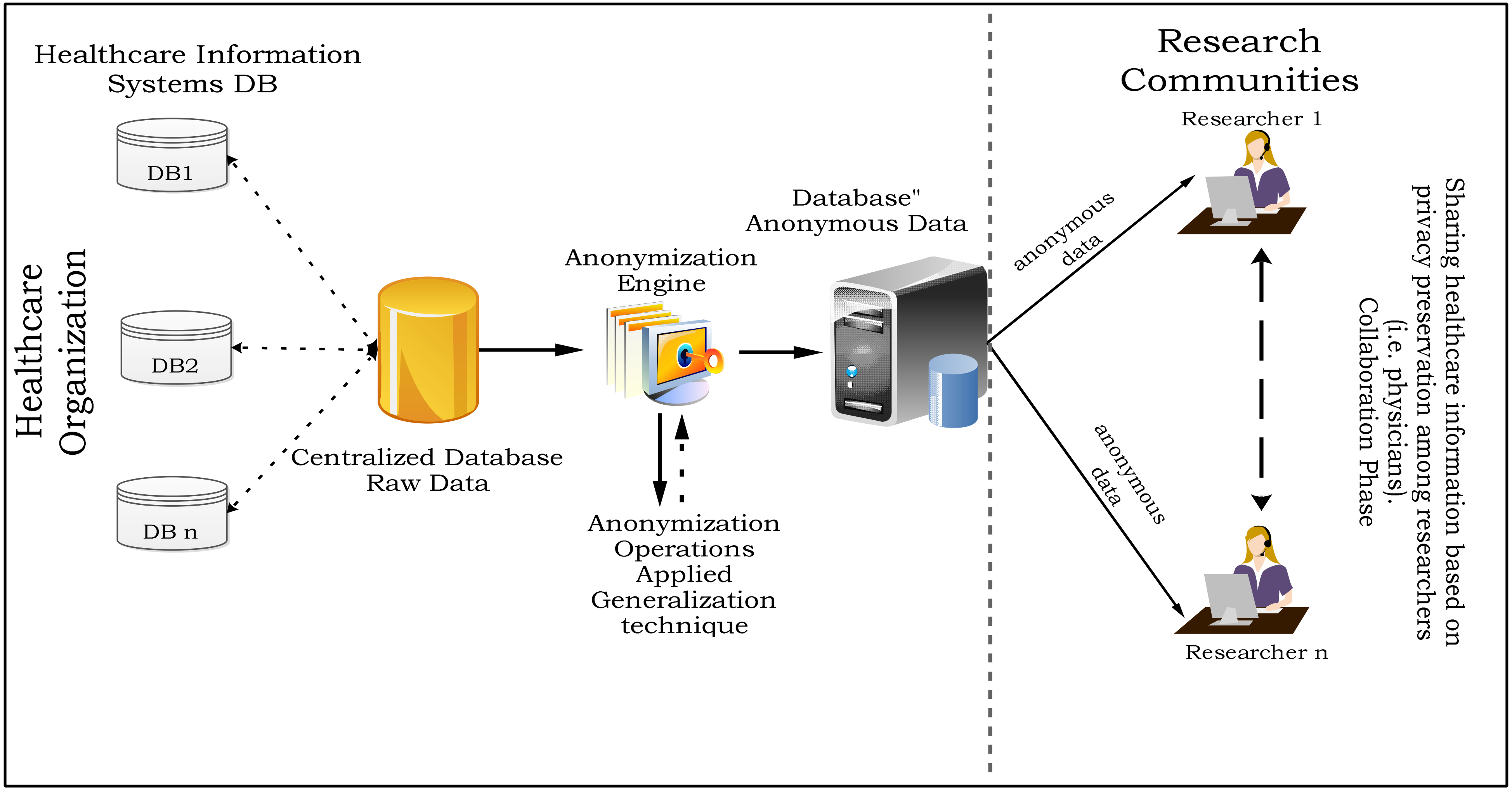


Figure 6.3: General Structure of the CHIMS

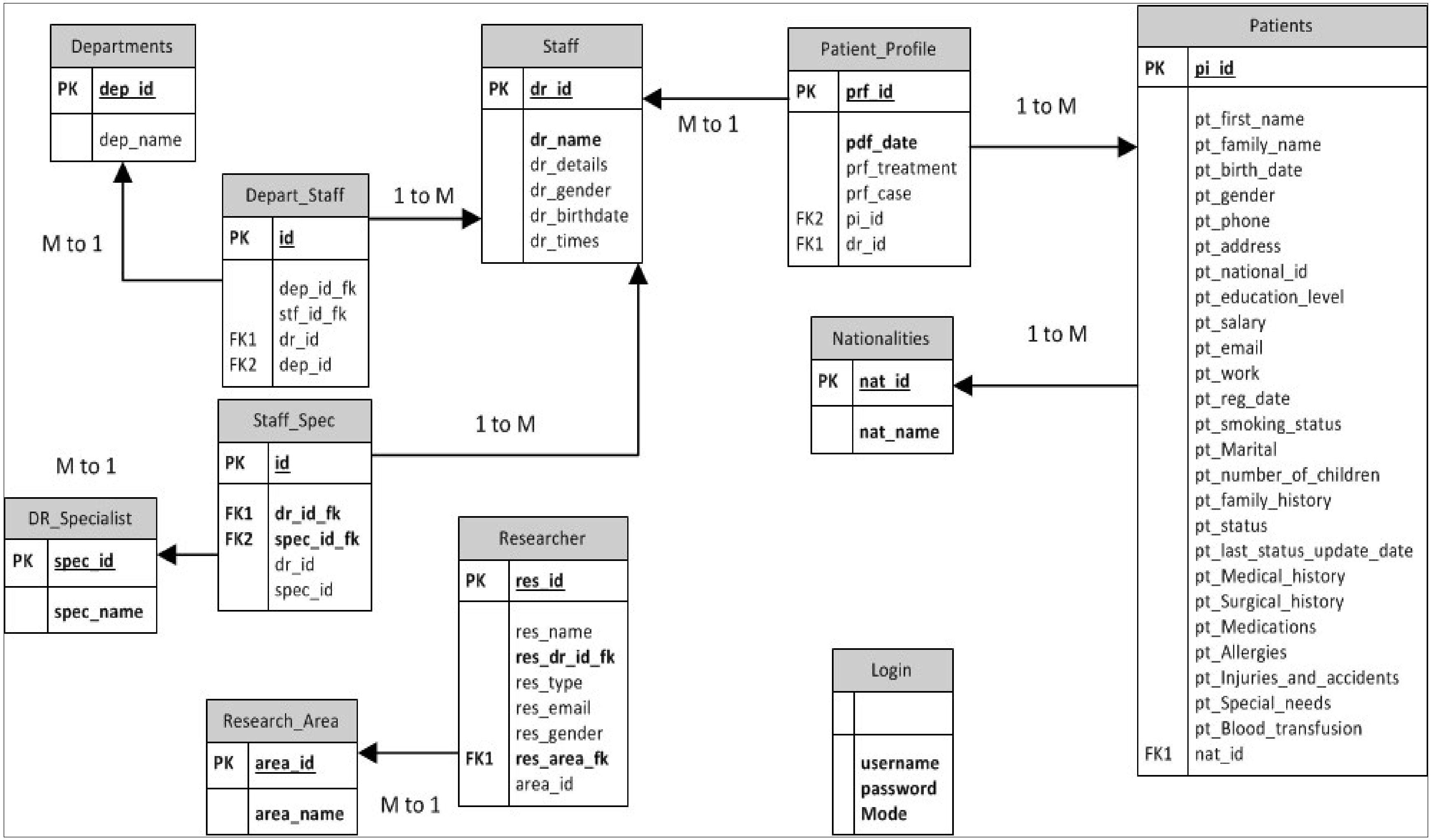


Figure 6.4 ERD of the Database Schema for the DB

The Unified Modelling Language (UML) is a standard language for writing software blueprints. The UML may be used to visualize, specify, construct, and document the artefacts of a software intensive system (Booch, Rumbaugh, & Jacobson, 1999).

The UML is appropriate for modelling systems ranging from enterprise information systems to distributed Web-based applications, and even difficult real-time embedded systems. The UML is a very expressive language that addresses all the views necessary to develop and deploy such systems.

The UML is not difficult to understand and use despite its expressiveness. Learning to effectively apply the UML starts with the formation of a conceptual model of the language that requires learning three major elements, namely, the basic building blocks of UML, the rules that dictate how these building blocks may be put together, and several common mechanisms that apply throughout the language. The UML is only a language, and thus is merely one part of a software development method. The UML is process independent, although optimally it should be used in a case-driven, architecture-centric, iterative, and incremental process (Booch, et al., 1999).

The following four aims can be achieved through modelling:

1. Models help in visualizing how a system is or how it should be.
2. Models allow for the specification of the structure or behaviour of a system.
3. Models provide a template that serves as a guide in constructing a system.
4. Models document formed decisions.

Figure 6.5 shows the UML of CHIMS classes.

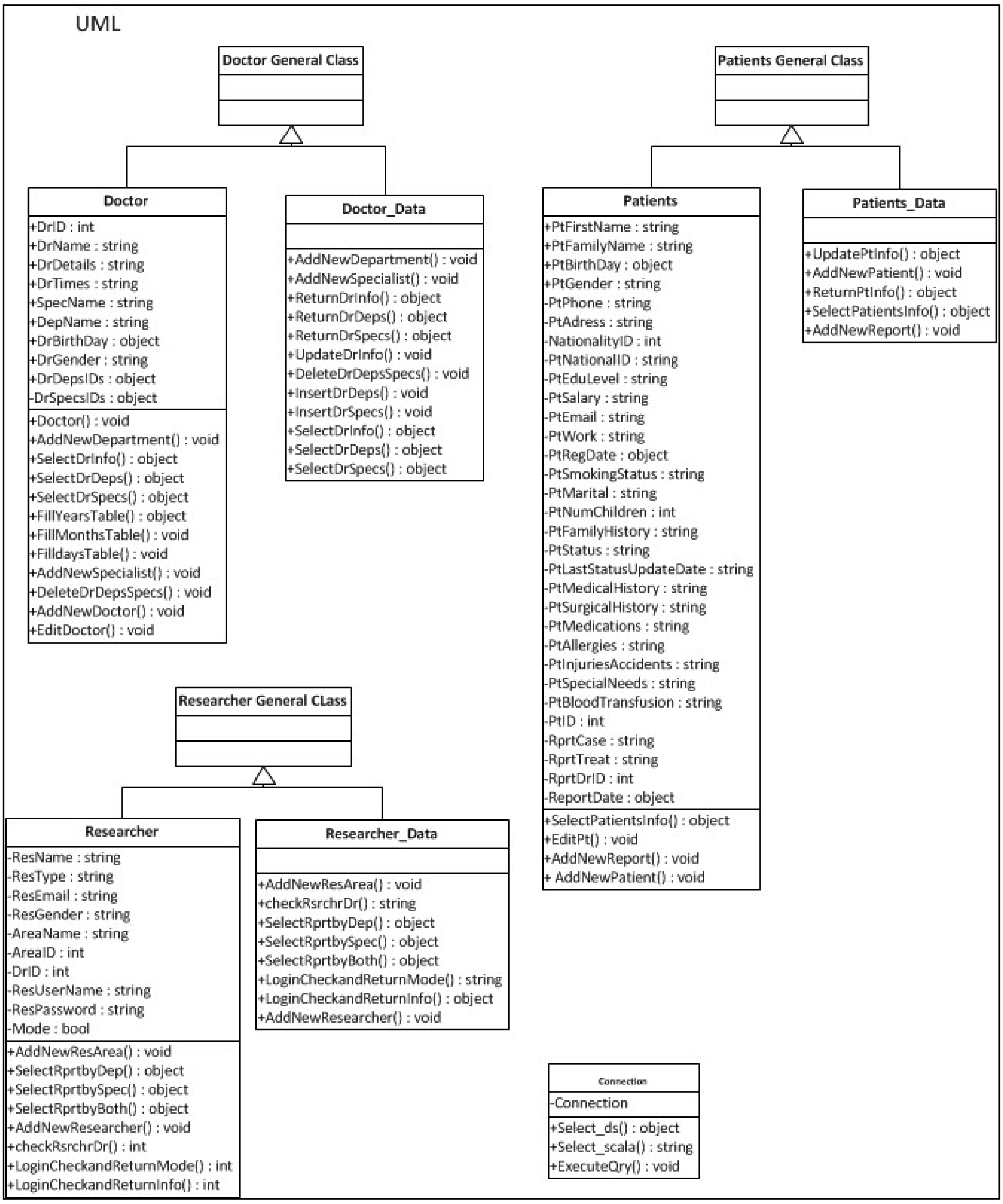


Figure 6.5: UML of CHIMS Classes

6.3.1.2 CHIMS System Implementation

The development platform for CHIMS was developed in a Web-server technology. Windows 2008 Server was selected because it is “now the most-used Web-server in the world and ASP.NET can be compiled as an Windows 2008 Server” (Dewson, 2008). ASP.NET, which is a Web application framework developed and marketed by

Microsoft, was selected to allow programmers to build dynamic Web sites. The combination of the Windows 2008 Server, MySQL, and ASP.NET is all but unbeatable, and thus provides a solid, stable, and flexible infrastructure for the CHIMS.

The CHIMS prototype has a database to store and retrieve resources. This study used MySQL, an open-source program supported by Oracle/Sun Microsystems, and which is, according to DMW Technologies (2008) (DuBois, 2009), "a powerful free SQL database, and PHP provides a comprehensive set of functions for working with it." MySQL is generally considered better than other Web database options because it is a true relational database, as well as the most widely used and best supported Web database (Pros, 2008). MySQL "stores data in separate tables rather than putting all the data in one big area; this adds flexibility, as well as speed" (Softpedia, 2008).

6.3.2 CHIMS Interface Modules

The CHIMS interface comprises modules and their functions. The CHIMS system network diagram describes the functional modules of the CHIMS interface through users (e.g., administrator and researchers), allowing them to navigate through different hospital departments. A user selects the login type (as the administrator or researcher) and locally logs into the system. The CHIMS then provides information for users depending on the authentication and authorization characteristics of the security service. In case of a security issue, the administrator and researchers are used as user roles to access information within the CHIMS. Figure 6.6 shows the CHIMS system network diagram. The details of the interface of several main modules are presented in the following subsections.

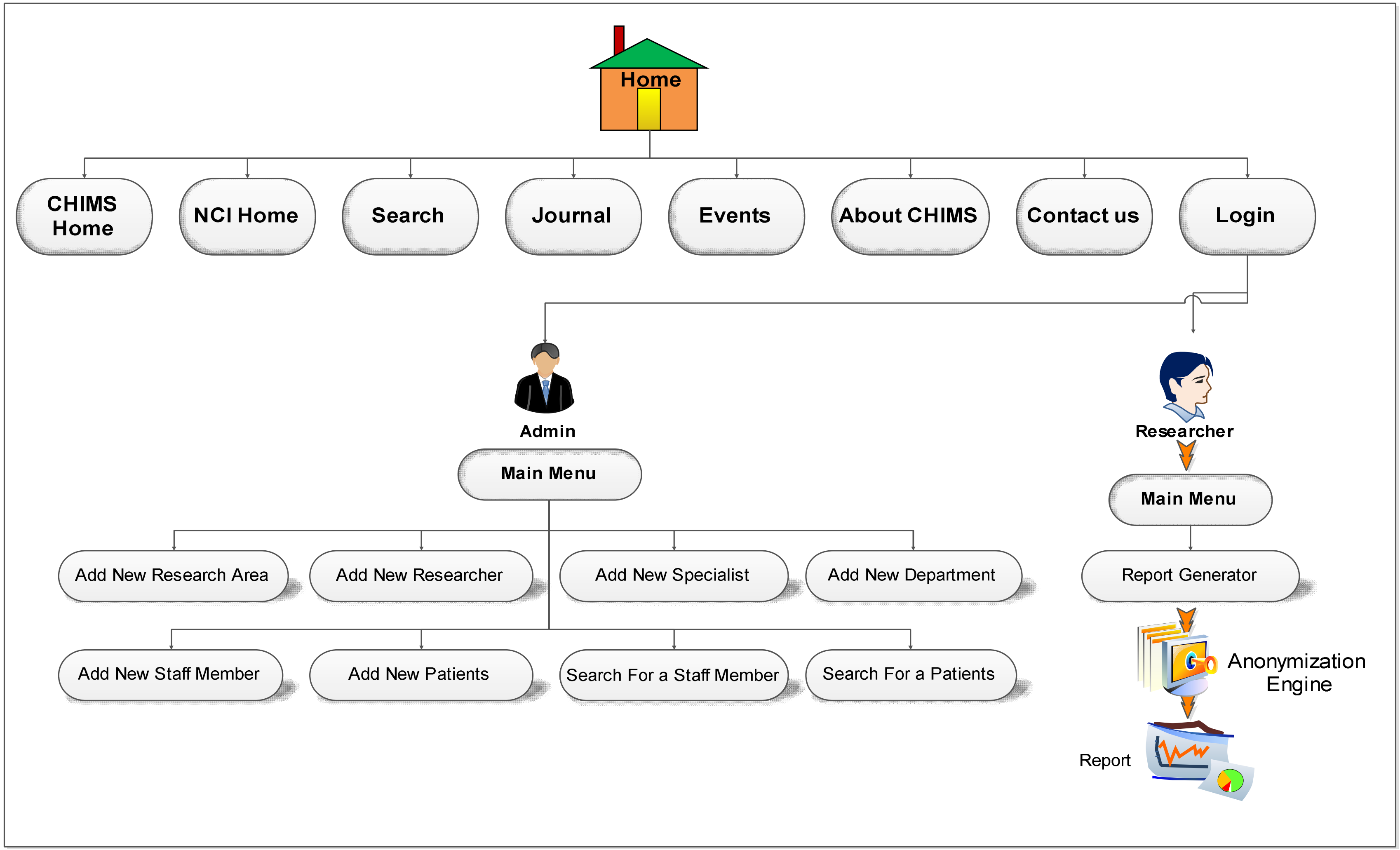


Figure 6.6: CHIMS System Network Diagram

The CHIMS comprises patient records, medical staff records, department data, and research areas. The users can navigate through the system and search for patient information by department, disease type, physician's name, and research area, then generate the report and export it to a personal computer. Table 6.2 summarizes the functions of the main modules of the CHIMS interface.

Table 6.2: Functions of CHIMS Interface Modules

No.	Interface Module Name	Functions
1	CHIMS Home	This module allows the user to view the main page of the CHIMS and relevant functions.
2	Hospital Home	This module allows the user connect to selected hospital main page and relevant activities.
3	Journal	This module allows the user connect to selected hospital journal and search inside it by topic and authors.
4	Events	This module allows the user to view the selected hospital events as conference, workshop and training.
5	Search	This module allows the user search inside the selected hospital as the general information.
6	Login	To validate the user to ensure authorized access to the CHIMS. Thus, when a user tries to log in, the system will check the authenticity and authority of the user in the local web server. This function for start use CHIMS for collaboration process in sharing healthcare information among medical staff such as physicians and researchers in/out hospital.
7	Contact us	This module allows the user to connect to admin for the registration or enquires.

6.3.2.1 Interface

The user interface employs one of the standard interfaces found on the Web. Interface design plays a crucial role in developing the CHIMS. The goal is to enable logical data entry and ease system navigation. The interface has three sections, namely (a) a title bar, (b) a navigation pane, and (c) a main pane. Figure 6.7 shows the interface layout of the main page of the CHIMS. The title bar is found at the top of each page. The name of the system is displayed on the left side of the title bar. Seven hyperlinks are located at the top left side for global navigation. Two hyperlinks are located at the top right of the login and help buttons. The hyperlinks are mentioned earlier in Table 6.2.

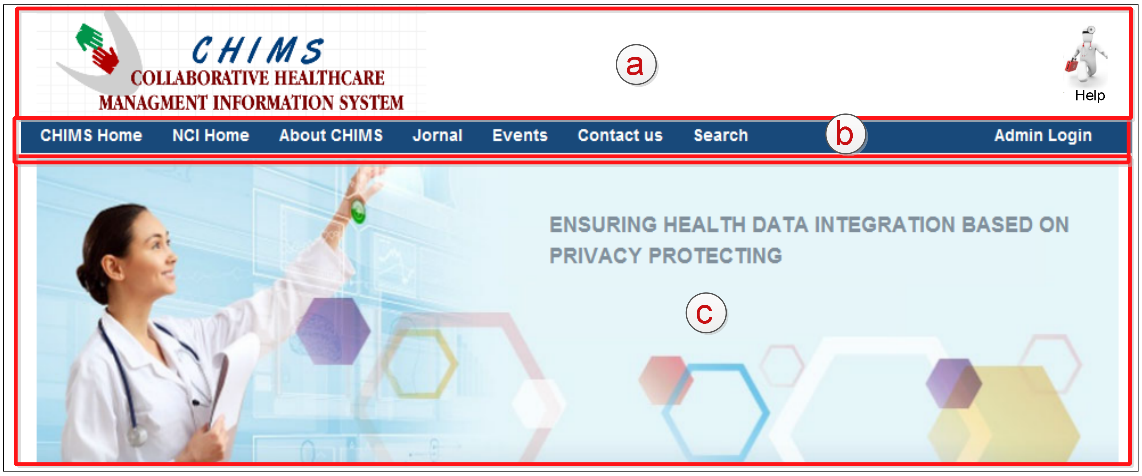


Figure 6.7: System interface design consisting of (a) title bar, (b) navigation pane, and (c) main pane

Figure 6.8 shows the interface layout of the main page of the CHIMS, where one can enter the CHIMS system through the login button. Two types of users can log into the system, the administrator and researchers, as depicted in Figure 6.8. The interface layout of the login page checks the authenticity and authority of the user in the local Web server. All particular modules implemented in the CHIMS can be viewed by the user in the interface layout of the home page, based on the authority of that user.

Figure 6.8: Interface Layout of Login Page

1. Administrator view

The CHIMS provides eight main modules for the user: CHIMS Home, NCI Home, About CHIMS, Journal, Events, Contact Us, Search, and Login, as shown on the navigation pane. Users, such as administrators and physicians, need to move from one module to another to obtain particular information. In terms of user role, the user with the administrator role can access all main modules. Figure 6.9 shows the interface layout of the administrator login page.

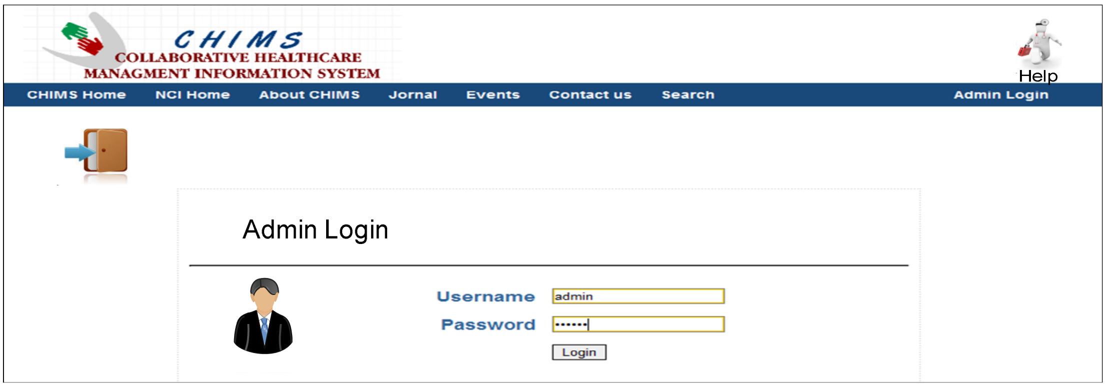


Figure 6.9: Interface Layout of the Admin Login Page

The administrator menu provides nine modules for the admin CHIMS, such as Add New Department, Add New Specialist, Add New Researcher, Add New Research Area, Add New Staff Member, Add New Patient, Staff Member Search, Patient Search, and Researcher Search. Figure 6.10 shows the interface layout of administrator main menu page.

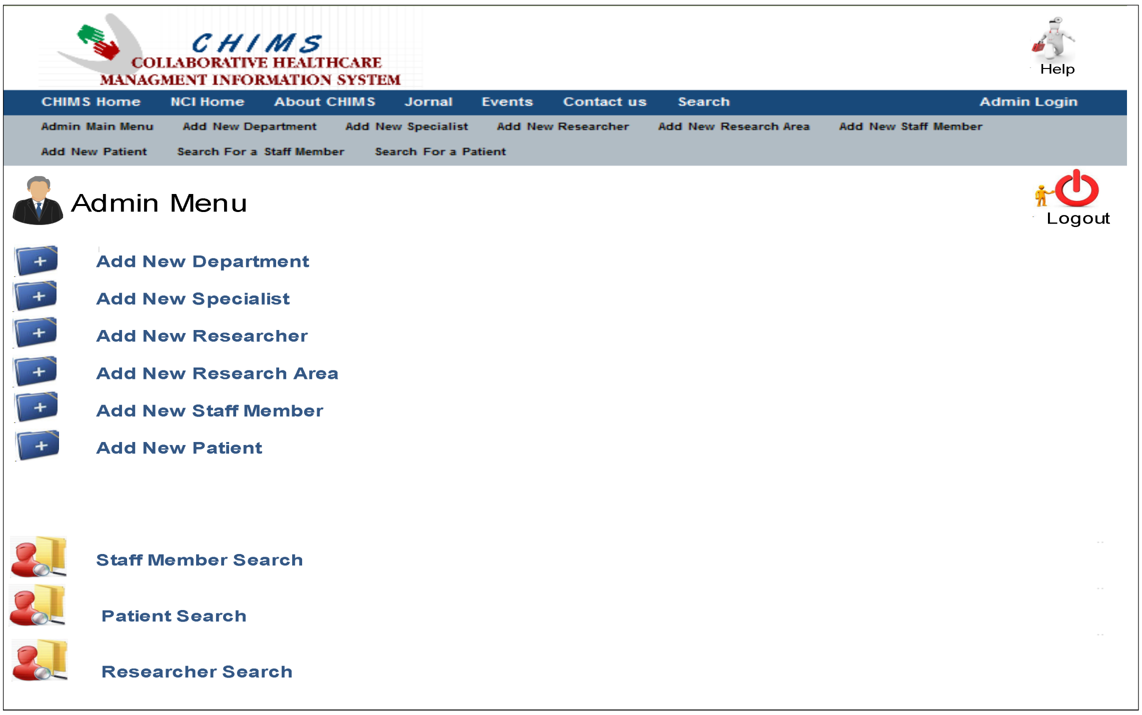


Figure 6.10: Interface Layout of the Admin Main Menu Page

The administrator main menu mentioned above comprises nine modules. Table 6.3 summarizes the functions of the administrator main menu modules of the CHIMS interface.

Table 6.3: Functions of the CHIMS Interface Modules

No.	Interface Module Name	Functions
1	Add New Department	This module allows the admin to add new department in hospital and inserted within search area
2	Add New Specialist	This module allows the admin to add new Specialist (e.g. new physician) in hospital and inserted within search area.
3	Add New Researcher	This module allows the admin to add new Researcher (e.g. new physician, researcher) in hospital and inserted within research area
4	Add New Research Area	This module allows the admin to add new research area and inserted within search range.
5	Add New Staff Member	This module allows the admin to add new staff member (e.g. expert in medical informatics) in hospital and inserted within search area
6	Add New Patient	This module allows the admin to add new patients in the hospital
7	staff member search	This module allows the admin to search of staff member by name, ID, department and specialist
8	patient search	This module allows the admin to search and collect data of patient by name, ID, disease, physician and department. Sharing healthcare information among hospital departments.
9	researcher search	This module allows the admin to search of researcher by name, ID, disease, department and research area.

2. Researcher view

The second type of users is researchers. Researchers have limited modules to search for patient, physician, and departmental data, as well as research areas, and then generate a report based on the search selected criteria. Healthcare information in this unit is based on privacy preservation using the K-anonymization model, as mentioned in (Chapter 2, Section 2.7) with regard to patient data. Figure 6.11 shows the interface layout of the researcher login page; Figure 6.12 depicts the interface layout of the researcher main menu page.

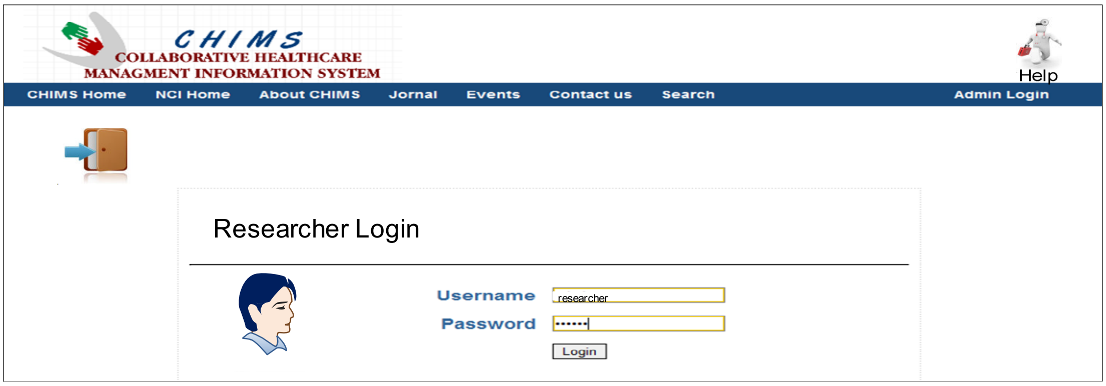


Figure 6.11: Interface Layout of the Researcher Login Page

Figure 6.12: Interface Layout of the Researcher Main Menu Page

Report Generator Module: Once the researcher logs into the system, the user can readily navigate around the page to update and view information. Figure 6.13 provides a screenshot view of the report generator module, where researchers can generate reports based on search selected criteria. The CHIMS can be used to search for patient, physician, and departmental data, as well as research areas. The system displays information on all medical staff, departments, physicians, and research areas available in the hospital system. The researcher can export data once the search results are shown. Figure 6.13 depicts the report generator module.

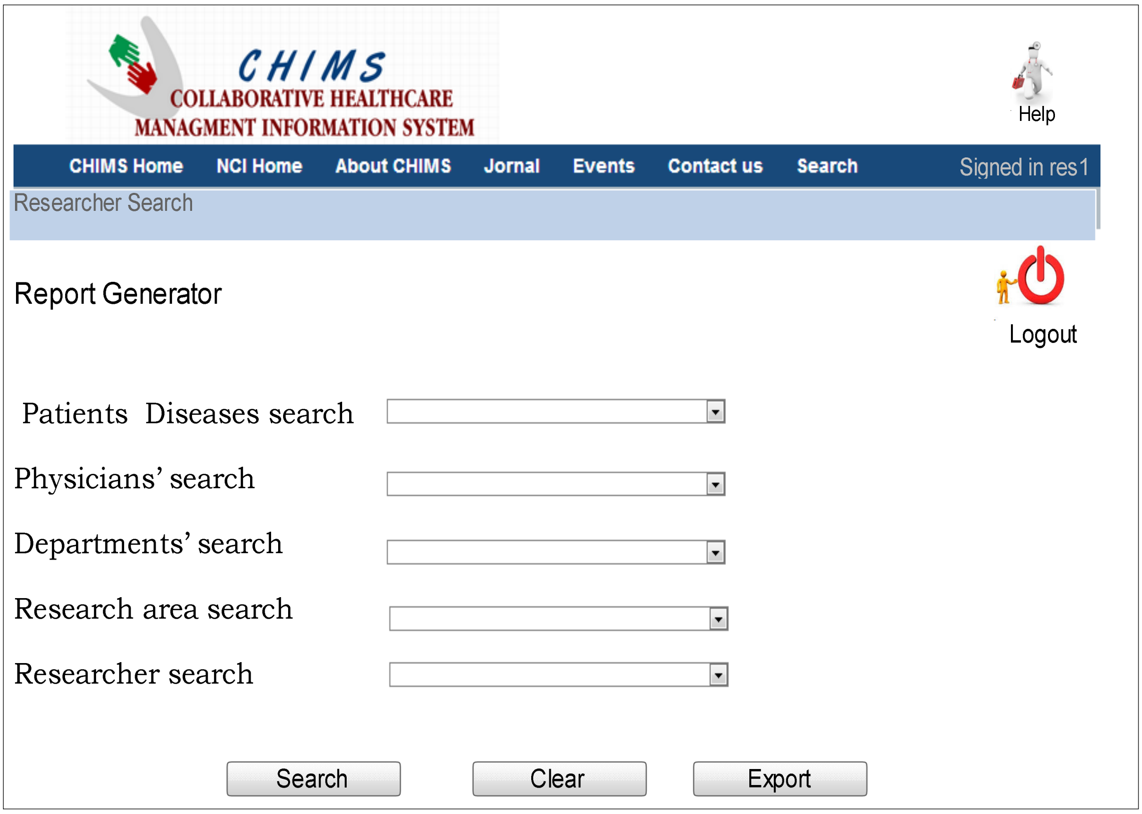


Figure 6.13: Interface Layout of the Researcher Report Generator Module

As shown in Figure 6.13, the generator module in CHIMS allows medical staff to search, collect, and export healthcare information from a centralized database (collect data from different hospital departments), sharing this information with other physicians and researchers based on privacy preservation using the k-anonymization model to achieve collaboration in research. The CHIMS provided researchers a version of healthcare information for the research studies based on the privacy preservation of a patient's information. This feature is non-existent in current HIS systems in the selected Egyptian hospital (see Section 4.3.1 in Chapter 4). Sharing data from different hospital departments with other physicians and researchers based on privacy preservation improves collaboration in research, which makes the data-sharing easier among physicians and researchers and at same time ensures the privacy preservation of patient information.

6.4 CHIMS Testing

Software testing is a process or a series of processes designed to ensure that the computer code does what it was designed to do and that it does not do anything unintended. Software should be predictable and consistent, thus providing no surprises to users (G. J. Myers, Sandler, & Badgett, 2011). Moreover, testing is an important phase in any software development project. It ensures that the software developed performs its tasks in a predictable manner. Testing also ensures that the requirements have been fulfilled.

The CHIMS initially underwent a testing procedure, and was then evaluated by potential users. The testing was necessary to control the quality of the system and determine whether or not the system can handle real applications. The testing primarily aims to ensure that the program and its resulting components fulfilled the requirement specification and eliminated errors (Kit & Finzi, 1995). Thus, a systematic test procedure was required to ensure that the system was thoroughly tested. The CHIMS system followed the classical strategy for testing software, beginning with unit testing that tests individual components independently; the purpose is to validate that each unit of the software performs as designed. Integration testing is a level of the software testing process where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units. The system is tested by incremental testing; the purpose of this test is to evaluate the system's compliance with the specified requirements. In incremental testing, small units are developed and tested before they are integrated to form a larger unit. This allows defects or errors to be discovered earlier and makes debugging easier since smaller units are tested before proceeding to larger one. For instance, the unit testing was performed in conjunction with system implementation or programming, module testing was carried out after a module had been developed, and finally, the system testing took place.

Figure 6.14 shows that the testing process starts from component unit testing, followed by integration testing, system testing, and finally acceptance testing.

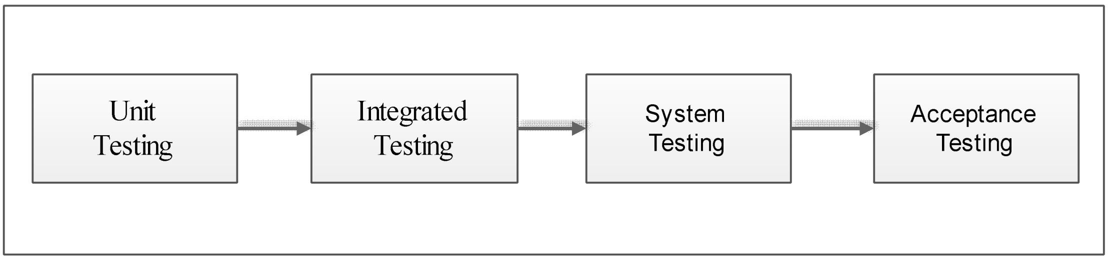


Figure 6.14: Process Flow of System Testing

The testing process is important to ensure that the system will perform appropriately without any errors upon its deployment. The testing process adopted in this study comprised of three phases, which included unit testing, module testing, and system testing. The following subsections explain the CHIMS testing process- starting from component unit testing, followed by integration testing, and finishing with system testing as presented in Figure 6.14.

1. Unit Testing

Unit testing is a process of testing individual subprograms, subroutines, or procedures in a program. That is, rather than initially testing the program as a whole, testing is initially focused on the smallest logical units of system code. The motivations for utilizing this type of testing are threefold. First, module testing is a means of managing the combined elements of testing as attention is initially focused on smaller units of the program. Second, module testing eases the task of debugging (the process of pinpointing and correcting a discovered error); when an error is found, the fact that it exists in a particular module is immediately known. In unit testing, every unit is treated as an independent unit without other system components (Sommerville & Kotonya, 1998). Unit testing is a part of white box or structural testing technique. It requires the knowledge of code and program internal structure to derive test data. The tests written based on the white box testing strategy incorporate coverage of the program code, branches, paths, statements, and internal logic of the program (Nilesh. Parekh, 2005). Errors resulted from unit testing can be logic, overload or overflow, timing, or memory leakage detection errors (Dustin, Rashka, & Paul, 1999). This is an iterative process and starts as the implementation begins since it is easier to locate and correct errors when the size of coding is still small.

Finally, module testing introduces parallelism into the program testing process by presenting us with the opportunity to simultaneously test multiple modules. Module testing aims to compare the function of a module with a certain functional or interface specification that defines the module. The goal of all testing processes is not to show that the module meets its specification, but to show that the module contradicts the specification (G. J. Myers, et al., 2011). Unit testing was done parallel to system programming. Every piece of code needs some sort of testing. Therefore, it is impossible to discuss all testing that has been conducted. For instance, Table 6.4 presents the unit testing for the login module.

Table 6.4: Unit Testing for the Login Module

No.	Test Case	Output	Analysis of the test
1	Insert user name and password	No error	Successful - User able to access to the CHIMS main menu (admin, researcher)
2	Incorrect user name or password	Error message	Login form is displayed again indicating that the unit is working well. Then, the error message comes out as ('Invalid Username or Password').

2. Module Testing

Module testing tests every system module against any defects or errors. It is performed after the completion of each system module. Module testing is needed to ensure that the module demonstrates and works according to the specification and requirements of the system. Black box, or the functional testing technique, is used to perform the module testing, and the results are validated with reference to the correlation between the inputs and outputs of each module. The black box testing strategy focuses on testing for the functionality of the program (Nilesh Parekh, 2005). Every module is tested independently. The collection of dependent components of CHIMS modules is indicated as module testing. This test aims to assess the interface and integration between the agent modules of the hospital departments and the CHIMS interface modules that comprise the entire system. For instance, Table 6.5 presents the module of administrator activities testing.

Table 6.5: Unit Testing for the Administrator Activities Module

No.	Test Case	Output	Analysis of the test
1	Add New Department	No error	Successful – This event triggers the agent to consider a new department insertion and add one to the number of departments in the hospital.
2	Add New Specialist	No error	Successful – This event triggers the agent to consider a new specialist insertion and add one to the list of specialists in the hospital and inserted within search area
3	Add New Researcher	No error	Successful – This event triggers the agent to consider a new Researcher insertion and add one to the list of Researchers in the hospital and inserted within research area.
4	Add New Research Area	No error	Successful – This event triggers the agent to consider a new research area insertion and add one to the range research.
5	Add New Staff Member	No error	Successful – This event triggers the agent to consider a new staff member insertion and add one to the list of staff within hospital.
6	Add New Patient	No error	Successful – This event triggers the agent to consider a patient insertion and add one to the number of patients list in the hospital.
7	Staff member search	No error	Successful – This event triggers the agent to search about the staff in hospital staff list.
8	patient search	No error	Successful – This event triggers the agent to search about the patient in hospital patients list.
9	researcher search	No error	Successful – This event triggers the agent to search about the researcher in the range of research area.
10	If any error occurs between the system modules	Error message	The same module is displayed with a red error message that indicates the erroneous part between the system modules.

3. **Integration Testing**

Integration testing was conducted to discover errors in complete functions and processes within and between units and to ensure that everything has been correctly linked together. The CHIMS involves subsystems that may be designed and implemented independently. Subsystem interface mismatch is often detected and rectified at this stage.

4. **System Testing**

System testing starts after all of the modules were integrated into a complete system. System testing aims to verify that the complete system successfully performs all the system functions that were discussed in the system requirements and deliverables. It also ensures that the system complies with the non-functional requirements specified. Besides that, it also tests against any possible errors that occur from inconsistent communications or interfaces between system modules. System testing is the most misunderstood and most difficult testing process. System testing is not a process of testing the functions of the complete system or program, because this would be redundant with the function testing process. In order to compare the system with its original objectives (G. J. Myers, et al., 2011), two implications emerge:

1. System testing is not limited to systems. If the product is a program, system testing is the process of attempting to demonstrate how the program, as a whole, does not meet its objectives.
2. System testing, by definition, is impossible with the absence of a set of written, measurable objectives for the product.

Upon completion of the unit, module, and integration testing, the entire system (i.e., the CHIMS) is tested in a participant hospital to ensure that the software product succeeds.

System testing can be broken down into two types, namely, security testing and performance testing.

5. Security Testing

Security Testing is a type of software testing that intends to uncover weaknesses of the system and determine that its data and resources are protected from possible intruders. The purpose of the Security testing is to verify the protection mechanism built into the CHIMS to protect the system from unauthorized users and hackers. In security testing, the user attempts to hack into the CHIMS. The user is given a user name and a password previously created by the administrator of the CHIMS in the hospital; the user cannot gain access without the appropriate user name and password.

6. Performance Testing

Performance testing is conducted to test the run-time performance of the software in the context of an integrated system. Hardware resources appear to be more important at this stage and are often necessary to measure the effectiveness of hardware utilization such as processor cycles. A higher-capacity RAM and a fast processor are essential for a system to perform well, especially for the CHIMS, because such a system works as a distributed system with multi-servers.

6.5 User Acceptance Testing

User acceptance testing, which is typically the final phase of the system testing, ensures that the product complies with user requirements. A set of input data and expected results that test the CHIMS with the purpose of causing failure and detecting faults is conducted as a test case. In this study, the medical staff of the selected hospital had the opportunity to test and evaluate the system from December 2012 to March 2013, as shown in the system evaluation in the following sections. The researcher initially informed the selected Egyptian hospital manager about the testing and evaluation of the CHIMS. Official permissions were obtained from the hospital managers.

The CHIMS was implemented for four months in the real testing stage. The evaluation process of the CHIMS aimed to measure the rate of the using CHIMS in the improvement of collaboration among physicians with regard to sharing information based on privacy preservation, such as the research activities. The evaluation process is detailed in the following sections.

6.6 Evaluation of the CHIMS

6.6.1 Method of Evaluation

In any system development, the evaluation process is essential in obtaining feedback from the right users to determine whether the system fulfils their requirements. In this study, the evaluation of CHIMS was carried out in the selected hospitals (Hospital A and Hospital B) as a case study. This evaluation was conducted to measure the rate of using CHIMS in the improvement of collaboration among physicians with regard to sharing information based on privacy preservation by using the questionnaire instrument of data collection (see Chapter 3, Section 3.3).

The results of the system evaluation are important to indicate the CHIMS evaluation rate from the perspective of participants in improving collaboration among specialists regarding the sharing healthcare information based on privacy preservation; moreover, it can assist in the detection of CHIMS flaws and problems. The CHIMS evaluation took place from December 2012 to March 2013. It was arranged in such a way that one participant evaluated the CHIMS at one time, and the evaluations were carried out in the selected hospital as case studies. The participants used the functionality of the CHIMS modules, such as the search function regarding a patient's diagnosis, to collect similar cases in the hospital that have common attributes based on privacy preservation. In addition, they can manage research and collaborate among physicians based on privacy preservation, while monitoring research and making reports. A notebook computer with the preinstalled software was used in the evaluation to avoid the occurrence of the network reliability problem.

In order to evaluate CHIMS, 60 participants volunteered in the system evaluation process within the selected Egyptian hospitals. The evaluation was conducted at a convenient time for the participants, due to the difficulty of gathering all participants at the same time for the prototype evaluation. The evaluation procedure took 15 to 30 minutes for each participant. The researcher was able to collect 50 questionnaires, which were then checked for completeness (i.e., whether all questions had been answered). The results of this process are detailed in the following subsections.

6.6.2 Results of the Evaluation of CHIMS: Section A

The first level of the evaluation looked into the demographics of the participants to obtain a better understanding of their nature, and to provide a point of comparison for future studies as shown in Table 6.6.

Table 6.6: Demographic Characteristics of the Respondents

Demographics Variables		Frequency	Percent (%)
Age	between 20 to 30	18	36 %
	between 31 to 40	18	36 %
	between 41 to 50	8	16 %
	between 51 to 60	3	6 %
	up to 61	3	6 %
	Total	50	100 %
Gender	Mala	26	52 %
	Female	24	48 %
	Total	50	100 %
Educational Background	Post-Graduate Degrees	40	80 %
	University Graduates	5	10 %
	University Student	5	10 %
	Total	50	100 %
Personnel	Healthcare Information Systems	8	16 %
	Medical	42	84 %
	Total	50	100 %
Experience with Computers	Between 1 TO 3	5	10 %
	More than 6 years	45	90 %
	Total	50	100 %
Perceived Experience	High	37	74 %
	Medium	13	26 %
	Total	50	100 %

The information in Table 6.6 shows that the demographic characteristics of the respondents, such as participants between 20 and 30 years old comprised 36%, whereas those between 31 to 40 years comprised 36%. These two groups accounted for 72% of the participants; the majority were composed of postgraduate students who commonly used information systems to conduct their research. Participants aged from 41 to 50 years old comprised 16% of the total. Moreover, 6% were aged between 51 and 60 years old. Of the total, 26 (52 %) were male and 24 (48%) were female.

The educational background of the respondents are as follows: 40 (7.40%) had postgraduate degrees, 5 (10 %) were university graduates, and 5 (10 %) were university students. These results indicate awareness in education and of the benefits of scientific research. The personnel indicate the nature of the field of work, for example, the physicians and healthcare information systems staff. The personnel of the respondents are as follows: 42 (84 %) were physicians and 8 (16 %) worked in the healthcare information systems sector. The experience with computers of the respondents is as follows: 5 (10 %) had experience in computer use between 1 to 3 years, and 45 (90 %) had more than 6 years' experience in computer use. The perceived experience levels in computer use of the respondents are as follows: 37 (74 %) of the respondents had a high level of perceived experience in computer use, and 13 (26 %) had a medium level in perceived experience.

6.6.3 Evaluation Rate of the Collaboration Among Physicians: Section B

The collaboration among physicians in sharing healthcare information among specialists based on privacy preservation was measured using a questionnaire that called for participants to self-report on their system (see Appendix F, Section B). Section B comprises 25 questions for the evaluation rate for using CHIMS in improved collaboration in sharing healthcare information among specialists based on privacy preservation. This section could be grouped into the following general themes: perceived usefulness (PU), perceived ease of use (PEOU), information quality, privacy preservation, system quality, and services quality. In this section, information on the use and evaluation rate of CHIMS in improved collaboration in sharing healthcare information among specialists based on privacy preservation were extracted from the responses of the respondents on a five-point Likert scale: (1) Strongly disagree, (2) Disagree, (3) Somewhat agree, (4) Agree, or (5) Strongly agree. Table 6.7 shows the mean level of using CHIMS in the improvement of collaboration among physicians with regard to sharing information based on privacy preservation. The result is based on the questionnaire of the user opinion on CHIMS.

Table 6.7: Mean Level of Collaboration Among Physicians Using CHIMS Based on Privacy Preservation (N=50)

Questions	**Strongly Disagree**	**Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**	**Mean (5)**
Q5	0	0	4%	22%	74%	4.67
Q21	0	0	2%	30%	68%	4.67
Q22	0	0	0	40%	60%	4.59
Q12	0	0	2%	40%	58%	4.53
Q25	0	0	2%	60%	38%	4.35
Q13	0	0	8%	50%	42%	4.31
Q1	0	0	2%	70%	28%	4.24
Q4	0	0	14%	46%	40%	4.24
Q23	0	2%	6%	60%	32%	4.2
Q2	0	0	2%	80%	18%	4.16
Q6	0	0	8%	68%	24%	4.14
Q8	0	0	8%	70%	22%	4.12
Q11	0	0	12%	62%	26%	4.12
Q24	0	0	14%	64%	22%	4.06
Q7	0	0	12%	70%	18%	4.04
Q3	0	0	16%	64%	20%	4.02
Q16	0	0	14%	74%	12%	3.98
Q17	0	0	20%	62%	18%	3.98
Q9	0	0	22%	66%	12%	3.9
Q15	0	0	22%	70%	8%	3.84
Q18	0	0	25%	64%	10%	3.82
Q14	0	2%	28%	60%	10%	3.76
Q10	0	0	34%	58%	8%	3.73
Q20	0	0	52%	26%	22%	3.69
Q19	0	2%	46%	42%	10%	3.59
Average						**4.11**

*' Strongly disagree = 1,' Disagree'=2,' Somewhat Agree'= 3, 'Agree'= 4,' Strongly agree'=5

The information in Table 6.7 shows the analysis of responses to the questions in Section B (questions which measure the rate of using CHIMS in improvement of collaboration among physicians with regard to sharing information based on privacy preservation). The questionnaire results show that the overall satisfaction of CHIMS is high. The mean responses for 25 questions ranged from 3.59 to 4.67 (the overall mean level of the collaboration among physicians using CHIMS based on privacy preservation score was 4.11) for all questions asked. This result indicates that the participants agreed that the CHIMS improves collaboration among physicians with regard to sharing information based on privacy preservation, that they found CHIMS to be easy to use, and that it saves time. Consequently, none of the questions had a mean less than the midpoint of 3.0. The analysis of responses to the questions in Section B (questions which evaluate the collaboration among physicians using CHIMS based on privacy preservation) of the evaluation questionnaire shows that the responses were positive (16 questions from 25 questions of Section B have a median of 4.0 or higher of positive responses) for all questions asked. This may indicate that the overall satisfaction of CHIMS is high, and that the user interface is clearly usable.

The 16 questions above the median all have an average mean of 4.0 or higher. These questions tend to be more concrete descriptions of the participants' experience. Participants probably perceived the ease in recognizing how the CHIMS was a part of the research environment to ascertain that it saved them time and effort in completing their work and improving collaboration in sharing healthcare information. CHIMS was helpful in order to collect data for research, and working with this CHIMS is satisfactory based on privacy preservation, as shown in Table 6.7. In this context, for example the physicians found that CHIMS allows them to collect data more quickly based on privacy preservation, with a mean level of 4.67 (which is high) (Q5 and Q21). In addition, the result from questionnaire regarding CHIMS improving collaboration in sharing information based on privacy preservation with a mean level of 4.59 is high, (Q22), and they would like to use it in the future with mean level 4.53 (Q12) this result which indicate to the overall satisfaction of CHIMS is also high and that CHIMS has a positive effect in regard to collaboration among physicians using CHIMS based on privacy preservation.

The nine questions, as shown in Table 6.7, that have a median of 4.00, and which have means from 3.59 to 3.98, tend to deal with more abstract ideas on the CHIMS. These questions include those on perceived usefulness and information quality. The statement with the lowest mean response (3.59, 3.69) was, “The system provides me with up-to-date information; the system provides reports that seem to be just about exactly what I need.” The two questions were likewise the only ones with a specifically high percentage of “somewhat agree” responses. Figure 6.15 shows the mean level of collaboration among physicians using CHIMS based on privacy preservation.

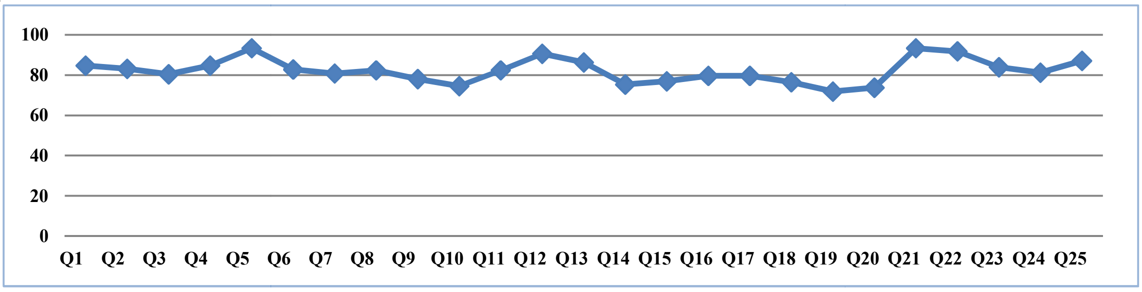


Figure 6.15: Mean Level of Collaboration Among Physicians Using CHIMS Based on Privacy Preservation

Figure 6.15 shows the high mean responses. This may indicate that the participants found CHIMS to improve collaboration in sharing information based on privacy preservation, with mean levels high, as mentioned earlier. In sum, the analysis of responses to the questions in Section B (questions which evaluate the collaboration among physicians using CHIMS based on privacy preservation) of the evaluation questionnaire shows that the responses were positive. In this context, the result of Section B of the questionnaire answers research question 5- "To evaluate the rate of the CHIMS in improved collaboration with regard to sharing health information among specialists based on privacy preservation". The result indicates that CHIMS, based on privacy preservation, improved the collaboration among physicians in sharing healthcare information.

6.6.4 Use of System: Section C

The questionnaire in Section C aimed to evaluate the functionality of the CHIMS as mentioned in (Chapter 3, Section 3.3), and was composed of seven questions pertaining to the CHIMS prototype system using a five-point Likert scale: (1) Very Poor, (2) Poor, (3) Satisfactory, (4) Good, or (5) Excellent. Table 6.8 shows the analysis of responses to the questions in Section C.

Table 6.8: Total Score for the System Use Functionality

Questions	**V. Poor %**	**Poor %**	**Satisfactory %**	**Acceptance**
Manage Research	0	6%	34%	60%
Collaboration work based PP	0	0	30%	70%
Monitor Research	0	0	32%	68%
Search	0	0	28%	72%
Report	0	0	24%	76%
View Lists	0	0	20%	80%
Export Data based PP	0	0	24%	76%
Average		**1%**	**27.4%**	**72%**

*'very poor'= 1,'poor'=2,'satisfactory'= 3, 'Acceptance (good= 4, Excellent=5)'

To get a clearer picture of the respondents' agreement on questions regarding Section C (use of system), the number of respondents who answered 'Good' or "Excellent" for a question was added together to form a single "Acceptance" category. The information in Table 6.8 shows that CHIMS was considered an acceptable application based on 72% of the responses. CHIMS was rated in the "Acceptance" category for its functionality (all participants were satisfied with the functionality of CHIMS). As such, the CHIMS generally had an appropriate functionality designed for the medical staff (as physicians and researchers) to handle the system.

6.6.5 General Comments: Section D

Questionnaire Section D indicated general comments, and was composed of four questions on the CHIMS prototype system. The first question was, “What was your overall impression of CHIMS?” The majority of participants in this survey indicated a good impression when using CHIMS. In addition, CHIMS is useful and brings many benefits to the healthcare services, especially in research activities. In this context, for example, one of the participants said, “The CHIMS system is useful in the hospital environment. This system can meet the requirements for providing and managing sharing healthcare information in research activities in a good way". Another participant said, “CHIMS saves time in collecting healthcare data to conduct researches studies. I like this system”. The third one said, "CHIMS provides a collaborative environment in sharing healthcare information and catalysing collaborative studies in research, and this system is good for hospitals". The second and third questions in Section D aimed to identify the strengths and worst features of CHIMS. The researcher listed the strengths and limitations in CHIMS of participants’ answer, as the shown in Table 6.9.

Table 6.9: Strengths and Limitations of the CHIMS

Majority of the participants in this survey indicated to strengths features of CHIMS as the following: 1) Data integration among different departments. 2) Collaboration among researchers 3) Shows the available research area 4) Provision of raw healthcare data 5) Data center 6) Issues of trust such as security and privacy 7) Web based system 8) CHIMS save time and cost 9) Export data	Majority of the participants in this survey indicated to Limitation of CHIMS as the following: 1) Provides limited functions report for researchers. 2) CHIMS needed more functions on data collection such as medical image, and videos of operations.

Finally, the researcher asked participants to give comments and recommendations (if any) that would help improve the use of CHIMS. In this context, the majority of participants recommended the integration of the CHIMS-based system with other systems in different places to increase its attributes, in order to increase the medical cases. They further suggested several added features, such as alerting features and calculation attributes for reports.

6.7 Summary

This chapter presented a detailed description of the CHIMS design, testing, and evaluation. In the CHIMS design stage, the details of the design and implementation steps for every unit and module in the CHIMS were described, and screenshots from the CHIMS modules and user interfaces were provided. The CHIMS was tested through a stringent procedure before it was released to the end users. The system underwent unit, module, integration, and system testing as a whole. Once the CHIMS was ready, it was implemented in the selected hospital in this research as a case study, and was evaluated by its physicians and researchers. A questionnaire instrument was used to evaluate system usability and the improvement of collaboration among physicians based on privacy preservation. Questionnaires were administered to 50 respondents who volunteered to participate in this study. Moreover, the respondents were able to efficiently use the modules, and the user interface design was sufficiently appropriate and functional to fulfil their requirements. In this context, the results indicate that CHIMS, based on privacy preservation, improved the collaboration among physicians in sharing healthcare information and had a positive effect on the healthcare sector.

The CHIMS was also found to require certain improvements based on the requirements of researchers and physicians. Indeed, the respondents found the system to be extremely useful, especially in the facilitation of collaborating research among researchers with regard to sharing data in order to catalyse collaborative research in the health sector based on privacy preservation. More details on the discussion, contributions, and recommendations of this study are presented in the Chapter 7.

CHAPTER 7

SUMMARY, CONTRIBUTIONS, AND FUTURE RESEARCH

7.1 Introduction

This chapter presents a summary of the research design and interpretation of the important research findings in relation to the objectives. The key findings from the previous chapter are discussed, and the recommendations derived from the findings are proposed. Several suggestions are provided for possible extensions of this study in the future. Lastly, conclusions are established to wrap up the study.

7.2 Summary of the Study

This section presents an overview of the study. The summary restates the problem, provides a brief description of how the study was conducted, and presents the major findings in relation to the research objectives

7.2.1 Overview of the Study

Health information systems (HISs) are important applications of ICT in healthcare organizations. HISs help ensure that patients immediately receive appropriate treatment. As mentioned in Chapter 2, Section 2.2, a number of studies have been conducted from 1994 to 2010 on the benefits of HISs in the healthcare sector to determine their effect on outcomes, including quality, efficiency, and provider satisfaction. In this context, Buntin and Burke (2011) summarized the findings of these studies and reported that 92% of the recent articles on health information technology have reached generally positive conclusions (Buntin, et al., 2011). Moreover, they found that the benefits of the technology begin to emerge in small practices and organizations as well as in large organizations that adopted the technology early.

The World Health Organization (WHO) (2004) mentioned that technology forms the backbone of healthcare services to prevent and diagnose illnesses, as well as treat patients. Collaboration is an important requirement in HISs; it is used to produce reliable and rigorous evidence required in making numerous critical decisions regarding healthcare services and the proper and immediate treatment of patients (Aggelidis & Chatzoglou, 2009). The collaboration among medical staff (i.e., physicians and researchers) in the healthcare sector in many developing countries, including Egypt, lacks healthcare information sharing through HISs (Blaya, et al., 2010; Braa, et al., 2007; Fraser, et al., 2005; Gaboury, et al., 2009; Heeks, 2002; Mamlin, et al., 2006; Tierney, et al., 2010; VanVactor, 2012). This deficiency is attributed to several factors, such as lack of connectivity (K. M. Adams & Corrigan, 2003; Blumenthal, 2009), lack of HIS adoption in healthcare centres (K. M. Adams & Corrigan, 2003; Blumenthal, 2009), decentralized and autonomous units that indicate the absence of shared goals (Dembo, 2010; Fried, et al., 2011), trust issues (including privacy issues), and misuse of shared data. HISs must be trusted by both the providers who use them and the patients they serve to ensure their effective implementation (Blumenthal, 2009; Goldzweig, et al., 2009). Information privacy in the healthcare sector is an issue of growing importance. The adoption of HISs and the increasing need for information among patients, providers, and payers require better information protection (Appari & Johnson, 2010; Ludwick & Doucette, 2009). The manual work system indicates that most work in healthcare centres involves the use of a paper-based system (Blumenthal, 2009; Goldzweig, et al., 2009). Consequently, the system results in poor data quality, including errors and differences in format. Medical staff (physicians and researchers) tends to work independently (Blumenthal, 2009; Dembo, 2010; Goldzweig, et al., 2009). Poorly computerized systems may result in the lack of collaboration among medical staff and consequently lead to harm on patients (M. C. Reddy, et al., 2011; Weir, et al., 2011).

Several researchers have proposed collaborative HIS models to improve the collaboration among medical staff in terms of sharing healthcare information. Healthcare information is valuable to many organizations for scientific research or analysis (L. Chen, et al., 2012). Sharing healthcare data among different organizations provides significant benefits for both medical treatment and scientific research in relevant sectors (Hillestad, et al., 2005; S. J. Wang, et al., 2003; H. Yang, et al., 2010). Healthcare data typically contains considerable amounts of private information. Sharing the data directly poses a threat to the privacy of patients. Thus, developing practical models to balance the utility of healthcare data sharing and privacy preservation is necessary (L. Chen, et al., 2012; B. C. M. Fung, et al., 2010; A. Gkoulalas-Divanis & Loukides, 2011; LeFevre, et al., 2006; B. Wang & Yang, 2011). Many models have been proposed to address the issue of privacy preservation (Chapter 2, Section 2.6); most of these models focus on a small scope of the problem and fail to improve the trade-off relation between privacy and data utility (Gao, Ma, Sun, & Li, 2013; A. Gkoulalas-Divanis & Loukides, 2011; T. Li & Li, 2009; Loukides & Shao, 2008). Aside from the difficulty in managing and controlling huge amounts of data in complex healthcare systems that wish to maintain autonomy, flexible collaborative approaches are not the norm in the development of collaborative HISs (Dembo, 2010; Skilton, et al., 2007; Skilton, et al., 2008). Most countries, including Egypt, have poor levels of collaboration in terms of information sharing in collaborative health research through HISs. Poor collaboration among medical staff can produce negative outcomes (Ridde, Robert, & Meessen, 2012). Generally, healthcare information sharing among medical staff at different places is rarely handled by collaborative HISs that are based on privacy preservation. This situation leads to a delay in the exchange of information and knowledge among healthcare practitioners, and does not help strengthen the collaboration among them within the hospital environment (Skilton, et al., 2008). CHIMS, based on the K-anonymization model, was developed in this study to preserve privacy and improve the collaboration among physicians in terms of sharing healthcare information through HISs in healthcare services, such as research activities in the selected Egyptian hospital. This study aims to create and improve a collaborative HIS among medical staff (i.e., physicians and researchers) that deals with data sharing based on privacy preservation, as well as allowing facilitates to collaborate research in the healthcare sector through the following secondary objectives.

1. Identify factors that affect technology acceptance with regard to collaboration in sharing information among specialists within the selected Egyptian hospitals based on privacy preservation;
2. Determine the main obstacles in adopting technology with regard to collaboration in sharing information among specialists within the selected Egyptian hospitals based on privacy preservation;
3. Determine the characteristics required in the developed model to improve collaboration among specialists in the field of healthcare based on privacy preservation with regard to sharing of information; and
4. Develop a CHIMS model intended to improve collaboration among specialists with regard to sharing health information.

This study employed a qualitative approach that combines observation and interview techniques for data collection. This approach was selected because of its increased popularity in the last two decades and its acceptance across a wide range of medical and health disciplines, including health services research, health technology assessment, nursing, and allied health (Mays & Pope, 2000; Pope & Mays, 2008). Reports on qualitative research in medical and health-related journals have likewise increased (Harding & Gantley, 1998). Qualitative methods can be used to understand complex social processes, capture the essential aspects of a phenomenon from the perspective of the study's participants (Malterud, 2001), and uncover beliefs, values, and motivations that underlie individual health behaviours (Berkwits & Inui, 1998; Crabtree & Miller, 1999). The research design of this study was adopted to highlight the research effort and address the research question in two stages. In the first stage, a qualitative approach that involves observation and semi-structured interviews (that included open-ended questions) was employed. In-depth interviews with 12 participants were conducted (see Appendix B), and the development of the proposed CHIMS model was outlined. In the second stage, the CHIMS model was evaluated with a questionnaire survey involving 60 participants (see Appendix F). The summary of the research design is shown in Figure 7.1. The details of the findings in relation to the research objectives are outlined in the succeeding section.

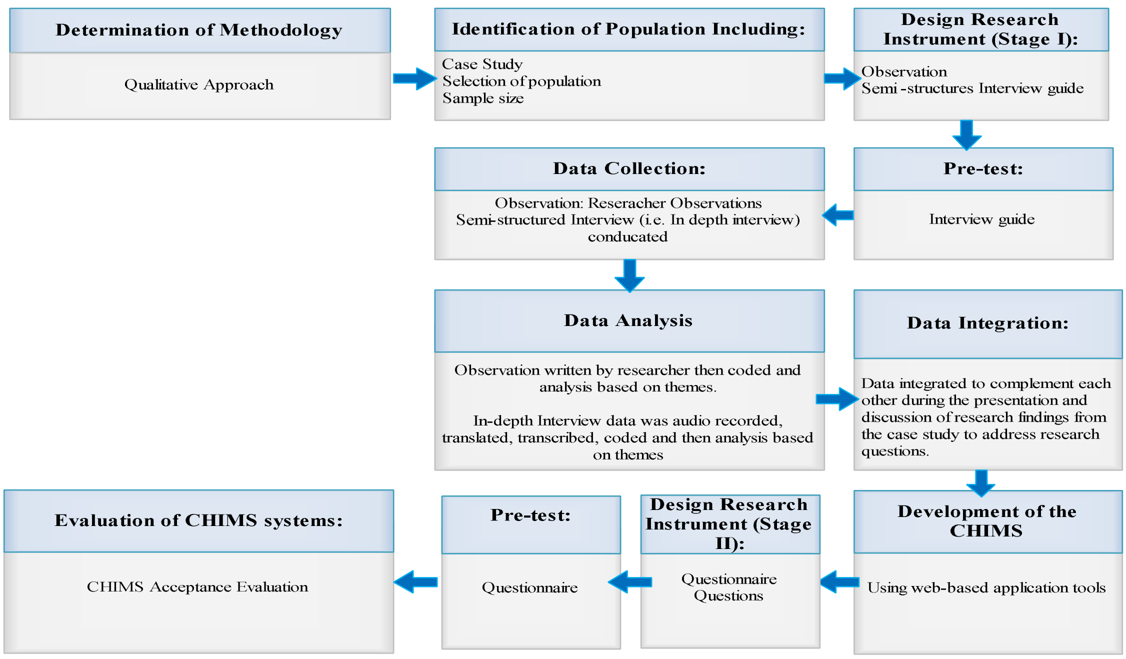


Figure 7.1: Summary of the Research Design

7.2.2 Strengths and Weaknesses of the CHIMS System

7.2.2.1 Strengths of the Proposed CHIMS System

The CHIMS efficiently provides valuable information for physicians and researchers through a flexible system structure. In addition, CHIMS, which is an integrated collaborative HIS based on the anonymization approach, was proposed after studying several collaborative HIS models (see Subsection 2.3.1 in Chapter 2). The anonymization model and its features were adopted in the conceptual framework to develop a flexible and collaborative model based on privacy preservation (see Section 2.6 in Chapter 2).

The efficiency of the CHIMS lies in its support of physicians and researchers by providing them with productive information through shared information in patient treatment and healthcare services (see Section 6.4 in Chapter 6). Through the CHIMS, physicians can acquire healthcare information from different hospital departments and use it in a research study or in any scientific purpose directly, because the information is collected based on the privacy preservation. Accordingly, CHIMS improves the collaboration in sharing healthcare information among physicians (see Section 6.6 in Chapter 6).

Many collaborative HISs have been proposed by several researchers (see Section 2.3.1 in Chapter 2). However, most of these researchers focused on the following: (1) improving collaboration among medical staff within hospital, (2) enhancing the healthcare services, and (3) improving the patient services outcomes. However, lack of the earlier research looked into achieving a collaborative HIS based on privacy preservation in regard to sharing healthcare information among physicians and researchers in research studies. The improvement of research findings by sharing healthcare information was not addressed in previous studies. Most of the earlier studies focused on patient information and information on providing better services to patients, such as patient follow-ups. However, there is a lack of research that looked at developing a collaborative HIS system model to improve research findings based on privacy preservation regarding sharing information. Therefore, the need to address such collaboration among physicians and researchers in research activities in the healthcare field based on privacy preservation is of utmost importance.

The literature review was done to identify any similar studies attempting to develop a collaborative healthcare information system that would aid in the improvement of sharing healthcare information among medical staff (physicians and researchers) based on privacy preservation. There were limited findings, because CHIMS is a new concept of a collaborative sharing of healthcare information based on privacy preservation using the k-anonymization model. As mentioned in the literature review, similar systems have not been implemented before in developing countries, especially in Egypt. In this context, many frameworks for privacy protection in information systems have been developed.

Based on the literature review, the researcher found a study by Chen (2012), who proposed a framework of privacy preserving data sharing (Lei Chen, et al., 2012). This framework offers a consistent, transparent, and replicable evaluation methodology for risk-benefit evaluation. Besides, this framework focuses on three key problems of privacy protection during data sharing, which are privacy definition and detection, privacy protection policy management, and privacy preserving health care data sharing. A simple implementation of the framework would be introduced to solve the problems of privacy-preserving electronic medical records publishing. The main contribution of the system implementation is on the privacy detection and anonymization components. The researchers developed approaches for detecting private data in EMR written in

Chinese with an accuracy rate higher than 85% on average. By using an approach implemented in the K-anonymity model, the EMR can be properly anonymized as the privacy policy requires. The system shows the idea of the framework for privacy preserving health care data sharing that could be implemented in practical way. The researchers plan to improve the framework by implementing all of the components in a more complicated application, and trying to improve the efficiency for a large dataset process. This framework was not validated yet, as mentioned in (Lei Chen, et al., 2012).

7.2.2.2 Limitation in the Evaluation of the Proposed CHIMS System

In evaluating the proposed CHIMS system, a comparative analysis with other system entities or organizations with similar systems is difficult. As mentioned in literature review (see Subsection 2.3.1 in Chapter 2), the limited similar systems have not been implemented before in developing countries, especially in Egypt. This limitation is expected because the CHIMS is a new concept of a collaborative system for sharing health information in the healthcare sector based on privacy preservation, particularly for a hospital environment. Nevertheless, the collaborative healthcare information systems in developing countries, especially in Egypt, are very limited, especially in medical research.

Nevertheless, the collaborative HISs in sharing healthcare information based on privacy preservation, especially in sharing healthcare information in medical research, have not been implemented before in developing countries, especially in Egypt. It is an obstacle to conduct a comparative analysis with other systems in Egypt. In this context, based on a literature review regarding collaborative healthcare information systems, the researcher found a similar study conducted in Iraq (2013). This study developed the Fractal-based Healthcare Information System (FHIS) model to improve cooperation among physicians in sharing information and skills within the same and between different hospitals (Nawzat S. Ahmed, 2013). The same researcher mentioned that the comparative analysis with his own FHIS and other system entities or organizations with similar systems cannot be carried out, because the FHIS is a new concept of a cooperative system for organizations, particularly in sharing healthcare information for a hospital environment (Nawzat S. Ahmed, 2013). FHIS developed, based on a fractal system, a set of self-similar agents, whose goals can be achieved through cooperation and coordination and can reorganize the configuration of the fractal system to a more efficient and effective one. The FHIS has been implemented in two hospitals to evaluate the system usability and the effect of this system in improving cooperation among physicians. The mixed method of questionnaires and semi-structured interviews were conducted in the FHIS evaluation process. Results indicated that the FHIS is satisfactory (system usability scale scores = 75.04) and the cooperation among physicians in sharing healthcare information corresponds to significant improvements in skill using a paired samples T test. In sum, the FHIS has many benefits, based on the viewpoint of physicians. In particular, the FHIS system can provide productive information, facilitate knowledge and skills among physicians, and promote cooperative sharing of information and skills within the same and between different hospitals. Nevertheless, the FHIS system sharing healthcare information among physicians is not based on privacy preservation, which is a gap in the FHIS system. In this context, the CHIMS system has been implemented in the hospital to evaluate the system acceptance and the effect of this system in improving cooperation among physicians using questionnaires. The CHIMS was found to be satisfactory as the mean level of the evaluation of the CHIMS system's acceptance was 4.11, and the scale of Cronbach's alpha score was 0.85. These results demonstrate that the combination of sharing health data based on privacy preservation through HIS improves the collaboration among medical staff and research findings. The proposed model provides a new version of the data intended for scientific research among researchers based on the preservation of privacy; this feature was not available in the FHIS system. In sum, sharing healthcare information based on privacy preservation has a positive effect on improving collaboration among physicians. Therefore, the need to address such collaboration among physicians and researchers in research activities in the healthcare field based on privacy preservation is of utmost importance. Table 7.1 shows the summary of the similar studies.

Table 7.1 Summary of the Comparative Analysis Among Similar Studies

Study	Summary
CHIMS	**a- Study Characteristics** 1- This study developed a collaborative healthcare information management system (CHIMS) prototype based on the k-Anonymization model for privacy preservation in sharing health care information in second purpose such as research. 2- This study aims to improve collaboration in the sharing of information among medical staff (i.e. physicians and researchers). 3- The CHIMS was found to be satisfactory as the mean level of the evaluation of the CHIMS the mean level collaboration among physicians using CHIMS based on privacy was 4.11 of 4.67 and the scale of Cronbach's alpha score was 0.85. 4- Country: Egypt 5- Year:2014 **b- Technique Used** K-anonymization measures privacy preservation by generalizing data and preventing re-identification. **c- System functions** 1- Developing an online collaborative process requires the provision of a centralized database to collect data from the departments of the selected Egyptian hospital based on privacy preservation using k-anonymization model. 2- The CHIMS connects the hospital departments and shares information among them in a timely manner. The information included patient data, activities of physician in patient treatment, and hospital characteristics, such as units, treatments, and available devices. This work could improve the research findings in patient treatment. 3- The following are some of the CHIMS activities: a) Provides a variety of reports that can create any required new report. b) Provides an easy-to-use report builder module to enable the system administrator to create/edit any report according to the hospital requirements. c) Offers a wide variety of queries to facilitate and speed up the work cycle and provides an ability to inquire about healthcare information via different methods. d) In addition, to security, contents, usability, and flexibility.

Table 7.1 Summary of the Comparative Analysis Among Similar Studies (Continued)

Study	Summary
(Ahmed, 2013)	**a- Study Characteristics** 1- This study developed the Fractal-based Healthcare Information System (FHIS) model in sharing information and skills within same and between different hospitals. 2- This study aims to improve cooperation among physicians in sharing information and skills within same and between different hospitals. 3- Results indicated that the FHIS is satisfactorily (system usability scale scores = 75.04). 4- Country: Iraq 5- Year:2013 **b- Technique Used** Fractal Approach in sharing information and skills within same and between different hospitals. **c- System functions** Functional requirements include the creation of a good HIS in the hospital for recording the patient information and the physician information and connecting these HISs among hospitals through research and development units.
(Chen, Yang, Wang, & Niu, 2012)	**a- Study Characteristics** 1- This study proposed a framework of privacy preserving data sharing. This framework offers a consistent, transparent and replicable evaluation methodology for risk-benefit evaluation. Besides, this framework focuses on three key problems of privacy protection during data sharing which are privacy definition and detection, privacy protection policy management, privacy preserving health care data sharing. 2- This study aims to improve sharing healthcare information in hospital environment using electronic medical record EMR. 3- The researchers develop approaches for detecting private data in EMR written in Chinese with accuracy rate higher than 85% on average. 4- Country: China 5- Year:2012 **b- Technique Used** K-anonymization model. **c- System functions** The researchers develop approaches for detecting private data in EMR written in Chinese with accuracy rate higher than 85% on average. And by using an approach implemented K-anonymity model, the EMR can be proper anonymized as the privacy policy requires. The system shows the idea of the framework for privacy preserving health care data sharing could be implemented in practical way. The researchers plan to improve the framework by implemented all the components in a more complicated application and try to improve the efficiency for large dataset process.

7.2.3 Discussion of the Findings

This section presents the findings of this study in relation to the four major research questions. These findings are subject to research limitations. Recommendations regarding the key findings are provided.

I. Identify factors that affect technology acceptance with regard to collaboration in information sharing among specialists within the selected Egyptian hospital based on privacy preservation.

This section presents the findings related to the first research objective, which in turn answers the first research question. Findings from the literature review and in-depth interviews revealed a lack of collaboration among medical staff in terms of information sharing in collaborative health research. Studies (K. M. Adams & Corrigan, 2003; Appari & Johnson, 2010; Blumenthal, 2009; Dembo, 2010; Garets & Davis, 2012; A. Gkoulalas-Divanis & Loukides, 2011; A. Gkoulalas-Divanis & Verykiosc, 2009; Goldzweig, et al., 2009; Ludman, et al., 2010; Ludwick & Doucette, 2009; Parmar, et al., 2011; B. Wang & Yang, 2011) have indicated that weak collaboration, particularly in healthcare information sharing through computerized systems, is prevalent among medical staff in numerous developing countries. This weakness is due to many factors that were collected from the recent studies (see Section 2.3 in Chapter 2). These factors are as follows:

1. The first factor is having decentralized, autonomous units, and a lack of shared goals, which is common among a number of healthcare systems. Many HISs are isolated from one another because of the fragmented nature of healthcare systems.

2. Second, the lack of connectivity indicates a lack of HISs adoption in healthcare centres.
3. Third, the physical work system requires that most work in healthcare centres be founded on paper-based systems, which is common among a number of developing countries, such as Egypt.
4. Fourth, medical staffs are forced to work independently because of the large number of patients.
5. Fifth, the socio-technical challenges faced by several health workers also play an important role in the healthcare field. Therefore, many developing countries need to introduce information technologies and effective collaboration into their healthcare systems (Mengiste, 2010).
6. Sixth, issues of trust, security, and privacy concerns serve important functions in the adoption and acceptance of HISs in healthcare sectors.
7. Seventh, logistics of implementation include low budget, low technology setting, and crowded and busy hospitals.
8. Eighth, data management is poor, which is due to a lack of high efficiency computer systems, lack of available high speed internet, absence of remote access to computers, and absence of institutional servers with automatic backups.
9. Ninth, training issues: Obstacles exist, such as visa issues between different countries and difficulty of agreeing on one place and time where collaborators can leave their routine hospital work.
10. Tenth, regulatory requirements: this refers to collecting approval from IRBs at different sites to conduct study.

The researcher observed that most of the work in the selected Egyptian hospital is performed with paper-based systems. The specialists in the selected Egyptian hospital work independently because of the time factor and a poor HIS in the hospital. A manual system of healthcare management is employed; this system makes paper-based information difficult to manage, control, and share. Consequently, the collaboration among specialists in terms of sharing healthcare information through HISs is weak. To identify the factors that affect technology acceptance with regard to collaboration in healthcare information sharing among specialists in the selected Egyptian hospital, data was analysed through a coding process and then categorized. The categories are as follows: ability and skill, management, time, age, culture, and poor technological infrastructure. These categories could directly or indirectly affect technology acceptance with regard to collaboration in healthcare information sharing among specialists in the selected Egyptian hospital (see Table 5.2.).

By contrast, the findings from the interview revealed a set of factors that may affect the acceptance and adoption of technology in the healthcare sector. These factors were analysed and grouped into nine categories, namely, ability and skill, management issues, time, age, culture, poor technological infrastructure, perceived usefulness (PU), perceived ease of use (PEOU), and privacy and security concerns (see Table 5.4).

Based on the answers of the participants, privacy concerns are an important issue that affects technology acceptance in healthcare information sharing. These concerns include lack of technological expertise (resulting in wariness about the use or misuse of technology), fear of misuse of personal and official records (which causes the medical staff to refrain from recording and sharing details in the HISs), mistrust of parties that share the data, lack of a law or convention for the protection of medical data, lack of confidence in the use of HISs, lack of protocol for the protection of confidentiality and privacy when using medical data systems, violation of the use of personal data, lack of rules on the use and sharing of medical data to ensure confidentiality and privacy, and the use of medical and personal data available through the HISs for non-scientific purposes. In addition, the management issue affects the adoption and acceptance of HIS within the selected healthcare organization. Management factors include lack of time management, lack of medical informatics/information system staff, limited HIS activities, complexity of work through HISs, lack of technological proficiency, overloading of tasks for each employee, and dependence of most work in the selected Egyptian hospital on a paper-based system. Furthermore, the poor technological infrastructure affects technology acceptance and sets off obstacles, such as the weak technological infrastructure and distributed systems, system complexity, poor computer-based systems, lack of a system for managing research, lack of accuracy in the medical data, and difficulty in implementing healthcare activities. Aside from the cultural issue that most participants stated, the other issues in this context are lack of an appropriate environment, paper-based work systems, weak technological infrastructure, limited HIS functions, and weakness in adopting HISs in the selected Egyptian hospital. The effect of PU on collaboration in healthcare information sharing in this context contributes to technology acceptance; factors, such as HISs, limited functionality, poor computer-based systems, lack of accuracy in the medical data, and absence of HISs in the hospital affect collaboration in terms of information sharing among medical staff. PEOU, including the complexity of systems, makes systems difficult to use and implement in research activities. These factors also affect collaboration in healthcare information sharing based on the responses of the participants in the interviews. In addition to security concerns, such as ensuring confidentiality and privacy of data and staff, “lack of control in managing HISs” also indicates poor computer-based systems. Time and age factors, including the time contract and the adoption of a paper-based system for quick processing, likewise affect technology acceptance with regard to collaboration in healthcare information sharing among specialists in the selected Egyptian hospital (refer to Table 5.5).

II. Determine the main obstacles in the adoption of technology with regard to healthcare information sharing among medical staff within the selected hospital based on privacy preservation.

The findings for factors that affect the acceptance and adoption of technology in the healthcare sector indicate that these factors act as obstacles that affect the collaboration among medical staff within the selected Egyptian hospital. Key obstacles were derived after analysing each data interview, where the interviewees stated particular issues frequently. The key obstacles consist of several points, as mentioned in the responses, in observations and in interviews. The largest number of responses was on poor technological infrastructure, including attitudes about technology PU and PEOU, management issues, privacy concerns, and culture, with regard to the behaviour of people (participants) in the organization (selected hospital) and their attitudes (see Tables 5.2 and 5.3). Table 5.6 shows the levels of key obstacles in the selected Egyptian hospital as stated in observations and interviews. Additional details on these factors can be found in (Chapter 5, Section 5.4).

III. Determine the characteristics required in the developed model to improve collaboration among specialists in the field of healthcare based on privacy preservation regarding the sharing of information.

This section presents the findings related to the third research objective, which answers the third research question. The findings are based on the literature review. Many studies have reported that the k-anonymity model provides a formal means of generalizing this concept because it provides a measure of privacy protection by preventing the re-identification of data to fewer than a group of k-data items (Bayardo & Agrawal, 2005b; Campan & Truta, 2009; El Emam, et al., 2012; El Emam & Dankar, 2008b; El Emam, et al., 2009; Goryczka, et al.; Wei Jiang & Chris Clifton, 2006;

Jurczyk & Xiong, 2009; LeFevre, et al., 2005; Parmar, et al., 2011; Sacharidis, et al., 2010; Sokolova, et al., 2012; Sweeney, 2002a, 2002c; Tassa & Gudes, 2012; Truta & Vinay, 2006). Several studies have indicated that a data record is k-anonymous if and only if it is indistinguishable in its identifying information from at least k-specific records or entities (Pierangela Samarati, 2001; Sweeney, 2002a, 2002c). The key step in making data anonymous is to generalize a specific value. Generalized data can be beneficial in several situations (W. Jiang & C. Clifton, 2006). A number of applications utilize generalized data in various areas, such as medical research, education studies, and targeted marketing. The succeeding section outlines the main features of the k-anonymity model based on the literature review. The k-anonymization model, which has been the focus of a number of studies (Barak, et al., 2007; Chiu & Tsai, 2007; Wei Jiang & Chris Clifton, 2006; Morton, et al., 2012; Narayanan & Shmatikov, 2009; Pierangela Samarati, 2001; Sweeney, 1997; Sweeney, 2002a, 2002c), is a simple and effective model that can maximize data utility while limiting the disclosure risk to an acceptable level, and guaranteeing that the data generated is accurate.

IV. Develop a CHIMS model intended to improve the collaboration among medical staff with regard to the sharing of information in collaborative research based on privacy preservation.

The conceptual framework of integrated collaborative HISs based on the anonymization approach was proposed after studying several collaborative HIS models. The anonymization model and its features were adopted in the conceptual framework to develop a flexible and collaborative model based on privacy preservation. The findings from in-depth interviews were used as user requirements in the construction of the CHIMS model. This model aims to provide a means for medical staff (physicians and researchers) to collaborate in sharing healthcare information in research activities. This section achieves the fourth research objective and answers the fourth research question.

The functional requirements of the CHIMS model proposed in this study were extracted from the viewpoint of the physicians who participated. These functional requirements include the creation of a good HIS to improve healthcare services in the hospital and establish a connection between hospital departments in terms of sharing healthcare information. The concept of “integrated healthcare systems” was cited as satisfactory by most participants. All respondents agreed that the use of HISs in the research unit at the hospital is important in enhancing the collaboration among researchers by sharing data to improve research findings in the healthcare sector. By establishing a collaborative healthcare system to share healthcare information in research, this system connects all hospital departments to improve the collaboration among specialists and the research findings.

The elements of HISs required by physicians are patient (i.e., personal information, examinations, diagnosis, and treatment) and physician (i.e., personal information and research area) information. Information among researchers required by physicians includes the activities of physicians in patient treatment (i.e., patient details, examination results, and diagnosis) and hospital characteristics, such as units, treatments, and available devices. Generally, the goal of these requirements is focused on the issue of collaboration among researchers (i.e., physicians) in sharing information within the same hospital and with different ones to improve research findings and the experiences of physicians. The results of the development of collaboration in the HIS environment based on privacy preservation indicate the following points:

1. An online collaborative process should be developed to provide a centralized database for data collection from the departments of the selected Egyptian

hospital based on privacy preservation. Such a system should have an open, flexible, and cooperative structure to improve cooperation among physicians in sharing information within the hospital.

2. The functional requirements of the CHIMS model proposed in this study were extracted from the viewpoint of the participants. CHIMS connects the hospital departments and facilitates and helps to share information among them in a timely manner. The shared information includes patient data, activities of physicians in patient treatment, and hospital characteristics, such as units, treatments, and available devices. This work can improve research findings on patient treatment. The following are some of the system activities.
    a. Authentication, Authorization, Access Control and Identification.
    b. Reporting and Queries.
    c. Integration.
    d. Audit Logs and Monitoring of Workarounds.
    e. Personal Health Information, Patient Privacy, and Confidentiality.

A number of non-functional requirements were set for the proposed system, such as the security process of the system, which is important in preventing unauthorized users from accessing any part of the system. System users have usernames and passwords provided by an authorized person (administrator) to enable them to access the system. The contents of the system only cover two types of information on the selected Egyptian hospital. The first type covers general information on the selected Egyptian hospital. The second type of information includes administrator and researcher information. The third type indicates usability and thus implies that the system should be convenient and practical. Ease-of-use requirements address the factors that constitute the capacity of the software to be understood, learned, and used by its intended users. The last non-functional requirement includes the flexibility of this process, which is

essential to the system development of CHIMS based on environmental requirements, especially the requirements of physicians in collaboration issues. Such a system can increase or extend the functionality of the software based on the new requirements (refer to Appendix G).
The CHIMS model initially underwent testing and was evaluated by potential users. Testing was necessary to control the quality of the system and determine whether the system can handle actual applications. The testing process began with component unit testing followed by integration and system testing (see Figure 6.14).

CHIMS was evaluated to assess its acceptance and the improvement of collaboration among physicians with regard to sharing information based on privacy preservation. The results of the system evaluation are important to indicate whether the system is accepted from the perspective of participants with regard to improving the collaboration among specialists in sharing healthcare information in research. Moreover, the evaluation can assist in the detection of the flaws and problems of CHIMS. 60 participants volunteered in the system evaluation within the selected Egyptian hospital. Evaluation was conducted at a time that was convenient for the participants because of the difficulty of gathering all participants at the same time for the prototype evaluation. The researcher collected 50 questionnaires, and the questionnaires were checked for completeness (i.e., whether all questions were answered). The results of this process are detailed in the succeeding section.

Section B of the questionnaire regarded the level of collaboration among physicians using CHIMS based on privacy preservation. The questionnaire results showed that the overall satisfaction of CHIMS is high. The mean responses for 25 questions ranged from 3.59 to 4.67 (the overall mean level of the collaboration among physicians using CHIMS based on privacy preservation score was 4.11) for all questions asked. This result indicates that the participants agreed that CHIMS improves collaboration among physicians with regard to sharing information based on privacy preservation, that they found CHIMS easy to use, and that it saves time. Consequently there are no questions that had a mean less than the midpoint of 3.0. The analysis of responses to the questions in Section B (questions which evaluate the collaboration among physicians using CHIMS based on privacy preservation) of the evaluation questionnaire shows that the responses were positive (16 questions from 25 questions of Section B have a median of 4.0 or higher where respondents rated positive) for all questions asked. This may indicate that the overall satisfaction of CHIMS is high, and that the user interface is clearly usable.

Consequently, no questions had a mean less than the midpoint of 3.0. All 16 questions above the median have an average mean of 4.0 or higher. These questions are concrete descriptions of the experience of the participants. Participants probably recognized CHIMS as a part of the research environment to conclude that it saves them time and effort in completing their work and improving collaboration in sharing healthcare information. CHIMS might have been perceived as helpful in collecting data for research. The participants may have also considered working with CHIMS as satisfactory based on privacy preservation (see Table 6.7). The nine questions shown in Table 6.7 have a median of 4.00 and means ranging from 3.59 to 3.98; the questions deal with more abstract ideas on CHIMS. These questions include those on perceived usefulness and information quality. The statements with the lowest mean response (3.59 and 3.69) are “the system provides me with up-to-date information” and “the system provides reports that seem to be just about exactly what I need.” These two statements are the only ones with a specifically high percentage of “somewhat agree” responses. Figure 6.15 shows that the high mean responses may indicate that the participants found CHIMS to improve collaboration in sharing information based on privacy preservation.

CHIMS was considered accepted by 72% of the participants (see Table 6.8). CHIMS was rated “accepted” for its functionality (all participants are satisfied with the functionality of CHIMS). CHIMS generally has an appropriate system functionality designed for medical staff, such as physicians and researchers. In sum, the analysis of responses to the questions in Section B, which evaluate the collaboration among physicians using CHIMS based on privacy preservation, shows that the responses were positive.

7.3 Contributions

The major contribution of this study can be assessed from two perspectives, namely, theoretical and practical. The following sub-section elaborates each contribution.

7.3.1 Theoretical Contribution

The collaboration among medical staff (i.e., physicians and researchers) of the healthcare sector in many developing countries, including Egypt, lacks healthcare information sharing through HISs. This deficiency indicates the lack of technology acceptance in the healthcare sector because of different factors (refer to Chapter 2, Section 2.3 and 2.4). Recent studies have directed their attention toward studying the issues of trust and their effect on collaboration among medical staff. These studies have indicated that privacy concerns are highly relevant to improving the collaboration among medical staff through HISs. For HISs to be implemented effectively, these systems must be trusted by the providers who use them and the patients they serve (Blumenthal, 2009; Goldzweig, et al., 2009). In this context, numerous collaborative HISs models have been proposed to improve collaboration among medical staff regarding healthcare information sharing (see Chapter 2, Sub-Section 2.3.1 and Section 2.6). Most of these models focus on a small scope of the problem and fail to improve the trade-off relation between privacy and data utility. No collaborative HIS model has been developed to improve collaboration in sharing healthcare information in research based on privacy preservation in the healthcare sector.

The main contribution of this study is the use of the k-anonymization model in the development of a flexible collaborative HIS model (i.e., CHIMS). The main goal of this model is to improve the collaboration among medical staff in sharing information within the same or different hospitals to enhance healthcare services provided to the patients. The CHIMS model was mainly developed by referring to the k-anonymity system proposed by Sweeney (2002), which relies on the generalization technique to preserve privacy. K-anonymity is a simple and effective model that can maximize data utility while limiting the disclosure risk to an acceptable level and guaranteeing that the data generated is accurate.

This study also contributes by identifying the factors that might affect collaboration in healthcare information sharing among medical staff (i.e., physicians and researchers) using HISs. These factors include ability and skill, management issues, time, age, culture, poor technology infrastructure, perceived usefulness (PU), perceived ease of use (PEOU), privacy concerns, and security concerns. Most of these factors were confirmed by recent studies. New factors were discovered through this research from the data collected that might affect on collaboration in healthcare information sharing among medical staff. These factors include ability and skill, management issues, age, PU, and PEOU. Moreover, privacy concerns are highly relevant to collaboration in sharing healthcare information. This study also indicated that these factors act as obstacles that affect the collaboration among medical staff within the selected Egyptian hospital. The key obstacles consist of several points, as mentioned in the responses, in observations, and in interviews with regard to the factors that affect technology acceptance. The largest number of responses was on poor technological infrastructure, including attitudes about technology PU and PEOU, management issues, privacy concerns, and culture, with regard to the behaviour of people in the organization and their attitudes. This study also contributes by identifying the factors that might improve collaboration in healthcare information sharing among medical staff (i.e., physicians and researchers). These factors include PU, PEOU, privacy, system quality, information quality, quality of services, and net benefits (refer to Chapter 5, Table 5.8).

The requirements of the CHIMS model were developed based on k-anonymity features. The findings from interviews regarding medical staff requirements in sharing healthcare information were applied in the development of CHIMS to improve collaboration in sharing healthcare research information among medical staff. The CHIMS model consists of four phases. The first phase involves collecting data from a different health information system and sending it to the central database. The second phase involves data pre-processing, such as identification of missing values and inconsistent data, data integration, data selection, and data transformation. The third phase involves data processing based on the anonymization engine, which implements an anonymization operation based on data generalization and entails "a strategy for protecting individual privacy in released microdata records." The final phase involves data sharing among researchers based on privacy preservation. The idea is that by reconstructing a more "general" and semantically consistent domain for the attributes and transforming its values to this domain, identifying individuals by linking this attribute with external data would become more difficult. From the information communications technology perspective, CHIMS construction was developed based on an agent-based technique. The CHIMS modules were linked in different departments at hospitals through Web-based application tools. CHIMS was used as an information system for catalysing collaborative research among medical staff (physicians and researchers) based on privacy preservation to improve health research findings and healthcare services. No other study utilized the anonymization approach in the development of a collaborative HIS model with regard to collaborative healthcare information in research in the healthcare sector (i.e., hospitals). Hence, the CHIMS model can be a primary collaborative model in the provision of an open, appropriate, flexible, and collaborative HIS environment based on privacy preservation.

7.3.2 Practical Contribution

The development of a CHIMS prototype is a significant contribution of this study. The CHIMS model is proposed to provide an integrated collaborative HIS environment that improves collaboration among researchers in the medical sector in terms of sharing medical data based on privacy preservation in collaborative research within the healthcare environment. This model aims to improve the findings of medical research and subsequently enhance the treatment of patients and healthcare services. CHIMS was developed based on the k-anonymization model and its features that link system units. This system was selected to provide an appropriate, open, flexible, and collaborative system environment based on privacy preservation. CHIMS consists of centralized and anonymization process units that retrieve data to provide the necessary information to researchers. Therefore, CHIMS is designed based on Web applications to manage and control healthcare information and to quickly and accurately disseminate this information among researchers within the same hospital and among different ones. CHIMS can provide and allow for the sharing of productive information among researchers to improve and support research based on privacy preservation. Thus, CHIMS can be improved to promote collaboration among medical staff (physicians and researchers) within the hospital environment and enhance healthcare services, such as research by physicians and researchers. The promotion of favourable cooperation among physicians in sharing healthcare information through CHIMS was customized to suit the Egyptian hospitals and cancer centres in particular. The limitations of this study are outlined in (Chapter 1, Section 1.7).

7.4 Recommendations for Future Research

A wide range of studies was explored during the course of this research; however, these studies were excluded from this dissertation because of the limitations in the length and scope of the thesis. Nevertheless, the benefits of such literature survey became very apparent, particularly toward the end of this study. Thus, we recommend that the following points be explored in future research.

1. The CHIMS model requires the provision of integrated healthcare information, including patient information and multimedia information on patients, among different hospitals for physicians based on privacy and security rules. Thus, the CHIMS model can be extended to provide more patient details for each healthcare organization.
2. Administrative and financial issues should be considered to ensure the adequate implementation of the CHIMS model in government and private hospitals. These issues can be considered to encompass other hospital activities, which can be useful in enhancing healthcare services within the hospital.
3. The role of research range in the CHIMS model should be broadened to provide integrated patient information among different hospitals. This integration will support research in different hospitals and improve findings. In such expansion, the research agent must consider the privacy of patient information, which will be distributed to different physicians among different hospitals, and the different formats of health data.
4. Data mining techniques should be applied in the medical database. Medical data mining involves the use of various data mining techniques, particularly in

medical applications. Various medical data is collected and stored in a repository. This data is used for various techniques and tasks. Among the techniques used are statistical techniques, neural network, rough set theory, and hybrid techniques. In medical research, new algorithms are introduced and embedded in the medical diagnostic system to support the research findings.

5. The implementation of the CHIMS model in different government hospitals in Egypt should be conducted with different software platforms and data models to enable the development of collaborative health systems.

7.5 Conclusion

Healthcare systems in most developing countries, including Egypt, face multiple challenges in improving and ensuring quality healthcare services, such as research activities within the hospital. The hospital environment lacks the acceptance of healthcare technology, particularly in the collaboration among physicians in sharing healthcare information through HISs. Thus, sharing and using healthcare data directly as the hard copy in research studies by physicians violates the privacy of patients. Furthermore, current healthcare services, especially in research, in Egyptian hospitals are very limited and involve a complex process in sharing and using healthcare information. Consequently, immediate and effective action is required to improve technology acceptance and use by physicians. HISs play an important role in providing healthcare information to physicians; thus, HISs serve as a significant factor in developing collaboration among physicians with regard to sharing healthcare information in research based on privacy preservation (Malin, El Emam, & O'Keefe, 2013; Ohno-Machado et al., 2012; K. S. Reddy et al., 2011). A successful model largely depends on the access of physicians to appropriate, flexible, and comprehensive healthcare information based on their requirements (Skilton, et al., 2008). CHIMS serves as a starting point for the expanded development of a viable model that facilitates health-information sharing to improve collaboration among medical staff and health research findings in Egypt. Finally, CHIMS provides concrete support for the application of collaboration and information in the health sector to catalyse collaborative healthcare information in research through HISs to improve research findings.

REFERENCES

Abdullah, R., Selamat, M. H., Sahibudin, S., & Alias, R. A. (2005). A framework for knowledge management system implementation in collaborative environment for higher learning institution. Journal of Knowledge Management Practice, 6(1).

Abu-Dalbouh, H. M. (2013). A Questionnaire Approach Based on the Technology Acceptance Model for Mobile Tracking on Patient Progress Applications. Journal of Computer Science, 9(6), 763.

Act, A. (1996). Health insurance portability and accountability act of 1996. Public Law, 104, 191.

Act, F. C. R. (1970). Fair Credit Reporting Act. Flood Disaster Protection Act and Financial Institute.

Adam, N. R., & Worthmann, J. C. (1989). Security-control methods for statistical databases: a comparative study. ACM Computing Surveys (CSUR), 21(4), 515-556.

Adams, D. A., Nelson, R. R., & Todd, P. A. (1992). Perceived usefulness, ease of use, and usage of information technology: a replication. Mis Quarterly, 227-247.

Adams, K. M., & Corrigan, J. (2003). Priority areas for national action: transforming health care quality: Natl Academy Pr.

Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: cognitive absorption and beliefs about information technology usage 1. Mis Quarterly, 24(4), 665-694.

Aggarwal, C. C., & Philip, S. Y. (2008). A general survey of privacy-preserving data mining models and algorithms: Springer.

Aggelidis, V. P., & Chatzoglou, P. D. (2009). Using a modified technology acceptance model in hospitals. International Journal of Medical Informatics, 78(2), 115.

Agrawal, R., Evfimievski, A., & Srikant, R. (2003). Information sharing across private databases. Paper presented at the Proceedings of the 2003 ACM SIGMOD international conference on Management of data.

Agrawal, R., Kiernan, J., Srikant, R., & Xu, Y. (2002). Hippocratic databases. Paper presented at the Proceedings of the 28th international conference on Very Large Data Bases.

Ahmad Samir AlFaar, M. S. B., Mohamed Kamal, Sameera Ezzat, Iman Zaky, Hala Taha, Amr Ismail, Sherif Abouelnaga. (2014). Accelerating innovation in outcomes and quality-of-care research through integrating clinical databases: Pediatric oncology experience in Egypt. (Abstract). (e17573). Retrieved 25 August 2014, from Journal of Clinical Oncology (ASCO - JCO) http://meetinglibrary.asco.org/content/125502-144

Ahmed, N. S. (2013). A Fractal-Based Model to Improve Cooperation among Physicians in Distributed Healthcare Information Systems. PhD, University Of Malaya Kuala Lumpur

Ahmed, N. S., & Yasin, N. M. (2012). Improvement the Cooperation Feature in Distributed Healthcare Information Systems Based on the Fractal Approach: An Empirical Study. Advanced Materials Research, 463, 861-867.

Aknine, S., & Aknine, H. (1999). Contribution of a multi-agent cooperation model in a hospital environment. Paper presented at the Proceedings of the third annual conference on Autonomous Agents.

Al-Busaidi, Z. Q. (2008). Qualitative research and its uses in health care. Sultan Qaboos University Medical Journal, 8(1), 11.

Al-Khawlani, M. A. A. (2009). A web-based integrated health care management system.

Al-Yaseen, H., Al-Jaghoub, S., Al-Shorbaji, M., & Salim, M. (2010). Post-Implementation Evaluation of HealthCare Information Systems in Developing Countries. Electronic Journal Information Systems Evaluation Volume, 13(1), 9-16.

Alavi, M., & Carlson, P. (1992). A review of MIS research and disciplinary development. Journal of Management Information Systems, 45-62.

Ammenwerth, E., Brender, J., Nykänen, P., Prokosch, H.-U., Rigby, M., & Talmon, J. (2004). Visions and strategies to improve evaluation of health information systems: Reflections and lessons based on the HIS-EVAL workshop in Innsbruck. International Journal of Medical Informatics, 73(6), 479-491.

Ammenwerth, E., Iller, C., & Mahler, C. (2006). IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study. Bmc Medical Informatics and Decision Making, 6(1), 3.

Ann Lewins, C. T. a. G. R. G. (2010). What is Qualitative Data Analysis (QDA)? Retrieved 22 August 2014, from University of Huddersfield and University of Surrey http://onlineqda.hud.ac.uk/Intro_QDA/what_is_qda.php

Appari, A., & Johnson, M. E. (2010). Information security and privacy in healthcare: current state of research. International journal of Internet and enterprise management, 6(4), 279-314.

Armer, J. M., Harris, K., & Dusold, J. M. (2004). Application of the concerns-based adoption model to the installation of telemedicine in a rural Missouri nursing home. Journal for Nurses in Professional Development, 20(1), 42-49.

Armstrong, B., Fogarty, G. J., Dingsdag, D., & Dimbleby, J. (2005). Validation of a computer user satisfaction questionnaire to measure IS success in small business. Journal of Research and Practice in Information Technology, 37(1), 27-42.

Asnina, E., Osis, J., & Kirikova, M. (2008). Design of Fractal-Based Systems Within MDA: Platform Independent Modelling. Paper presented at the SIGSAND-EUROPE.

Aufderheide, P. (1999). Communications policy and the public interest: The Telecommunications Act of 1996: Guilford Press.

Baggs, J. G., & Schmitt, M. H. (1988). Collaboration between nurses and physicians. Journal of Nursing Scholarship, 20(3), 145-149.

Bakalar, R., & Whittick, D. (2005). Diagnostic imaging on demand, information management insights based on canadian DI/EHR strategies. Paper presented at the Computers in Cardiology, 2005.

Bakker, A. R., & Leguit, F. A. (1999). Evolution of an integrated HIS in the Netherlands. International Journal of Medical Informatics, 54(3), 209-224.

Ball, E., Chadwick, D. W., & Mundy, D. (2003). Patient privacy in electronic prescription transfer. Security & Privacy, IEEE, 1(2), 77-80.

Ballantine, J., Bonner, M., Levy, M., Martin, A., Munro, I., & Powell, P. (1996). The 3-D model of information systems success: the search for the dependent variable continues. Information Resources Management Journal (IRMJ), 9(4), 5-15.

Barak, B., Chaudhuri, K., Dwork, C., Kale, S., McSherry, F., & Talwar, K. (2007). Privacy, accuracy, and consistency too: a holistic solution to contingency table release. Paper presented at the Proceedings of the twenty-sixth ACM SIGMOD-SIGACT-SIGART symposium on Principles of database systems.

Barrows, R. C., & Clayton, P. D. (1996). Privacy, confidentiality, and electronic medical records. Journal of the American Medical Informatics Association, 3(2), 139-148.

Bates, D., Cohen, M., Leape, L., Overhage, J. M., Shabot, M. M., & Sheridan, T. (2001). Reducing the frequency of errors in medicine using information technology. Journal of the American Medical Informatics Association, 8(4), 299-308.

Bates, D. W., Pappius, E. M., Kuperman, G. J., Sittig, D., Burstin, H., Fairchild, D., . . . Teich, J. M. (1998). Measuring and improving quality using information systems. Studies in health technology and informatics, 52, 814.

Baxter, L. A., & Babbie, E. R. (2004). The basics of communication research. Leslie A. Baxter, 4.

Bayardo, R. J., & Agrawal, R. (2005a). Data privacy through optimal k-anonymization. Paper presented at the Data Engineering, 2005. ICDE 2005. Proceedings. 21st International Conference on.

Bayardo, R. J., & Agrawal, R. (2005b). Data privacy through optimal k-anonymization.

Belanger, F., Hiller, J. S., & Smith, W. J. (2002). Trustworthiness in electronic commerce: the role of privacy, security, and site attributes. The Journal of Strategic Information Systems, 11(3), 245-270.

Benbasat, I., & Zmud, R. W. (1999). Empirical research in information systems: the practice of relevance. Mis Quarterly, 3-16.

Benbasat, I., & Zmud, R. W. (2003). The identity crisis within the IS discipline: Defining and communicating the discipline's core properties. Mis Quarterly, 183-194.

Berg, B. L. (2004). Qualitative research methods for the social sciences. (Vol. 5). Boston: Pearson

Berg, B. L. (2007). Qualitative research methods for the social sciences: Allyn & Bacon.

Berg, M., Aarts, J., & van der Lei, J. (2003). ICT in health care: sociotechnical approaches. Methods of information in medicine, 42(4), 297-301.

Bergman, M. M. (2008). Advances in mixed methods research: Theories and applications: SAGE Publications Limited.

Berkwits, M., & Inui, T. S. (1998). Making use of qualitative research techniques. Journal of general internal medicine, 13(3), 195-199.

Bernard, H. R. (2000). Social research methods: qualitative and quantitative approaches: SAGE.

Bernard, H. R. (2000). Social research methods: Qualitative and quantitative approaches: Sage Publications (Thousand Oaks, Calif.).

Bernard, H. R., & Bernard, H. R. (2012). Social research methods: Qualitative and quantitative approaches: Sage.

Bertino, E., Fovino, I. N., & Provenza, L. P. (2005a). A framework for evaluating privacy preserving data mining algorithms. Data Mining and Knowledge Discovery, 11(2), 121-154. doi: 10.1007/s10618-005-0006-6

Bertino, E., Fovino, I. N., & Provenza, L. P. (2005b). A framework for evaluating privacy preserving data mining algorithms*. Data Mining and Knowledge Discovery, 11(2), 121-154.

Bjørn, P., & Ngwenyama, O. (2009). Virtual team collaboration: building shared meaning, resolving breakdowns and creating translucence. Information Systems Journal, 19(3), 227-253.

Black, A. D., Car, J., Pagliari, C., Anandan, C., Cresswell, K., Bokun, T., . . . Sheikh, A. (2011). The impact of eHealth on the quality and safety of health care: a systematic overview. PLoS medicine, 8(1), e1000387.

Blaya, J. A., Fraser, H. S., & Holt, B. (2010). E-health technologies show promise in developing countries. Health Affairs, 29(2), 244-251.

Blumenthal, D. (2009). Stimulating the adoption of health information technology. New England Journal of Medicine, 360(15), 1477-1479.

Booch, G., Rumbaugh, J., & Jacobson, I. (1999). The unified modeling language user guide: Pearson Education India.

Bossen, C., Jensen, L. G., & Udsen, F. W. (2013). Evaluation of a comprehensive EHR based on the DeLone and McLean model for IS Success: Approach, Results, and Success Factors. International Journal of Medical Informatics.

Bowman, S. (2012). Impact of Electronic Health Record Systems on Information Integrity.

Boyle, P., & Levin, B. (2008). World cancer report 2008: IARC Press, International Agency for Research on Cancer.

Braa, J., Hanseth, O., Heywood, A., Mohammed, W., & Shaw, V. (2007). Developing health information systems in developing countries: the flexible standards strategy. Mis Quarterly, 381-402.

Bradley, E. H., Curry, L. A., & Devers, K. J. (2007). Qualitative data analysis for health services research: developing taxonomy, themes, and theory. Health services research, 42(4), 1758-1772.

Bryman, A. (1998). Quantitative and qualitative research strategies in knowing the social world. Knowing the social world, 138-156.

Bryman, A. (2008). Social research methods (3th ed.): Oxford university press.

Bryman, A., Becker, S., & Sempik, J. (2008). Quality criteria for quantitative, qualitative and mixed methods research: A view from social policy. International Journal of Social Research Methodology, 11(4), 261-276.

Budgen, D., Rigby, M., Brereton, P., & Turner, M. (2007). A data integration broker for healthcare systems. Computer, 40(4), 34-41.

Buntin, M. B., Burke, M. F., Hoaglin, M. C., & Blumenthal, D. (2011). The benefits of health information technology: a review of the recent literature shows predominantly positive results. Health Affairs, 30(3), 464-471.

Burns, N., & Susan, K. (2005). Grove. The practice of Nursing Research, Conduct, Critique, & Utilization. WB Saunders Company. Third Edition. ISBN: 0-7216-3054-5.

Burns, R. B., & Bursn, R. B. (2000). Introduction to research methods.

Burnside, R. S. (1987). Electronic Communications Privacy Act of 1986: The Challenge of Applying Ambiguous Statutory Language to Intricate Telecommunication Technologies, The. Rutgers Computer & Tech. LJ, 13, 451.

Byun, J.-W., Bertino, E., & Li, N. (2005). Purpose based access control of complex data for privacy protection. Paper presented at the Proceedings of the tenth ACM symposium on Access control models and technologies.

Campan, A., & Truta, T. (2009). Data and structural k-anonymity in social networks. Privacy, Security, and Trust in KDD, 33-54.

Carlisle, D., Rodrian, M., & Diamond, C. (2007). California inpatient data reporting manual, medical information reporting for california: Tech. rep., Office of Statewide Health Planning and Development.

Carver, R. H., & Nash, J. G. (2011). Doing Data Analysis with SPSS, Version 18: Version 18.0: Brooks/Cole.

Chang, J.-Y., Chen, L.-K., & Chang, C.-C. (2009). Perspectives and expectations for telemedicine opportunities from families of nursing home residents and caregivers in nursing homes. International Journal of Medical Informatics, 78(7), 494-502.

Charnkit, P. (2010). Using the technology acceptance model to investigate knowledge conversion in Thai public organisations. Victoria University.

Chau, P. Y., & Hu, P. J.-H. (2002). Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. Information & Management, 39(4), 297-311.

Chau, P. Y., & Hu, P. J. H. (2001). Information technology acceptance by individual professionals: A model comparison approach*. Decision Sciences, 32(4), 699-719.

Chaum, D. L. (1981). Untraceable electronic mail, return addresses, and digital pseudonyms. Communications of the ACM, 24(2), 84-90.

Chen, L., Yang, J.-J., Wang, Q., & Niu, Y. (2012). A framework for privacy-preserving healthcare data sharing. Paper presented at the e-Health Networking, Applications and Services (Healthcom), 2012 IEEE 14th International Conference on.

Chen, L., Yang, J. J., Wang, Q., & Niu, Y. (2012). A framework for privacy-preserving healthcare data sharing. Paper presented at the e-Health Networking, Applications and Services (Healthcom), 2012 IEEE 14th International Conference on.

Chen, X., Orlowska, M., & Li, X. (2004). A new framework of privacy preserving data sharing. Paper presented at the Proceedings of 4th IEEE International Workshop on Privacy and Security Aspects of Data Mining, IEEE Press.

Chetley, A. (2007). Improving health, connecting people: the role of ICTs in the health sector of developing countries: A framework paper: InfoDev.

Chismar, W. G., & Wiley-Patton, S. (2003). Does the extended technology acceptance model apply to physicians. Paper presented at the System Sciences, 2003. Proceedings of the 36th Annual Hawaii International Conference on.

Chiu, C.-C., & Tsai, C.-Y. (2007). A k-anonymity clustering method for effective data privacy preservation. Advanced Data Mining and Applications, 89-99.

Chomeya, R. (2010). Quality of psychology test between Likert scale 5 and 6 points. Journal of Social Sciences, 6(3), 399-403.

Christensen, C., & Larson, J. R. (1993). Collaborative medical decision making. Medical Decision Making, 13(4), 339-346.

Ciriani, V., & De Capitani di Vimercati, S. (2007). Samarati P. k-anonymity. Secure Data Management in Decentralized Systems: Springer.

Clifton, C., & Atallah, M. (2007). Collaborative Research: ITR: Distributed Data Mining to Protect Information Privacy.

Clifton, C., Kantarcioğlu, M., Doan, A., Schadow, G., Vaidya, J., Elmagarmid, A., & Suciu, D. (2004). Privacy-preserving data integration and sharing. Paper presented at the Proceedings of the 9th ACM SIGMOD workshop on Research issues in data mining and knowledge discovery.

Clifton, C., Kantarcioglu, M., Vaidya, J., Lin, X., & Zhu, M. Y. (2002). Tools for privacy preserving distributed data mining. ACM Sigkdd Explorations Newsletter, 4(2), 28-34.

Coffey, A., Holbrook, B., & Atkinson, P. (1996). Qualitative data analysis: Technologies and representations.

Collins, S. A., Bakken, S., Vawdrey, D. K., Coiera, E., & Currie, L. (2011). Model development for EHR interdisciplinary information exchange of ICU common goals. International Journal of Medical Informatics, 80(8), e141-e149.

Commission, F. T. (1998). Children's online privacy protection act of 1998. Online at: http://www. cdt. org/legislation/105th/privacy/coppa. html.

Committee, P. s. I. T. A. (2004). Revolutionizing health care through information technology. Report to the President of the United States.

Crabtree, B. F., & Miller, W. L. (1999). Using codes and code manuals: a template organizing style of interpretation. Doing qualitative research, 2, 163-177.

Cranor, L., Langheinrich, M., Marchiori, M., Presler-Marshall, M., & Reagle, J. (2002). The platform for privacy preferences 1.0 (P3P1. 0) specification. W3C recommendation, 16.

Creswell, J. (2011). Just the FACTS101 E-Study Guide For: Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research: Cram101.

Creswell, J. W. (1994). Research design: Sage publications Thousand Oaks, CA.

Creswell, J. W. (2005). Educational research: planning, conducting, and evaluating quantitative and qualitative research: Prentice Hall.

Creswell, J. W. (2007). Qualitative inquiry & research design: Choosing among five approaches: Sage Publications, Inc.

Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches: Sage Publications, Inc.

Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches.

CRESWELL, J. W. (2011a). Educational research. Recherche, 67, 02.

Creswell, J. W. (2011b). Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research. 4th Edn., . Boston,: Pearson Education.

Creswell, J. W. (2012). Qualitative inquiry and research design: Choosing among five approaches: SAGE Publications, Incorporated.

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches: Sage.

Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research: Wiley Online Library.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. Handbook of mixed methods in social and behavioral research, 209-240.

Croll, J. (2009). The impact of usability on clinician acceptance of a health information system.

Curry, L. A., Nembhard, I. M., & Bradley, E. H. (2009). Qualitative and mixed methods provide unique contributions to outcomes research. Circulation, 119(10), 1442-1452.

Dalenius, T. (1977). Towards a methodology for statistical disclosure control. Statistik Tidskrift, 15(429-444), 2-1.

David Ferraiolo, K. R. (1992). Role-based access control (rbac). Paper presented at the In15th NIST-NCSC National Computer Security Conference.

Davies, W. M., & Beaumont, T. J. (2007). CASE STUDIES: RESEARCH METHODS: TEACHING AND LEARNING UNIT,Faculty of Business and Economics, The University of Melbourne., from http://fbe.unimelb.edu.au/celt/

Davis, A., Overmyer, S., Jordan, K., Caruso, J., Dandashi, F., Dinh, A., . . . Sitaram, P. (1993). Identifying and measuring quality in a software requirements specification. Paper presented at the Software Metrics Symposium, 1993. Proceedings., First International.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. Mis Quarterly, 319-340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. Management Science, 35(8), 982-1003.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace1. Journal of applied social psychology, 22(14), 1111-1132.

Davis, W. S., & Yen, D. C. (1998). The information system consultant's handbook: Systems analysis and design: CRC Press (Boca Raton, Fla.).

De Britto, A. J., Raj, T., & Chelliah, D. A. (2008). Prediction of Biological Activity Spectra for Few Anticancer Drugs Derived from Plant Sources. Ethnobotanical Leaflets, 2008(1), 109.

Dean, B. B., Lam, J., Natoli, J. L., Butler, Q., Aguilar, D., & Nordyke, R. J. (2010). Use of Electronic Medical Records for Health Outcomes Research: A Literature Review. Medical Care Research and Review, 66(6), 611-638.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. Information Systems Research, 3(1), 60-95.

Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. J. Manage. Inf. Syst., 19(4), 9-30.

Delone, W. H., & Mclean, E. R. (2004). Measuring e-commerce success: Applying the DeLone & McLean information systems success model. International Journal of Electronic Commerce, 9(1), 31-47.

Dembo, D. (2010). Unified Communication Systems, Enhancing patient care. Asia Hospital and Healthcare Management.

Denscombe, M. (2007). The good research guide: for small-scale social research projects: Open University Press.

Denzin, N. K., & Lincoln, Y. S. (2005). The Sage handbook of qualitative research: Sage Publications, Incorporated.

Despont-Gros, C., Mueller, H., & Lovis, C. (2005). Evaluating user interactions with clinical information systems: a model based on human–computer interaction models. Journal of biomedical informatics, 38(3), 244-255.

Dewson, R. (2008). Beginning SQL server 2008 for developers: from novice to professional: Dreamtech Press.

Dey, S., & Soliman, A. S. (2010). Cancer in the global health era: opportunities for the Middle East and Asia. Asia-Pacific Journal of Public Health, 22(3 suppl), 75S-82S.

Dinev, T., & Hart, P. (2006). An extended privacy calculus model for e-commerce transactions. Information Systems Research, 17(1), 61-80.

DIRECTIVE, H. A. T. (1997). Council Directive 97/43/Euratom of 30 June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, and repealing Directive 84/466/Euratom. Official Journal No. L, 180(09/07), 0022-0027.

DuBois, P. (2009). MySQL: Addison-Wesley Professional.

Ducey, A. J. (2013). Predicting Tablet Computer Use: An Extended Technology Acceptance Model. PhD graduate theses and dissertations, University of South Florida, Florida. Retrieved from http://scholarcommons.usf.edu/etd/4471 (4471).

Duffy, M. E. (1985). Designing nursing research: the qualitative - quantitative debate. Journal of Advanced Nursing, 10(3), 225-232.

Duffy, P. J. (1989). The Employee Polygraph Protection Act of 1988. CUPA Journal, 40(2), 29-42.

Dustin, E., Rashka, J., & Paul, J. (1999). Automated software testing: introduction, management, and performance: Addison-Wesley Professional.

E. Ammenwerth, S.Gräber, G.Herrmann, T.Bürkle, & J.König. (2003). Evaluation of health information systems—problems and challenges. International Journal of Medical Informatics, 71(2), 125-135.

Egan, K. K., & Haile, L. A. (2012). FDA Catches Up with Health IT Revolution.

Egypt, C. s. C. H. (2014). Children's Cancer Hospital Egypt Vision & Mission, 2014, from http://www.57357.com/

Egypt, C. s. C. H. (2014). Health Information Technology. CCHE IT Cario. Retrieved from http://www.57357.com/category/health-information-technology/

El Emam, K., Arbuckle, L., Koru, G., Eze, B., Gaudette, L., Neri, E., . . . Gluck, J. (2012). De-identification methods for open health data: the case of the Heritage Health Prize claims dataset. Journal of medical internet research, 14(1).

El Emam, K., & Dankar, F. K. (2008a). Protecting privacy using k-anonymity. Journal of the American Medical Informatics Association, 15(5), 627.

El Emam, K., & Dankar, F. K. (2008b). Protecting privacy using k-anonymity. Journal of the American Medical Informatics Association, 15(5), 627-637.

El Emam, K., Dankar, F. K., Issa, R., Jonker, E., Amyot, D., Cogo, E., . . . Vaillancourt, R. (2009). A globally optimal k-anonymity method for the de-identification of health data. Journal of the American Medical Informatics Association, 16(5), 670-682.

El Emam, K., & Fineberg, A. (2009). An overview of techniques for de-identifying personal health information. Access to Information and Privacy Division of Health Canada.

El Emam, K., Information, C. H. C. A. t., Division, P., & Information, C. I. f. H. (2011). Data anonymization practices in clinical research: a descriptive study: CHEO Research Institute.

El Emam, K., Jonker, E., & Fineberg, A. (2011a). The Case for De-identifying Personal Health Information.

El Emam, K., Jonker, E., & Fineberg, A. (2011b). The Case for De-identifying Personal Health Information. Electronic Health Information Laboratory, Children's Hospital of Eastern Ontario Research Institute, Ottawa, Canada, 3.

El Hattab, O. (2001). New millennium hospital management information system: experience of the National Cancer Institute-Cairo University. Studies in health technology and informatics(1), 727-729.

Elattar, I. (2004). Cancer in the Arab World: Magnitude of the problem.

Elattar, I. (2005). Cancer in the Arab World: Magnitude of the problem. Department of Biostatistics & Epidemiology NCI, Egypt, UICC.

Elattar, I. A., Nelly H. Ali-eldin, Manar M. Moneer, Amany A. Elbasmy, Dalia Belal, Naguiba Aref, . . . Mohammed, R. (2002). CANCER STATISTICS AT NATIONAL CANCER INSTITUTE 2002-2003. NATIONAL CANCER INSTITUTE, CAIRO UNIVERSITY, EGYPT.

Ernstmann, N., Ommen, O., Neumann, M., Hammer, A., Voltz, R., & Pfaff, H. (2009). Primary Care Physician's Attitude Towards the GERMAN e-Health Card Project—Determinants and Implications. Journal of medical systems, 33(3), 181-188.

Esmaeilzadeh, P., & Sambasivan, M. (2012). Healthcare Professionals' Adoption of Clinical IT in Hospital: A View of Relationship between Healthcare Professionals and Hospital. Management, 2(5), 161-170.

Ezzat, S. (2014). Setting Up Analytical Studies: Case-control Study From Egypt. Children's Cancer Hospital 57357

Fagin, C. M. (1992). Collaboration between nurses and physicians: no longer a choice. Academic Medicine, 67(5), 295-303.

Fedele, F., & Srl, G. (1995). Healthcare and Distributed Systems Technology. Cambridge-UK: ANSAworks, 95.

Ferlay, J., Bray, F., Forman, D., Mathers, C., & Parkin, D. (2010). Cancer Incidence and Mortality Worldwide: IARC Cancer Base No. 10. Lyon, France: International Agency for Research on Cancer 2010.

Ferlay, J., Shin, H. R., Bray, F., Forman, D., Mathers, C., & Parkin, D. M. (2010). Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. International Journal of Cancer, 127(12), 2893-2917.

Fichman, R. G., Kohli, R., & Krishnan, R. (2011). The role of information systems in healthcare: current research and future trends. Information Systems Research, 22(3), 419-428.

Fishbein, M. A. I. (1975). Belief, attitude, intention, and behavior : an introduction to theory and research. Reading, Mass.: Addison-Wesley Pub. Co.

Fitzpatrick, J., Wright, D. J., & Secrist, J. (1998). Secrets for a successful dissertation: SAGE Publications, Incorporated.

Fontanella, B. J. B., Ricas, J., & Turato, E. R. (2008). Amostragem por saturação em pesquisas qualitativas em saúde: contribuições teóricas [Saturation sampling in qualitative health research: theoretical contributions]. Cad. Saúde Pública, 24(1), 17-27.

Fraser, H. S., Biondich, P., Moodley, D., Choi, S., Mamlin, B. W., & Szolovits, P. (2005). Implementing electronic medical record systems in developing countries. Informatics in primary care, 13(2), 83-96.

Freidson, E. (1970). Profession of medicine: a study of the sociology of applied knowledge: University of Chicago Press.

Fried, B., Carpenter, W. R., & Deming, W. E. (2011). Understanding and improving team effectiveness in quality improvement. McLaughlin and Kaluzny's Continuous Quality Improvement in Health Care, 117.

Friedman, C. P., & Wyatt, J. (1997). Evaluation methods in medical informatics: Springer (New York).

Friedman, C. P., & Wyatt, J. (2006). Evaluation methods in biomedical informatics: Springer Verlag.

Fung, B., Wang, K., Chen, R., & Yu, P. S. (2010). Privacy-preserving data publishing: A survey of recent developments. ACM Computing Surveys (CSUR), 42(4), 1-53.

Fung, B., Wang, K., Wang, L., & Hung, P. C. K. (2009). Privacy-preserving data publishing for cluster analysis. Data & Knowledge Engineering, 68(6), 552-575.

Fung, B. C. M., Wang, K., Chen, R., & Yu, P. S. (2010). Privacy-preserving data publishing: A survey of recent developments. ACM Comput. Surv., 42(4), 1-53. doi: 10.1145/1749603.1749605

Fung, B. C. M., Wang, K., Chen, R., & Yu, P. S. (2010). Privacy-preserving data publishing: A survey on recent developments. Computing, 5(4), 1-53.

Fung, B. C. M., Wang, K., & Yu, P. S. (2007). Anonymizing classification data for privacy preservation. Ieee Transactions on Knowledge and Data Engineering, 19(5), 711-725. doi: 10.1109/tkde.2007.1015

Gaboury, I., Bujold, M., Boon, H., & Moher, D. (2009). Interprofessional collaboration within Canadian integrative healthcare clinics: Key components. Social Science & Medicine, 69(5), 707-715.

Gagnon, M.-P., Godin, G., Gagné, C., Fortin, J.-P., Lamothe, L., Reinharz, D., & Cloutier, A. (2003). An adaptation of the theory of interpersonal behaviour to the study of telemedicine adoption by physicians. International Journal of Medical Informatics, 71(2), 103-115.

Gao, S., Ma, J., Sun, C., & Li, X. (2013). Balancing trajectory privacy and data utility using a personalized anonymization model. Journal of Network and Computer Applications.

Garets, D., & Davis, M. (2012). Electronic Patient Records. HIMSS Analytics, Chicago

Garfinkel, S. (2000). The Death of Privacy: California: O'Reilly & Associates.

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: An integrated model. Mis Quarterly, 51-90.

Gehrke, J. (2006). Models and methods for privacy-preserving data analysis and publishing.

Gerteis, M., Edgman-Levitan, S., Daley, J., & Delbanco, T. L. (1993). Through the patient's eyes: understanding and promoting patient-centered care: Jossey-Bass San Francisco.

Gkoulalas-Divanis, A., & Loukides, G. (2011). Medical Data Sharing: Privacy Challenges and Solutions.

Gkoulalas-Divanis, A., & Loukides, G. (2013). Conclusions and Open Research Challenges Anonymization of Electronic Medical Records to Support Clinical Analysis (pp. 65-69): Springer.

Gkoulalas-Divanis, A., & Verykiosc, V. S. (2009). An overview of privacy preserving data mining. Crossroads, 15(4), 6.

Glaser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory: Strategies for qualitative research: Aldine de Gruyter.

Goldzweig, C. L., Towfigh, A., Maglione, M., & Shekelle, P. G. (2009). Costs and benefits of health information technology: new trends from the literature. Health Affairs, 28(2), w282-w293.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. Mis Quarterly, 213-236.

Gorman, G., Clayton, P. R., Rice-Lively, M. L., & Gorman, L. (1997). Qualitative Research for the Information Professional: A Practical Handbook: Library Association Publishing (UK).

Goryczka, S., Xiong, L., & Fung, B. C. Secure Distributed Data Anonymization and Integration with m-Privacy.

Gostin, L. O., Turek-Brezina, J., Powers, M., Kozloff, R., Faden, R., & Steinauer, D. D. (1993). Privacy and security of personal information in a new health care system. JAMA: the journal of the American Medical Association, 270(20), 2487.

Govender, D. W. (2011). Information and communications technology (ICT) integration in teaching and learning: a critical analysis.

Grandison, T., & Bhatti, R. (2010). HIPAA compliance and patient privacy protection. Studies in health technology and informatics, 160(Pt 2), 884-888.

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of innovations in service organizations: systematic review and recommendations. Milbank Quarterly, 82(4), 581-629.

Guimaraes, T., & Igbaria, M. (1997). Client/server system success: Exploring the human side. Decision Sciences, 28(4), 851-876.

Hall GE, W. R., Dossett W. (1973). A developmental conceptualization of the adoption process within educational institutions. p. 5.

Hameed, S. A., Abdalla Hashim, A.-H., Sharifudeen, M., Shabnam, S., Meho, V., & Khalifa, O. O. (2008). An efficient emergency, healthcare, and medical information system. International Journals of Biometric and Bioinformatics (IJBB), 2(5), 1-9.

Hannan, A. (2006). Observation Techniques: Devon, UK: University of Plymouth.

Harding, G., & Gantley, M. (1998). Qualitative methods: beyond the cookbook. Family Practice, 15(1), 76.

Harrison, P., & Ramanujan, S. (2011). Electronic Medical Records: Great Idea Or Great Threat To Privacy? Review of Business Information Systems (RBIS), 15(1).

Hartney. (2012). Data Analysis Retrieved 2012, from http://www.datamology.com/analysis.shtml

Heeks, R. (2002). Information systems and developing countries: Failure, success, and local improvisations. The information society, 18(2), 101-112.

Heeks, R. (2006). Health information systems: Failure, success and improvisation. International Journal of Medical Informatics, 75(2), 125-137.

Hendrickson, A. R., Massey, P. D., & Cronan, T. P. (1993). On the test-retest reliability of perceived usefulness and perceived ease of use scales. Mis Quarterly, 227-230.

Heuser, H., Gerlach, G., Pollack, T., & Niederlag, W. (2001). Technology basis supporting regional cooperation of hospitals and medical centers. Paper presented at the International Congress Series.

Hevner, A., & Chatterjee, S. (2010). Design science research in information systems: Springer.

Hiller, J., McMullen, M. S., Chumney, W. M., & Baumer, D. L. (2011). Privacy and security in the implementation of health information technology (electronic health records): US and EU compared. BUJ Sci. & Tech. L., 17, 1.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R., & Taylor, R. (2005). Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. Health Affairs, 24(5), 1103-1117.

Holden, R. J., & Karsh, B.-T. (2009). A theoretical model of health information technology usage behaviour with implications for patient safety. Behaviour & Information Technology, 28(1), 21-38.

Holden, R. J., & Karsh, B. T. (2010). Methodological Review: The Technology Acceptance Model: Its past and its future in health care. Journal of biomedical informatics, 43(1), 159-172.

Holloway, I., & Wheeler, S. (2009). Qualitative research in nursing and healthcare: Wiley-Blackwell.

Hossain, L., & de Silva, A. (2009). Exploring user acceptance of technology using social networks. The Journal of High Technology Management Research, 20(1), 1-18.

Hripcsak, G., Bloomrosen, M., FlatelyBrennan, P., Chute, C. G., Cimino, J., Detmer, D. E., . . . Hammond, W. E. (2014). Health data use, stewardship, and governance: ongoing gaps and challenges: a report from AMIA's 2012 Health Policy Meeting. Journal of the American Medical Informatics Association, 21(2), 204-211.

Hsiao, C.-J., & Hing, E. (2012). Use and Characteristics of Electronic Health Record Systems Among Office-based Physician Practices, United States, 2001-2012: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.

Hsu, C.-L., & Lee, M.-R. (2013). User Acceptance of a Community-Based Healthcare Information System Preserving User Privacy Universal Access in Human-Computer Interaction. Applications and Services for Quality of Life (pp. 453-462): Springer.

Hu, J., Chen, H.-H., & Hou, T.-W. (2010). A hybrid public key infrastructure solution (HPKI) for HIPAA privacy/security regulations. Computer Standards & Interfaces, 32(5), 274-280.

Hu, P. J., Chau, P. Y., Sheng, O. R. L., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. Journal of Management Information Systems, 91-112.

Hu, P. J., Chau, P. Y. K., Sheng, O. R. L., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. Journal of Management Information Systems, 91-112.

Hubona, G. S., & Geitz, S. (1997). External variables, beliefs, attitudes and information technology usage behavior. Paper presented at the System Sciences, 1997, Proceedings of the Thirtieth Hawaii International Conference on.

Hyett, N., Kenny, A., & Virginia Dickson-Swift, D. (2014). Methodology or method? A critical review of qualitative case study reports. International journal of qualitative studies on health and well-being, 9.

Igbaria, M., Parasuraman, S., & Baroudi, J. J. (1996). A motivational model of microcomputer usage. Journal of Management Information Systems, 127-143.

Itani, W., Kayssi, A., & Chehab, A. (2009). Privacy as a service: Privacy-aware data storage and processing in cloud computing architectures. Paper presented at the Dependable, Autonomic and Secure Computing, 2009. DASC'09. Eighth IEEE International Conference on.

Ives, B., Olson, M. H., & Baroudi, J. J. (1983). The measurement of user information satisfaction. Communications of the ACM, 26(10), 785-793.

Iyengar, V. S. (2002). Transforming data to satisfy privacy constraints.

Jakobsson, M., Juels, A., & Rivest, R. L. (2002). Making mix nets robust for electronic voting by randomized partial checking.

Jemal, A., Bray, F., Center, M. M., Ferlay, J., Ward, E., & Forman, D. (2011). Global cancer statistics. CA: a cancer journal for clinicians, 61(2), 69-90.

Jennex, M., Olfman, L., Panthawi, P., & Park, Y.-T. (1998). An organizational memory information systems success model: an extension of DeLone and McLean's I/S success model. Paper presented at the System Sciences, 1998., Proceedings of the Thirty-First Hawaii International Conference on.

Jha, A. K., DesRoches, C. M., Campbell, E. G., Donelan, K., Rao, S. R., Ferris, T. G., . . . Blumenthal, D. (2009). Use of electronic health records in US hospitals. New England Journal of Medicine, 360(16), 1628-1638.

Jiang, W., & Clifton, C. (2006). A secure distributed framework for achieving k-anonymity. The VLDB Journal—The International Journal on Very Large Data Bases, 15(4), 316-333.

Jiang, W., & Clifton, C. (2006). A secure distributed framework for achieving k-anonymity. Vldb Journal, 15(4), 316-333. doi: 10.1007/s00778-006-0008-z

Johnson, B., & Christensen, L. (2008). Educational research: Quantitative, qualitative, and mixed approaches: Sage.

Jones, S. R., Torres, V., & Arminio, J. (2006). Negotiating the complexities of qualitative research in higher education: Fundamental elements and issues: CRC Press.

Jurczyk, P., & Xiong, L. (2009). Distributed anonymization: Achieving privacy for both data subjects and data providers Data and Applications Security XXIII (pp. 191-207): Springer.

Kanaracus, C. (2008). Gartner: global IT spending growth stable. InfoWorld.

Kaplan, B. (2001). Evaluating informatics applications--some alternative approaches: theory, social interactionism, and call for methodological pluralism. International Journal of Medical Informatics, 64(1), 39-56.

Kaplan, B., Truex, D. P., & Wastell, D. (2004). Information systems research: Relevant theory and informed practice (Vol. 143): Springer.

Kaplan, R. S., & Norton, D. P. (1996). The balanced scorecard: translating strategy into action: Harvard Business Press.

Kaushal, R., Barker, K. N., & Bates, D. W. (2001). How can information technology improve patient safety and reduce medication errors in children's health care? Archives of pediatrics & adolescent medicine, 155(9), 1002.

Keller, G. T. D. S. A., & Stokes, M. S. L. (2003). Disclosure Risk vs. Data Utility: The RU Confidentiality Map. Disclosure.

Kenig, B., & Tassa, T. (2012). A practical approximation algorithm for optimal k-anonymity. Data Mining and Knowledge Discovery, 25(1), 134-168.

Kenneally, E., & Claffy, K. (2009). An internet data sharing framework for balancing privacy and utility. Paper presented at the Engaging Data: First International Forum on the Application and Management of Personal Electronic Information.

Ketikidis, P., Dimitrovski, T., Lazuras, L., & Bath, P. A. (2012). Acceptance of health information technology in health professionals: An application of the revised technology acceptance model. Health Informatics Journal, 18(2), 124-134.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. Information & Management, 43(6), 740-755.

Kit, E., & Finzi, S. (1995). Software testing in the real world: improving the process: ACM Press/Addison-Wesley Publishing Co.

Kohn, L. T., Corrigan, J., & Donaldson, M. S. (1999). To err is human: Building a safer health system. Committee on Health Care in America. Institute of Medicine: Washington (DC): National Academy Press.

Kopala, M., & Suzuki, L. A. (1999). Using qualitative methods in psychology: Sage Thousand Oaks, CA.

Kulkarni, U. R., Ravindran, S., & Freeze, R. (2007). A knowledge management success model: theoretical development and empirical validation. Journal of Management Information Systems, 23(3), 309-347.

Kuziemsky, C. E., O'Sullivan, T. L., & Corneil, W. (2012). An Upstream-Downstream Approach for Disaster Management Information Systems Design. Paper presented at the Proceedings of the ISCRAM Conference.

Kuziemsky, C. E., & Varpio, L. (2011). A model of awareness to enhance our understanding of interprofessional collaborative care delivery and health information system design to support it. International Journal of Medical Informatics, 80(8), e150-e160.

Labib, N. M., & Malek, M. N. (2005). Data mining for cancer management in Egypt case study: childhood acute lymphoblastic leukemia. Transactions on Engineering, Computing & Technology, 8, 309-314.

Lahrmann, G., & Marx, F. (2010). Systematization of maturity model extensions Global Perspectives on Design Science Research (pp. 522-525): Springer.

Larson, M. S. (1977). The rise of professionalism: A sociological analysis: University of California Press (Berkeley).

Lau, E. C., Mowat, F. S., Kelsh, M. A., Legg, J. C., Engel-Nitz, N. M., Watson, H. N., Whyte, J. L. (2011). Use of electronic medical records (EMR) for oncology outcomes research: assessing the comparability of EMR information to patient registry and health claims data. Clinical epidemiology, 3, 259.

Lau, F., Price, M., Boyd, J., Partridge, C., Bell, H., & Raworth, R. (2012). Impact of electronic medical record on physician practice in office settings: a systematic review. Bmc Medical Informatics and Decision Making, 12(1), 10.

Lau, F., Price, M., & Keshavjee, K. (2010). From benefits evaluation to clinical adoption: making sense of health information system success in Canada. Healthcare Quarterly (Toronto, Ont.), 14(1), 39-45.

Leach, M. (1990). Philosophical choice. Journal of Education, 3(3), 16-18.

Leary, M. R. (2012). Introduction to Behavioral Research Methods (6th Edition): Pearson Eduction,Inc. .

Lee, S. M., Kim, I., Rhee, S., & Trimi, S. (2006). The role of exogenous factors in technology acceptance: The case of object-oriented technology. Information & Management, 43(4), 469-480.

Lee, W.-B., & Lee, C.-D. (2008). A cryptographic key management solution for HIPAA privacy/security regulations. Information Technology in Biomedicine, IEEE Transactions on, 12(1), 34-41.

Leedy, P. D., & Ormrod, J. E. (2005). Practical research: Planning and design: Prentice Hall Upper Saddle River, NJ.

Leedy, P. D., & Ormrod, J. E. (2005). Practical research: Planning and design.

LeFevre, K., DeWitt, D. J., & Ramakrishnan, R. (2005). Incognito: Efficient full-domain k-anonymity.

LeFevre, K., DeWitt, D. J., & Ramakrishnan, R. (2006). Mondrian multidimensional k-anonymity.

Lewis, W., Agarwal, R., & Sambamurthy, V. (2003). Sources of influence on beliefs about information technology use: an empirical study of knowledge workers. Mis Quarterly, 657-678.

Lezzar, F., Zidani, A., & Atef, C. (2012). A Collaborative Web-based Application for Health Care Tasks Planning. Paper presented at the ICWIT.

Li, K., & Yao, D. (2006). Cooperative Work in Heterogeneous Medical Information Systems. Paper presented at the Communications, Circuits and Systems Proceedings, 2006 International Conference on.

Li, T., & Li, N. (2009). On the tradeoff between privacy and utility in data publishing. Paper presented at the Proceedings of the 15th ACM SIGKDD international conference on Knowledge discovery and data mining.

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic inquiry (Vol. 75): Sage Publications, Inc.

Lindell, Y., & Pinkas, B. (2002). Privacy preserving data mining. Journal of cryptology, 15(3), 177-206.

Lingwood, R. J., Boyle, P., Milburn, A., Ngoma, T., Arbuthnott, J., McCaffrey, R., Kerr, D. J. (2008). The challenge of cancer control in Africa. Nature Reviews Cancer, 8(5), 398-403.

Lippeveld, T., Sauerborn, R., & Bodart, C. (2000). Design and implementation of health information systems: World Health Organization Geneva.

Locatelli, P., Restifo, N., Gastaldi, L., & Corso, M. (2012). Health Care Information Systems: Architectural Models and Governance. Innovative Information Systems Modelling and Techniques, Rijeka (Croatia): InTech, 71-96.

Loukides, G., & Shao, J. (2008). Data utility and privacy protection trade-off in k-anonymisation. Paper presented at the Proceedings of the 2008 international workshop on Privacy and anonymity in information society.

Lowenhaupt, M. (2004). Removing barriers to technology. Physician executive, 30(2), 12.

Lu, Y. C., Xiao, Y., Sears, A., & Jacko, J. A. (2005). A review and a framework of handheld computer adoption in healthcare. International Journal of Medical Informatics, 74(5), 409.

Ludman, E. J., Fullerton, S. M., Spangler, L., Trinidad, S. B., Fujii, M. M., Jarvik, G. P., . . . Burke, W. (2010). Glad you asked: participants' opinions of re-consent for dbGaP data submission. Journal of empirical research on human research ethics: JERHRE, 5(3), 9.

Ludwick, D., & Doucette, J. (2009). Adopting electronic medical records in primary care: lessons learned from health information systems implementation experience in seven countries. International Journal of Medical Informatics, 78(1), 22-31.

Ma, Q., & Liu, L. (2004). The technology acceptance model: a meta-analysis of empirical findings. Journal of Organizational and End User Computing (JOEUC), 16(1), 59-72.

MacDonald, M., & Szpuszta, M. (2007). Pro ASP. NET 3.5 in C# 2008: Apress.

Macinko, J., Starfield, B., & Shi, L. (2003). The contribution of primary care systems to health outcomes within Organization for Economic Cooperation and Development (OECD) countries, 1970–1998. Health services research, 38(3), 831-865.

Mäenpää, T., Suominen, T., Asikainen, P., Maass, M., & Rostila, I. (2009). The outcomes of regional healthcare information systems in health care: a review of the research literature. International Journal of Medical Informatics, 78(11), 757-771.

Makoul, G., Curry, R. H., & Tang, P. C. (2001). The use of electronic medical records communication patterns in outpatient encounters. Journal of the American Medical Informatics Association, 8(6), 610-615.

Malhotra, N. K., Kim, S. S., & Agarwal, J. (2004). Internet users' information privacy concerns (IUIPC): The construct, the scale, and a causal model. Information Systems Research, 15(4), 336-355.

Malin, B. A., El Emam, K., & O'Keefe, C. M. (2013). Biomedical data privacy: problems, perspectives, and recent advances. Journal of the American Medical Informatics Association, 20(1), 2-6.

Malterud, K. (2001). Qualitative research: standards, challenges, and guidelines. Lancet, 358(9280), 483-487.

Mamlin, B. W., Biondich, P. G., Wolfe, B. A., Fraser, H., Jazayeri, D., Allen, C., . . . Tierney, W. M. (2006). Cooking up an open source EMR for developing countries: OpenMRS–a recipe for successful collaboration. Paper presented at the AMIA Annual Symposium Proceedings.

Masaud-Wahaishi, A. M., & Ghenniwa, H. (2009). Privacy Based Information Brokering for Cooperative Distributed e-Health Systems. Journal of Emerging Technologies in Web Intelligence, 1(2), 161-171.

Matatov, N., Rokach, L., & Maimon, O. (2010). Privacy-preserving data mining: A feature set partitioning approach. Information Sciences, 180(14), 2696-2720.

Mathieson, K. (1991). Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. Information Systems Research, 2(3), 173-191.

Mays, N., & Pope, C. (2000). Qualitative research in health care: Assessing quality in qualitative research. BMJ: British Medical Journal, 320(7226), 50.

Mbananga, N., Madale, R., & Becker, P. (2002). Evaluation of Hospital Information System in the Northern Province in South Africa Using Outcome Measure. Report prepared for the health systems trust, the medical research of South Africa, Pretoria.

Melas, C. D., Zampetakis, L. A., Dimopoulou, A., & Moustakis, V. (2011). Modeling the acceptance of clinical information systems among hospital medical staff: An extended TAM model. Journal of biomedical informatics, 44(4), 553-564.

Mengiste, S. A. (2010). Analysing the Challenges of IS implementation in public health institutions of a developing country: the need for flexible strategies. Journal of Health Informatics in Developing Countries, 4(1).

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook: Sage.

Mingers, J. (2001). Combining IS research methods: towards a pluralist methodology. Information Systems Research, 12(3), 240-259.

Moores, T. T. (2012). Towards an integrated model of IT acceptance in healthcare. Decision Support Systems, 53(3), 507-516.

Morton, S., Mahoui, M., & Gibson, P. J. (2012). Data anonymization using an improved utility measurement. Paper presented at the Proceedings of the 2nd ACM SIGHIT symposium on International health informatics.

Myers, B. L., Kappelman, L. A., & Prybutok, V. R. (1997). A comprehensive model for assessing the quality and productivity of the information systems function: toward a theory for information systems assessment. Information Resources Management Journal (IRMJ), 10(1), 6-26.

Myers, G. J., Sandler, C., & Badgett, T. (2011). The art of software testing: Wiley.

Narayanan, A., & Shmatikov, V. (2009). De-anonymizing social networks. Paper presented at the Security and Privacy, 2009 30th IEEE Symposium on.

Neamatullah, I., Douglass, M. M., Li-wei, H. L., Reisner, A., Villarroel, M., Long, W. J., . . . Clifford, G. D. (2008). Automated de-identification of free-text medical records. Bmc Medical Informatics and Decision Making, 8(1), 32.

Neuman, W. (2007). Qualitative and quantitative research designs. Communication research methods: Quantitative and qualitative approaches, 175-204.

Nosowsky, R., & Giordano, T. J. (2006). The Health Insurance Portability and Accountability Act of 1996 (HIPAA) privacy rule: implications for clinical research. Annu. Rev. Med., 57, 575-590.

Nunnally, J. (1978). C.(1978). Psychometric theory: New York: McGraw-Hill.

O'Daniel, M., & Rosenstein, A. H. (2008). Professional communication and team collaboration. Patient safety and quality: An evidence-based handbook for nurses, 2, 08-0043.

Ohno-Machado, L. (2013). Sharing data for the public good and protecting individual privacy: informatics solutions to combine different goals. Journal of the American Medical Informatics Association, 20(1), 1-1.

Ohno-Machado, L., Bafna, V., Boxwala, A. A., Chapman, B. E., Chapman, W. W., Chaudhuri, K., . . . Jiang, X. (2012). iDASH: integrating data for analysis, anonymization, and sharing. Journal of the American Medical Informatics Association, 19(2), 196-201.

Oliveira, S. R. M., & Zaïane, O. R. (2004). Toward standardization in privacy-preserving data mining.

Ömürbek, N., & Altın, F. (2009). Sağlık Bilişim Sistemlerinin Uygulanmasına lişkin Bir Araştırma: zmir Örneği. Süleyman Demirel Üniversitesi Fen Edebiyat Fakültesi Sosyal Bilimler Dergisi, 10(1), 211-232.

Organization, W. H. (2006). WHO Country Cooperation Strategy. Geneva: World Health Organization, 31.

Organization, W. H. (2010). Country Cooperation Strategy for WHO and Egypt 2010–2014.Cario.http://www. who. int/countryfocus/cooperation_strategy/ccs_egy_en. pdf.

Orlikowski, W., & Baroudi, J. J. (1990). Studying information technology in organizations: Research approaches and assumptions.

Orlikowski, W. J., & Iacono, C. S. (2001). Research commentary: Desperately seeking the “IT” in IT research—A call to theorizing the IT artifact. Information Systems Research, 12(2), 121-134.

Pai, F.-Y., & Huang, K.-I. (2011). Applying the Technology Acceptance Model to the introduction of healthcare information systems. Technological Forecasting and Social Change, 78(4), 650-660.

Palacio, C., Harrison, J. P., & Garets, D. (2010). Benchmarking electronic medical records initiatives in the US: a conceptual model. Journal of medical systems, 34(3), 273-279.

Pallant, J. (2010). SPSS survival manual: Open University Press.

Parekh, N. (2005). Software Testing-Black Box Testing Strategy. Buzzle. com, Apr.

Parekh, N. (2005). Software testing – White box testing strategy. Buzzle. com, Apr.

Parmar, A. A., Rao, U. P., & Patel, D. R. (2011). Blocking based approach for classification Rule hiding to Preserve the Privacy in Database.

Pascot, D., Bouslama, F., & Mellouli, S. (2011). Architecturing large integrated complex information systems: an application to healthcare. Knowledge and Information Systems, 27(1), 115-140.

Patel, H., Pettitt, M., & Wilson, J. R. (2012). Factors of collaborative working: A framework for a collaboration model. Applied Ergonomics, 43(1), 1-26.

Patton, M. (2002). Qualitative research & evaluation methods: Thousand Oaks, CA: Sage Publications.

Patton, M. Q. (1990). Qualitative evaluation and research methods: SAGE Publications, inc.

Patton, M. Q. (1990). Qualitative evaluation and research methods: SAGE Publications, inc.

Peer, S., Vogl, R., Peer, R., & Jaschke, W. (1999). Sophisticated hospital information system/radiology information system/picture archiving and communications system (PACS) integration in a large-scale traumatology PACS. Journal of Digital Imaging, 12(1), 99-102.

Pei-Yun, H., Grandison, T., Ci-Wei, L., IenHao, H., Chang, H., & Hao-Ting, P. (2012, 8-10 July 2012). Privacy protection for personal data integration and sharing in care coordination services: A case study on wellness cloud. Paper presented at the Service Operations and Logistics, and Informatics (SOLI), 2012 IEEE International Conference on.

PEKER, C. (2010). An Analysis of The Main Critical Factors that affect the acceptance of Technology In Hospital Management systems. Middle East Technical University.

Petter, S., DeLone, W., & McLean, E. (2008). Measuring information systems success: models, dimensions, measures, and interrelationships. European Journal of Information Systems, 17(3), 236-263.

Petter, S., & McLean, E. R. (2009). A meta-analytic assessment of the DeLone and McLean IS success model: An examination of IS success at the individual level. Information & Management, 46(3), 159-166.

Pettit, L. (2012). Understanding EMRAM and how it can be used by policy-makers, hospital CIOs and their IT teams. World hospitals and health services: the official journal of the International Hospital Federation, 49(3), 7-9.

Pitt, L. F., Watson, R. T., & Kavan, C. B. (1995). Service quality: a measure of information systems effectiveness. Mis Quarterly, 173-187.

Piwowar, H. A., Becich, M. J., Bilofsky, H., & Crowley, R. S. (2008). Towards a data sharing culture: recommendations for leadership from academic health centers. PLoS medicine, 5(9), e183.

Pope, C., & Mays, N. (1995). Reaching the parts other methods cannot reach: an introduction to qualitative methods in health and health services research. BMJ: British Medical Journal, 311(6996), 42.

Pope, C., & Mays, N. (2008). Qualitative research in health care: BMJ books.

Pope, C., Ziebland, S., & Mays, N. (2000). Qualitative research in health care: Analysing qualitative data. BMJ: British Medical Journal, 320(7227), 114.

Price, M., & Lau, F. (2014). The clinical adoption meta-model: a temporal meta-model describing the clinical adoption of health information systems. Bmc Medical Informatics and Decision Making, 14(1), 43.

Price, M., Lau, F., & Lai, J. (2011). Measuring EMR Adoption: A Framework and Case Study. Electronic Healthcare, 10(1), e25-e30.

Program, T. N. a. I. T. R. a. D. N. (2004). President's Information Technology Advisory Committee (PITAC) Retrieved 20 November, 2013, from http://www.nitrd.gov/pitac/.

Pros, D. (2008). Custom programming: why we use MySQL Retrieved viewed 23 October 2012, from http://www.dynamicpros.com/custom/whyweusemysql/

Qi, X., & Zong, M. (2012). An Overview of Privacy Preserving Data Mining. Procedia Environmental Sciences, 12, 1341-1347.

Quan, W.-w., Lu, G.-p., Qi, W.-h., Li, Y.-m., Shen, Y., & Yuan, R. (2008). Diagnostic value of magnetocardiography in patients with coronary heart disease and in-stent restenosis. Chinese Medical Journal-Beijing-English Edition-, 121(1), 22.

Rada, R. (2008). Information systems and healthcare enterprises: IGI Pub.

Rahm, E., & Bernstein, P. A. (2001). On matching schemas automatically. Vldb Journal, 10(4), 334-350.

Rai, A., Lang, S. S., & Welker, R. B. (2002). Assessing the validity of IS success models: An empirical test and theoretical analysis. Information Systems Research, 13(1), 50-69.

Raitoharju, R. (2007). Information Technology Acceptance in the Finnish Social asnd Healthcare Sector B Exploring The Effects Of Cultural Factors: Turku School Of Economics.

Rashid, A. H., & Yasin, N. B. M. Anonymization Approach for Protect Privacy of Medical Data and Knowledge Management.

Reddy, K. S., Patel, V., Jha, P., Paul, V. K., Kumar, A., & Dandona, L. (2011). Towards achievement of universal health care in India by 2020: a call to action. The Lancet, 377(9767), 760-768.

Reddy, M. C., Gorman, P., & Bardram, J. (2011). Special issue on supporting collaboration in healthcare settings: The role of informatics. International Journal of Medical Informatics, 80(8), 541-543.

Reddy, M. C., & Jansen, B. J. (2008). A model for understanding collaborative information behavior in context: A study of two healthcare teams. Information Processing & Management, 44(1), 256-273.

Ridde, V., Robert, E., & Meessen, B. (2012). A literature review of the disruptive effects of user fee exemption policies on health systems. BMC Public Health, 12(1), 289.

Rights, F. E. (2006). Privacy Act of 1974. Implementation Guidelines–An amendment to the Elementary and Secondary.

Robertson, A., Cresswell, K., Takian, A., Petrakaki, D., Crowe, S., Cornford, T., . . . Jacklin, A. (2010). Implementation and adoption of nationwide electronic health records in secondary care in England: qualitative analysis of interim results from a prospective national evaluation. BMJ: British Medical Journal, 341.

Robson, C. (2002). Real world research: A resource for social scientists and practitioner-researchers (Vol. 2): Blackwell Oxford.

Rodrigues, J. (2009). Health information systems: concepts, methodologies, tools and applications: IGI Global.

Røstad, L., & Nytrø, Ø. (2008). Personalized access control for a personally controlled health record. Paper presented at the Proceedings of the 2nd ACM workshop on Computer security architectures.

RS, P. (2001). Software engineering: a practitioner's approach. Software Engineering: A Practitioner's Approach.

Ruxwana, N. L., Herselman, M. E., & Conradie, D. P. (2010). ICT applications as e-health solutions in rural healthcare in the Eastern Cape Province of South Africa. Health Information Management Journal, 39(1), 17-26.

Ryan, F., Coughlan, M., & Cronin, P. (2007). Step-by-step guide to critiquing research. Part 2: qualitative research. British Journal of Nursing, 16(12), 738-744.

Sacharidis, D., Mouratidis, K., & Papadias, D. (2010). K-anonymity in the presence of external databases. Knowledge and Data Engineering, IEEE Transactions on, 22(3), 392-403.

Sadeghi, P., Benyoucef, M., & Kuziemsky, C. E. (2012). A mashup based framework for multi level healthcare interoperability. Information systems frontiers, 14(1), 57-72.

SADREDDINI, M. (2003). A framework for integrating distributed healthcare information systems. Iranian Journal of Information Science and Management (IJISM), 1(1), 56-70.

SADREDDINI, M. (2012). A framework for integrating distributed healthcare information systems. International Journal of Information Science and Management (IJISM), 1(1), 56-70.

Sailors, R. M., & East, T. D. (1999). Clinical informatics: 2000 and beyond. Paper presented at the Proceedings of the AMIA Symposium.

Saldaña, J. (2012). The coding manual for qualitative researchers: Sage.

Salim, E. (2010). Arab World Cancer Declaration. Paper presented at the Initiative to Improve Cancer Care in the Arab World (ICCAW), Riyadh, KSA www.amaac.org/images/PAJO_march_2010.pdf.

Salim, E. I., Moore, M. A., Al-Lawati, J. A., Al-Sayyad, J., Bazawir, A., Bener, A., . . . Maziak, W. (2009). Cancer epidemiology and control in the arab world-past, present and future. Asian Pac J Cancer Prev, 10(1), 3-16.

Samarati, P. (2001). Protecting respondents identities in microdata release. Knowledge and Data Engineering, IEEE Transactions on, 13(6), 1010-1027.

Samarati, P., & Sweeney, L. (1998). Protecting privacy when disclosing information: k-anonymity and its enforcement through generalization and suppression: Technical report, SRI International.

Samir AlFaar, A., Ezzat, S., & AbouElNaga, S. (2011). “Bringing them together” – An essential role in retinoblastoma team; a disease coordinator. Paper presented at the International Society of Genetic Eye Diseases and Retinoblastoma meeting, Bangaluru, India.

Samuel, P. R. J. (2009). ICT integration in enhancing english language teching and learning. Thesis (PhD), University of Malaya, Kuala Lumpur.

Satzinger, J. W., Jackson, R. B., & Burd, S. D. (2011). Systems analysis and design in a changing world: Course Technology Ptr.

Scandurra, I., Hägglund, M., & Koch, S. (2008). From user needs to system specifications: multi-disciplinary thematic seminars as a collaborative design method for development of health information systems. Journal of biomedical informatics, 41(4), 557-569.

Schabetsberger, T., Ammenwerth, E., Andreatta, S., Gratl, G., Haux, R., Lechleitner, G., Wilhelmy, I. (2006). From a paper-based transmission of discharge summaries to electronic communication in health care regions. International Journal of Medical Informatics, 75(3), 209-215.

Schepers, J., & Wetzels, M. (2007). A meta-analysis of the technology acceptance model: Investigating subjective norm and moderation effects. Information & Management, 44(1), 90-103.

Schoeman, F. D. (1984). Philosophical dimensions of privacy: An anthology: Cambridge University Press.

Schoen, C., Osborn, R., Doty, M. M., Squires, D., Peugh, J., & Applebaum, S. (2009). A survey of primary care physicians in eleven countries, 2009: perspectives on care, costs, and experiences. Health Affairs, 28(6), w1171-w1183.

Scott, R. E. (2007). e-Records in health—Preserving our future. International Journal of Medical Informatics, 76(5), 427-431.

Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. Information Systems Research, 8(3), 240-253.

Seddon, P. B., Graeser, V., & Willcocks, L. P. (2002). Measuring organizational IS effectiveness: an overview and update of senior management perspectives. ACM SIGMIS Database, 33(2), 11-28.

Seddon, P. B., & Kiew, M. Y. (1996). A partial test and development of DeLone and McLean's model of IS success. Australian Journal of Information Systems, 4(1).

Seddon, P. B., Staples, S., Patnayakuni, R., & Bowtell, M. (1999). Dimensions of information systems success. Communications of the AIS, 2(3es).

Segars, A. H., & Grover, V. (1993). Re-examining perceived ease of use and usefulness. Mis Quarterly, 17(4), 517-525.

Seidel, J., & Kelle, U. (1995). Different functions of coding in the analysis of textual data. Computer-aided qualitative data analysis: Theory, methods and practice, 52-61.

Shahmoradi, L., Ahmadi, M., & Haghani, H. (2007). Determining the most important evaluation indicators of healthcare information systems (HCIS) in Iran. Health Inform. Manag. J, 36(1), 13.

Sharma, A. (1997). Professional as agent: Knowledge asymmetry in agency exchange. Academy of Management Review, 22(3), 758-798.

Shekelle, P., Morton, S. C., & Keeler, E. B. (2006). Costs and benefits of health information technology.

Silver, M. S., Markus, M. L., & Beath, C. M. (1995). The information technology interaction model: a foundation for the MBA core course. Mis Quarterly, 361-390.

Silverman, D. (2009). Doing qualitative research: SAGE Publications Limited.

Simon, H. A. (1969). The sciences of the artificial (Vol. 136): MIT press.

Sinha, R. K. (2010). Impact of Health Information Technology in Public Health. Sri Lanka Journal of Bio-Medical Informatics, 1(4), 223-236.

Sittig, D. F., & Singh, H. (2011). Defining health information technology-related errors: new developments since to err is human. Archives of internal medicine, 171(14), 1281.

Skilton, A., Gray, W., Allam, O., & Morrey, D. (2007). A new approach to connecting information systems in healthcare Data Management. Data, Data Everywhere (pp. 168-171): Springer.

Skilton, A., Gray, W. A., Allam, O., Morry, D., & Bailey, H. (2008). Role Based Access to Support Collaboration in Healthcare Sharing Data, Information and Knowledge (pp. 177-180): Springer.

Smith, H. E. (2001). A Context-Based Access Control Model for HIPAA Privacy and Security Compliance. SANS Security Essentials. CISSP.

Smith, H. J., Milberg, S. J., & Burke, S. J. (1996). Information privacy: measuring individuals' concerns about organizational practices. Mis Quarterly, 167-196.

Smith, K., Seligman, L., & Swarup, V. (2008). Everybody share: The challenge of data-sharing systems. Computer, 41(9), 54-61.

Sofaer, S., & Firminger, K. (2005). Patient perceptions of the quality of health services. Annu. Rev. Public Health, 26, 513-559.

Softpedia. (2008). MySQL description: MySQL is the world's most popular open source database.

Sokolova, M., El Emam, K., Arbuckle, L., Neri, E., Rose, S., & Jonker, E. (2012). P2P Watch: Personal Health Information Detection in Peer-to-Peer File-Sharing Networks. Journal of medical internet research, 14(4).

Sommerville, I., & Kotonya, G. (1998). Requirements engineering: processes and techniques: John Wiley & Sons, Inc.

Stead, W. W., Kelly, B. J., & Kolodner, R. M. (2005). Achievable steps toward building a National Health Information infrastructure in the United States. Journal of the American Medical Informatics Association, 12(2), 113-120.

Straub, D., Limayem, M., & Karahanna-Evaristo, E. (1995). Measuring system usage: Implications for IS theory testing. Management Science, 41(8), 1328-1342.

Struck, D. (2002). Don't store my data, Japanese tell government. International Herald Tribune, 25.

Subramanian, G. H. (1994). A Replication of Perceived Usefulness and Perceived Ease of Use Measurement*. Decision Sciences, 25(5-6), 863-874.

Succi, M. J., & Walter, Z. D. (1999). Theory of user acceptance of information technologies: an examination of health care professionals. Paper presented at the

System Sciences, 1999. HICSS-32. Proceedings of the 32nd Annual Hawaii International Conference on.

Sullivan, J. M. (2006). Recent Developments and Future Trends in Electronic Medical and Personal Health Records. Health Law., 19, 16.

Sunil Kumar, C., Guru Rao, C., & Govardhan, A. (2012). A framework for interoperable healthcare information systems. International Journal of Computer Information Systems and Industrial Management Applications(4), 554-561.

Suter, E., Oelke, N. D., Adair, C. E., & Armitage, G. D. (2009). Ten key principles for successful health systems integration. Healthcare Quarterly (Toronto, Ont.), 13(Spec No), 16.

Sweeney, L. (1997). Guaranteeing anonymity when sharing medical data, the Datafly System. Paper presented at the Proceedings of the AMIA Annual Fall Symposium.

Sweeney, L. (2000). Uniqueness of simple demographics in the US population. LIDAP-WP4. Carnegie Mellon University, Laboratory for International Data Privacy, Pittsburgh, PA.

Sweeney, L. (2002a). Achieving k-anonymity privacy protection using generalization and suppression. International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 10(05), 571-588.

Sweeney, L. (2002b). Achieving k-anonymity privacy protection using generalization and suppression. International Journal of Uncertainty Fuzziness and Knowledge-Based Systems, 10(5), 571-588.

Sweeney, L. (2002c). k-anonymity: A model for protecting privacy. International Journal of Uncertainty Fuzziness and Knowledge Based Systems, 10(5), 557-570.

Systems, C. (2008). New Hospital Uses Network to Improve Patient Care, 2014, from http://www.cisco.com/c/dam/assets/global/EA/assets/pdf/CCHE_AFNCI_Digital_Hospital_case_study_for_final_Cisco_approval.pdf.

Szajna, B. (1994). Software evaluation and choice: predictive validation of the technology acceptance instrument. Mis Quarterly, 319-324.

Talla, M., & Valverde, R. (2012). Data oriented and Process oriented Strategies for Legacy Information Systems Reengineering. ACEEE International Journal on Information Technology, 2(1).

Tan, J. (2005). E-health care information systems: an introduction for students and professionals: John Wiley & Sons.

Tashakkori, A., & Creswell, J. W. (2007). Editorial: The new era of mixed methods. Journal of mixed methods research, 1(1), 3-7.

Tassa, T., & Gudes, E. (2012). Secure distributed computation of anonymized views of shared databases. ACM Transactions on Database Systems (TODS), 37(2), 11.

Taylor, B. J., Kermode, S., & Roberts, K. (2006). Research in nursing and health care: Evidence for practice.

Taylor, C., & Gibbs, G. (2010). What is Qualitative Data Analysis (QDA)? Retrieved April, 22, 2011.

Taylor, S., & Todd, P. (1995). Assessing IT usage: The role of prior experience. Mis Quarterly, 561-570.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. Information Systems Research, 6(2), 144-176.

Thomas, G. (2011). A typology for the case study in social science following a review of definition, discourse, and structure. Qualitative Inquiry, 17(6), 511-521.

Tierney, W. M., Achieng, M., Baker, E., Bell, A., Biondich, P., Braitstein, P., . . . McKown, B. (2010). Experience implementing electronic health records in three East African countries. Stud Health Technol Inform, 160(Pt 1), 371-375.

Trubow, G. B., & Hudson, D. L. (1978). Right to Financial Privacy Act of 1978: New Protection from Federal Intrusion, The. J. Marshall J. Prac. & Proc., 12, 487.

Truta, T. M., & Vinay, B. (2006). Privacy protection: p-sensitive k-anonymity property. Paper presented at the Data Engineering Workshops, 2006. Proceedings. 22nd International Conference on.

Tsui, F.-C., Espino, J. U., Dato, V. M., Gesteland, P. H., Hutman, J., & Wagner, M. M. (2003). Technical description of RODS: a real-time public health surveillance system. Journal of the American Medical Informatics Association, 10(5), 399-408.

Turner, M., Kitchenham, B., Brereton, P., Charters, S., & Budgen, D. (2010). Does the technology acceptance model predict actual use? A systematic literature review. Information and Software Technology, 52(5), 463-479.

Unertl, K. M., Johnson, K. B., & Lorenzi, N. M. (2012). Health information exchange technology on the front lines of healthcare: workflow factors and patterns of use. Journal of the American Medical Informatics Association, 19(3), 392-400.

Vaidya, J., Zhu, M., & Clifton, C. W. (2006). Privacy preserving data mining (Vol. 19): Springer-Verlag New York Inc.

Vaishnavi, V., Vaishnavi, V. K., & Kuechler, W. (2007). Design science research methods and patterns: innovating information and communication technology: Auerbach Pub.

van de Wetering, R., & Batenburg, R. (2009). A PACS maturity model: a systematic meta-analytic review on maturation and evolvability of PACS in the hospital enterprise. International Journal of Medical Informatics, 78(2), 127-140.

Van de Wetering, R., Batenburg, R., & Lederman, R. (2010). Evolutionistic or revolutionary paths? A PACS maturity model for strategic situational planning. International journal of computer assisted radiology and surgery, 5(4), 401-409.

Van Der Meijden, M., Tange, H. J., Troost, J., & Hasman, A. (2003). Determinants of success of inpatient clinical information systems: a literature review. Journal of the American Medical Informatics Association, 10(3), 235-243.

VanVactor, J. D. (2012). Collaborative leadership model in the management of health care. Journal of Business Research, 65(4), 555-561.

Vedder, A. (2011). Privacy 3.0 Innovating Government (pp. 17-28): Springer.

Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived ease of use: Development and test*. Decision Sciences, 27(3), 451-481.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), 186-204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. Mis Quarterly, 425-478.

Wallis, K. (2006). Technology And Health Information Privacy: Consumers And The Implementation Of Digital Medical Records Technology.

Walter, Z., & Lopez, M. S. (2008). Physician acceptance of information technologies: Role of perceived threat to professional autonomy. Decision Support Systems, 46(1), 206-215.

Wang, B., & Yang, J. (2011). The state of the art and tendency of privacy preserving data mining.

Wang, C., Wang, Q., Ren, K., & Lou, W. (2010). Privacy-preserving public auditing for data storage security in cloud computing. Paper presented at the INFOCOM, 2010 Proceedings IEEE.

Wang, S. J., Middleton, B., Prosser, L. A., Bardon, C. G., Spurr, C. D., Carchidi, P. J., . . . Sussman, A. J. (2003). A cost-benefit analysis of electronic medical records in primary care. The American journal of medicine, 114(5), 397-403.

Wang, Y.-S., Wang, Y.-M., Lin, H.-H., & Tang, T.-I. (2003). Determinants of user acceptance of internet banking: an empirical study. International Journal of Service Industry Management, 14(5), 501-519.

Warner, S. L. (1965). Randomized response: A survey technique for eliminating evasive answer bias. Journal of the American Statistical Association, 63-69.

Warren, S. D., & Brandeis, L. D. (1890). The right to privacy. Harvard law review, 4(5), 193-220.

Weaver, K., & Olson, J. K. (2006). Understanding paradigms used for nursing research. Journal of Advanced Nursing, 53(4), 459-469.

Weber, R. (1987). Toward a theory of artifacts: A paradigmatic base for information systems research. Journal of Information Systems, 1(2), 3-19.

Weir, C. R., Hammond, K. W., Embi, P. J., Efthimiadis, E. N., Thielke, S. M., & Hedeen, A. N. (2011). An exploration of the impact of computerized patient documentation on clinical collaboration. International Journal of Medical Informatics, 80(8), e62-e71.

Weßel, C., Weymann, F., & Spreckelsen, C. (2006). Streamlining Qualitative Research Methods for Medical Informatics-A Methodological Approach. Paper and Poster. Maastricht NL: MIE.

Westin, A. (1970). Privacy and freedom. 1967. Atheneum, New York.

Wickramasinghe, N., & Geisler, E. (2008). Encyclopedia of Healthcare Information Systems (3 Volumes) (Vol. Hershey, PA, USA): IGI Global.

Williams, K., Solodar, H. S., Saul, H. C., & Rules, A. S. (2007). Health Insurance Portability and Accountability Act (HIPAA) Fundamentals. Audiology practice management, 3.

Willms, D., & Johnson, N. (1993). Essentials in Qualitative Research. A Notebook for the Field, McMaster University, Newbury Park, Ca.

Wong, L. (2008). Data analysis in qualitative research: A brief guide to using NVivo. Malaysian Family Physician, 3(1), 14-20.

Wu, S., Chaudhry, B., Wang, J., Maglione, M., Mojica, W., Roth, E., . . . Shekelle, P. G. (2006). Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Annals of internal medicine, 144(10), 742-752.

Yang, H., Liu, K., & Li, W. (2010). Adaptive requirement-driven architecture for integrated healthcare systems. Journal of Computers, 5(2), 186-193.

Yang, T.-H., Sun, Y. S., & Lai, F. (2009). A scalable healthcare information system based on a service-oriented architecture. Journal of medical systems, 35(3), 391-407.

Yang, T.-H., Sun, Y. S., & Lai, F. (2011). A scalable healthcare information system based on a service-oriented architecture. Journal of medical systems, 35(3), 391-407.

Yang, Y., Qin, T.-f., Jiang, J.-n., & Liu, Z.-m. (2008). Distributed Medical Information System for Chronic Viral Hepatitis. Paper presented at the Information Science and Engineering, 2008. ISISE'08. International Symposium on.

Yang, Z., Zhong, S., & Wright, R. N. (2005). Anonymity-preserving data collection.

Yarbrough, A. K., & Smith, T. B. (2007). Technology Acceptance among Physicians A New Take on TAM. Medical Care Research and Review, 64(6), 650-672.

Yin, R. K. (2003). Case study research: Design and methods (Vol. 5): sage.

Yin, R. K. (2009). Case study research: Design and methods (Vol. 5): Sage publications, INC.

Yin Robert, K. (1994). Case study research: Design and methods. sage publications.

Yousafzai, S. Y., Foxall, G. R., & Pallister, J. G. (2007). Technology acceptance: a meta-analysis of the TAM: Part 1. Journal of Modelling in Management, 2(3), 251-280.

Yu, H.-J., Lai, H.-S., Chen, K.-H., Chou, H.-C., Wu, J.-M., Dorjgochoo, S., . . . Lai, F. (2013). A sharable cloud-based pancreaticoduodenectomy collaborative database for physicians: Emphasis on security and clinical rule supporting. Computer Methods and Programs in Biomedicine, 111(2), 488-497. doi: http://dx.doi.org/10.1016/j.cmpb.2013.04.019

Yu, W., & Chekhanovskiy, M. A. (2007). An electronic health record content protection system using smartcard and PMR. Paper presented at the e-Health Networking, Application and Services, 2007 9th International Conference on.

Yusof, M. M., Kuljis, J., Papazafeiropoulou, A., & Stergioulas, L. K. (2008). An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). International Journal of Medical Informatics, 77(6), 386-398.

Zheng, K., Padman, R., Krackhardt, D., Johnson, M. P., & Diamond, H. S. (2010). Social networks and physician adoption of electronic health records: insights from an empirical study. Journal of the American Medical Informatics Association, 17(3), 328-336.

Zikmund, W. G. (2003). Business Research Methods, Mason, Ohio, South-Western. X the Restaurant Behaviour of the Berlin People.

LIST OF PUBLICATION

Asmaa H.Rashid and Norizan Mohd Yasin. (2011) Privacy Preserving Data Publishing: (Review). International Journal of the Physical Sciences (IJPS): 11-1795 (Accepted ISI-Cited Publication).

Asmaa H.Rashid and Norizan Mohd Yasin. (2011) Controlling the Publication of Medical Data Based on Customer Relationship Management: A Review. Scientific Research and Essays (SRE): 11-862 (Accepted ISI-Cited Publication).

Rashid, A. (2011). Protect Privacy of Medical Information Based on Anonymization Model. Paper presented at the 3rd International Conference on Machine Learning and Computing (ICMLC 2011), Singapore (ISI-Proceeding).

Rashid, A. H., & Yasin, N. B. M. (2012). Anonymization Approach for Protect Privacy of Medical Data and Knowledge Management. Chapter in Book "Medical Informatics". DOI: 10.5772/37190.

Rashid, A. H., & Yasin, N. M. (2014). Generalization Technique for Privacy Preserving of Medical Information. International Journal of Engineering and Technology, 6(4).

Asmaa H.Rashid and Norizan Mohd Yasin. (2013) Collaborative Healthcare Information Systems based Privacy Preservation using K - Anonymization Model. IEEE Journal of Biomedical and Health Informatics (Under Review) (ISI-Journal).

Asmaa H.Rashid and Norizan Mohd Yasin. (2013) Investigation to Adoption of Collaborative Health Information Systems using Extended Technology Acceptance Model: A Qualitative Research Study. Theoretical Computer Science (Under Review) (ISI-Journal).

APPENDICES

Appendix A

Through a written letter and personal visits, the researcher informed National Cancer Institute dean and hospital manager about the upcoming study. Then, official permission was obtained from the national cancer institute to conduct this study, of National Cancer Institute, Cairo Governorate, Ministry of Health, Egypt before gathering any information as shown in this APPENDIX.

National Cancer Institute

Cairo – Arab Republic of Egypt

Permission to Conduct Research

1. Official Document in Arabic
2. English Translation
3. Confirmation Letters from University of Malaya

أ.د عــلاء الحـــداد

عميد المعهد القومي للاورام – القاهرة - جمهورية مصر العربية

السلام عليكم ورحمة الله تعالى وبركاته, وبعد:

م/ تيسير مهمة باحث

الرجاء التفضل بالموافقة على تيسير مهمة الباحثة:

اسمـــاء حـــاتم رشيـــد

من كلية الحاسبات وتكنولوجيا المعلومات – جامعة مالايا بدولة ماليزيا, لأجراء دراسة بحثية في المعهد القومي للاورام والمستشفى التعليمي التابع له, البحث بعنوان / الحفاظ على خصوصية المعلومات الطبية في الانشطة البحثية التعاونية باستخدام نظم المعلومات الصحية , وذلك لأستكمال متطلبات الحصول على درجة الدكتوارة.

ولكم مني جزيل الشكر والتقدير,,,

المرفقات :

1 - كتاب تأييد من جامعة مالايا الى المعهد القومي للاورام.
2 -كتاب تأييد من جامعة مالايا الى من يهمه الامر.

Rashid

مقدم الطلب
اسماء حاتم رشيد
طالبة دكتوارة
كلية الحاسبات وتكنولوجيا المعلومات
جامعة مالايا – ماليزيا

أ.د خـــالد ابو العينين

مدير مستشفى المعهد القومي للاورام – القاهرة - جمهورية مصر العربية

السلام عليكم ورحمة الله تعالى وبركاته, وبعد:

م/ تيسير مهمة باحث

الرجاء التـفضل بالموافقة على تيسير مهمة الباحثة:

اسمـــاء حـــاتم رشيـــد

من كلية الحاسبات وتكنولوجيا المعلومات – جامعة مالايا بدولة ماليزيا, لأجراء دراسة بحثية في المعهد القومي للاورام, البحث بعنوان / الحفاظ على خصوصية البيانات الطبية في الانشطة البحثية التعاونية في القطاع الطبي , وذلك لأستكمال متطلبات الحصول على درجة الدكتوارة.

ولكم مني جزيل الشكر والتقدير,,,

المرفقات :

1 - كتاب تأييد من جامعة مالايا الى المعهد القومي للاورام.
2 -كتاب تأييد من جامعة مالايا الى من يهمه الامر.

Rashid

مقدم الطلب
اسماء حاتم رشيد
طالبة دكتوارة
كلية الحاسبات وتكنولوجيا المعلومات
جامعة مالايا – ماليزيا

Prof .Dr Alaa Hadad

Dean of the National Cancer Institute
Cairo
Arab Republic of Egypt

Subject: Facilitating the Mission of Researcher /Asmaa Hatem Rashid

Dear Sir

Please facilitate the mission of researcher / Asmaa Hatem Rashid, student of the Faculty of Computer Sciences and Information Technology, University of Malaya - Malaysia. In order to conduct the research study at National Cancer Institute (NCI) in Cairo - Egypt. The subject of the research is "Privacy Preservation of Medical Information in Collaborative Research Using Healthcare Information Systems", for completion the PhD degree requirements.

Appreciating your Consideration and Cooperation

Rashid

Applicant
Asmaa Hatem Rashid
PhD Candidate
Faculty of Computer Sciences and Information Technology
University of Malaya – Malaysia

Prof .Dr Khaled abou Elenin

Hospital Manager
National Cancer Institute
Cairo
Arab Republic of Egypt

Subject: Facilitating the Mission of Researcher /Asmaa Hatem Rashid

Dear Sir

Please facilitate the mission of researcher / Asmaa Hatem Rashid, student of the Faculty of Computer Sciences and Information Technology, University of Malaya - Malaysia. In order to conduct the research study at National Cancer Institute (NCI) in Cairo - Egypt. The subject of the research is "Privacy Preservation of Medical Information in Collaborative Research Using Healthcare Information Systems", for completion the PhD degree requirements.

Appreciating your Consideration and Cooperation

Rashid

Applicant
Asmaa Hatem Rashid
PhD Candidate
Faculty of Computer Sciences and Information Technology
University of Malaya – Malaysia

UNIVERSITY
OF MALAYA

UM.W/IT/WHA100031

Date: 7 August 2012

NATIONAL CANCER INSTITUTE (NCI)
CAIRO UNIVERSITY, EGYPT

Dear Sir/Madam,

DOCTOR OF PHILOSOPHY CANDIDATURE

NAME OF CANDIDATE	:	**ASMAA HATEM RASHID**
PASSPORT NO.	:	**G2020396**
MATRIC NO.	:	**WHA100031**

This is to confirm that the above-mentioned name is currently registered as a Doctor of Philosophy candidate at the Faculty of Computer Science and Information Technology, University of Malaya under the supervision of Dr. Norizan Mohd Yasin. The candidate's field of research is in Computer Science (Information System).

Her initial registration for the programme was on 30 December 2010, Semester II, 2010/2011 session and the maximum period of study of twelve (12) semesters will expire at the end of Semester 1 of the 2016/2017 academic session.

Thank you.

Yours faithfully,

ASSOC. PROF. DR. MISS LAIHA MAT KIAH
Deputy Dean (Postgraduate)

c.c. Candidate's File

Faculty of Computer Science & Information Technology, University of Malaya, 50603 Kuala Lumpur, MALAYSIA
Tel: (603) 7967 6300 / 7967 6301 / 7967 6306 / 7967 6307 • Fax: (603) 7957 9249 • http://www.fsktm.um.edu.my

UNIVERSITY OF MALAYA

UM.W/IT/ WHA100031

Date: 30th January 2012

National Cancer Institute (NCI)
Cairo University, Egypt

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

DOCTOR OF PHILOSOPHY CANDIDATURE

NAME OF CANDIDATE : **ASMAA HATEM RASHID**

PASSPORT NO. : **G2020396**

MATRIC NO. : **WHA100031**

This is to confirm that the above-mentioned name is currently registered as a Doctor of Philosophy candidate at the Faculty of Computer Science and Information Technology, University of Malaya under the supervision of Dr. Norizan Mohd Yasin. The candidate's field of research is in Computer Science (Information System).

Her initial registration for the programme was on 30 December 2010, Semester II, 2010/2011 session and the maximum period of study of twelve (12) semesters will expire at the end of Semester 1 of the 2016/2017 academic session.

Thank you.

Yours faithfully,

ASSOC. PROF. DR. MISS LAIHA MAT KIAH
Deputy Dean (Postgraduate)

c.c. Candidate's File

Faculty of Computer Science & Information Technology, University of Malaya, 50603 Kuala Lumpur, MALAYSIA
Tel: (603) 7967 6300 / 7967 6301 / 7967 6306 / 7967 6307 • Fax: (603) 7957 9249 • http://www.fsktm.um.edu.my

Appendix B

Interview Guide

Research Study

Privacy Preservation of Medical Information in Collaborative Research Using Healthcare Information Systems

Interviewee Code:
Time of Interview:
Date:
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender:
Age:
Qualification:
Personal:
Year of employee:
Experience with computers:
Perceived experience:

Information sharing was become part of the routine activity of many individuals, companies, organizations, and government agencies. Privacy-preserving data publishing is a promising approach to information sharing, while preserving individual privacy and protecting sensitive information. Recent developments have helped improve decision making especially in the fields of medical sector. Through improvement the collaboration among distributed health information systems and provide medical information to catalyze the collaborative medical research.

The sources of data being collected for this study to understand the health information system environment in selected hospital through the patients data store , and use this data in medical research , any related information help to build collaboration medical research system .

The purpose of the study improvement the collaboration among distributed health information systems and provide medical information to catalyze the collaborative medical research based on privacy preserving for medical staff (physicians, researchers) , data holders (Patients), determined the factors affect of the acceptance and success health information system in healthcare organization, and collect the collaborative healthcare information system requirements of viewpoint of specialists in order to improve the collaboration among specialists and enhance the research findings. The interview will take among 30-120 minutes.

Interviewer: Asmaa Hatem Rashid
Organization: University of Malaya - Malaysia
Faculty: Computer Science and information Technology

Interview Questions:

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?

Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?

Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?

Question (4): Can you explain about the activities of medical research activities in your hospital.

Question (5): What are the benefits of the (BiOSCED) activities?

Question (6): Are there any health information systems to manage medical research activities in your hospital?

Question (7): Is there any database in your hospital, can you tell me something about it?

Question (8): What are the elements of this database?

Question (9): What kinds of data are stored in the (BiOSCED) database?

Question (10): Are there any connections between HISs in your hospital departments.

Question (11): Do researchers (i.e. physicians, experts) sharing healthcare information using HISs in your hospital?

Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?

Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?

Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?

Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?

Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?

Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?

Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?

Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?

Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?

Thank the individuals for their cooperation and participation in this interview. Assure them of the confidentiality of the responses and the potential for future interviews.

Appendix C

In-depth Interview of Specialists in the Selected Egyptian Hospital

A data display matrix for analyzing patterns of responses for each specialist in the selected Egyptian hospital is shown below.

Interviewee Code: DNCI01
Date: 16/7/2011
Time of Interview: 10 am -11.15 am
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Female
Age: 55 years
Qualification: PhD in Medicine
Personal: Medical
Year of employee: More than 10 years
Experience with computers: More than 6 years
Perceived experience: High

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?

Response	**Initial Coding**	**Focussed Coding**
My experience weak in use HISs activities; due to poor technological infrastructure and time factor in our hospital. In addition to the activities of health information systems (HIS) in the medical field are limited, especially in terms of storing medical information about patients, to be used by the medical statisticians. Due to the lack of expertise and weak technological infrastructure, there is a big gap in adopting the health information systems in our hospital.	HIS activities are limited on the data storage and use in biostatistics. The adoption of HIS is very weak, due to the lack of expertise in the domain of health informatics.	Adoption of HIS is very weak, HIS activity limited on storage data. Lack of expertise in the domain of health informatics.

Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
All hospital departments are interested in medical data; however, the Biostatistics and cancer epidemiology department deals with patients aggregate data.	Biostatistics and cancer epidemiology department uses the aggregation data, among all hospital departments.	BiOSCED is interested in collect healthcare data of all hospital departments.
Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
Patient information is stored on computers and this data is used in medical statistics for issuing periodic reports about the status of cancer in this country.	Patient's data are stored and used it biostatistics and periodic reports on cancer in the country are generated.	Storing patient's data and used in biostatistics.
Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
The medical research unit is not a separate unit, but the research activities are included in the BiOSCED department. This department involves in preparation, follow-up and statistical analysis of all research plans in various fields of cancer, and registering cancer patients in collaboration with the National Cancer Network.	There is no separate unit for medical research; the BiOSCED also deals with research activities such as, preparation, planning, biostatistics analysis for different cancer types, collaboration with national cancer network, to register the cancer cases.	No medical research system available in selected hospital.

Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
Provide statistics and medical data, to facilitate the prevention and control the spread of disease, provide the necessary data to the research students, to conduct their research and improve the quality of researches.	Provide a vision for the future, to prevent and control the spread of disease, and improve the medical research quality.	Provide a vision for the future to help control the spread of diseases and prevention.
Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No information system is available to manage and control the medical research unit; hence, the process of sharing medical data is very weak.	No information system is available to manage and control the medical research unit; hence, the process of sharing medical data is very weak.	No information system available to manage and control the medical research unit and medical data sharing.
Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
Yes, there are medical databases in the National Cancer Institute, where the patients' records stored, which include the case history of the patients comprising their health condition, demographic information etc. The details are electronically recorded by the medical statisticians, based on the in the information recorded manually in the paper-based system.	Simple database is available just to store the patient records, sometimes the data in DB is not accurate, and the most of the works in own hospital depend on the paper based system.	Simple data based, majority of the work in own hospital depend on the paper based system.

Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Patient data are divided as administrative, therapeutic information, financial transaction and personal information.	Patient's demographic info, administrative and therapeutic information, and financial transaction, personal, information.	Patient data and administrative information.
Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
Patient data, medical departments, Administrative Information.	Patient data, medical departments, Administrative Information.	Patient data and administrative information.
Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
There are no connections between the HISs and other sections of the Institute, where, each department manages its work and patients belonging to the department, independent and organized particulars, the functions differ from one department to another. There is a need system to collect data from different hospital departments.	No connection among own hospital departments, works are dealt independently.	No connection among own hospital departments and independent units. Need system to collect data from different hospital departments.
Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No, they no share healthcare information among doctors, therapists, or even scientific research students in graduate department.	No share healthcare information is shared, through databases.	No share activities, lack collaboration among medical staff in the selected Egyptian hospital.

Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No, medical protocol for privacy and I think this is one of the strongest reasons for the lack of data sharing or medical expertise by medical staff.	No privacy preserving protocol, hence there is a lack of data sharing among medical staff.	No privacy preserving protocol in sharing healthcare data (hard copy or soft copy) among physicians and researchers in the selected hospital.
Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
If possible to clarify meaning data privacy, the intent of maintaining the privacy of data, such as: the medical data of patients, medical expertise and medical specialties and etc. It is very crucial to secure the privacy of the medical staff patients and even research students. The weakness in security might lead to the misuse of personal and official records. This poses a great threat among the users; hence they refrain from recording and sharing details in HIS.	Data might be misused by untrusted parties.	The weakness in security might lead to the misuse of personal and official records.
Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Yes, surely we can improve the trust in our healthcare services by publishing and updating the medical information, and reveal the percentages about the success rate of treatments. In	Integrate healthcare information system. Yes, surely we can improve the trust in our healthcare services by publishing and updating the medical information, and reveal	Necessity of having integrated healthcare information system in order to improve the trust in our healthcare services by publishing and updating the medical information, and reveal

fact, this information can be collected from by integrating the healthcare information system among the different departments in selected hospital.	the percentages about the success rate of treatments.	the percentages about the success rate of treatments.
Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?		
Response	**Initial Coding**	**Focussed Coding**
To the extent Very Good increases the level of medical services and scientific research. Because the presence of Medical Research Unit in the hospital collects and analyzes medical data in ways very logical scientific extraction results have a significant positive impact on the level of medical services, and the level of scientific research. The value of scientific research large and very effective if a joint research among a group of researchers from different sections where they are studying the subject from different perspectives, using HISs can manage and control the medical data for research and allowing to reach reliable results and at the same time this leads to improved decision-making processes proper medical leading to better health and time less.	the work of medical research system increase the quality and improvement the medical services and medical research through the integration system among the researchers providing the medical data for studying and extract right medical decision, leading to better health and time less. In addition the using HISs can manage and control the medical data for research.	Medical Research system activities increase the quality and improvement of healthcare services and medical research through the integration system, and manage and control the medical data for research.

Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Certainly health systems for hospitals is very useful if Free and used according to the needs of the organization and provision of medical informatics experts to explain all the services and operations of the system in a scientific way is simple and uncomplicated. The existence of such systems helps to collect medical data from different sections in the hospital at the same time for patients helps to understand and easy to diagnose the condition in less time this for patients, but for the scientific research it will provide medical database real reliable thus increasing the quality of results joint medical research and will be very encouraging if it is based on the protection of privacy on two levels for patient data and medical staff data, researchers and certainly increase the level of medical decision right which leads to a healthy life.	Collaborative healthcare information system is very useful when used according to the needs of the medical organization, this process helpful to integration among different medical organization units , centralized data provider, helps to understand and easy to diagnose the condition in less time this for patients on real life time . Viewpoint of the medical research perspective it will provide medical database real reliable.	The medical staff need to system is simple and uncomplicated to use through the dynamic work within hospital environment.
Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?		
Response	**Initial Coding**	**Focussed Coding**
We need to collect medical data from all hospital departments including the Patient's information, medical departments, treatments,	We need to collect medical data from all hospital departments including the Patient's information, medical departments, treatments,	Patient's information, medical staff, and treatment available.

medical staff, and administrative information. Moreover, if this information is stored research system will be helpful to improve healthcare services and raise the level and efficacy of scientific research.	medical staff, and administrative information. Moreover, if this information is stored research system will be helpful to improve healthcare services and raise the level and efficacy of scientific research.	
Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		
Response	**Initial Coding**	**Focussed Coding**
Provide medical information full of patients, whether administrative or therapeutic or clinical, provide information about the medical staff available and the scientific expertise available to them and the areas of their jurisdiction minute, providing a database of graduate students from a reliable source of data is true and accurate and reflect the existing reality. We need system provided search function for the information with regard to patients information, medical staff available, and the scientific expertise available to them and the areas of their jurisdiction minute. In addition provide database of graduate students and research areas available.	Search function for the information with regard to patients information, medical staff available, and the scientific expertise available to them and the areas of their jurisdiction minute. In addition provide database of graduate students and research areas available.	Search function for the information with regard to patients information, medical staff available, and the scientific expertise available to them and the areas of their jurisdiction minute. In addition provide database of graduate students and research areas available.
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
It is essential to provide reliable sources for research works,	Provide reliable sources of the medical data, and easy access to	Reliable sources of the medical data through the web

including medical information of patients, details about medical staff and specialties, experiences of scientific and therapeutic reflecting medical fact recorded through health information system. It could far better if this information can be accessed through the network, so that the concerned parties refrain from meeting personally, whereby the confidentiality can be protected.	this data through the web application, for protecting data privacy, all these will be useful for researchers and minimizes cost and time.	application, easy access to this data for privacy preserving.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
The collaboration among physicians from same/different healthcare organizations is crucial issue. The collaboration among physicians leads to improve the quality of service in patients' treatment, research, and performance. Besides to organize of research activities According to me, the cooperation among researchers from different organizations, for conducting joint research activities, especially in health care is very crucial. The cooperation among the researchers will enhance the quality of service, research and performance. The coordination of research activities will bring a lot of benefits to the country as a whole, especially in controlling cancer.	Collaborative research improves performance, to get the new knowledge in terms of treating patients and research findings. The collaboration among physicians from same/different healthcare organizations is crucial issue. The collaboration among physicians leads to improve the quality of service in patients' treatment, research, and performance	Collaborative research improves performance, to get the new knowledge in terms of treating patients and research findings. The collaboration among physicians from same/different healthcare organizations is crucial issue. The collaboration among physicians leads to improve the quality of service in patients' treatment, research, and performance.

Interviewee Code: DNCI02
Date: 23/7/2011
Time of Interview: 12 am -1 pm
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Male
Age: 60
Qualification: PhD in Medicine
Personal: Medical
Year of employee: More than 10 years
Experience with computers: between 4 to 6 years
Perceived experience: Mediocre

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?		
Response	**Initial Coding**	**Focussed Coding**
Health information systems are important in the health sector, if there an appropriate environment of medical staff intern on the use and the presence of experts from the medical informatics, these systems are helpful in carrying out a lot of functions, however, due to the limitations of the data storage, we are forced to use 14 system on different locations of the institute, which makes it to difficult to deal with the data, where the medical staff treated with these regimes are very weak this is due to the weak technological background and lack of time, Health information systems , necessity in the health field. The adoption of HISs in our hospital is very weak, due to the lack of medical informatics staff, and the complexity of various systems implemented in our hospital, the activities of	Health information systems are crucial in the health field. The adoption of HISs in hospital is very weak due to the lack of medical informatics staff, and implementation of different systems in our hospital, hence dealing with all those systems become more complex. The activities of HISs in our hospital are limited on the data storage, where medical the staffs is treated very weakly with these regimes mainly due to the weak technological background and lack of time.	HISs is crucial in medical sector, adoption of HISs in our hospital is very weak, lack in medical informatics staff, and medical staff experiences weak.

HISs in our hospital are limited on the data storage, and where medical the staff is treated very weakly with these regimes mainly due to the weak technological background and lack of time.		
Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
Biostatistics and Cancer Epidemiology Department (BiOSCED) deal with medical data for second purpose in Biostatistics. The (BiOSCED) activities depend patient's records that are stored as a paper based system, where the medical files of patients are stored in the unit. The medical file consists of 20-40 archives per paper file. There are 15 employees, who enter patient files categorized, by the type of cancer, furthermore the 5 experts in Computer Science and Systems Analysis, and work periodically and are divided by groups based on working days. The medical data are not used in other systems because it is the first independent system and there is no contact with the each other, and in most cases there may be no officer responsible for the introduction of medical data for a specific department, it sometimes leads to the existence of such nominal systems	(BiOSCED) department deal and collect the medical data for second purpose in Biostatistics, from all hospital departments, most work of this department depends on the data entered from patients records, no connection among hospital DB, lack of medical informatics and information system staff to organize the functions of hospital system.	(BiOSCED) department deals with medical data, no connection with independence departments, lack of medical informatics and information system staff, most work depends on paper based system.

without any benefit and this is due to the lack of specialized staff in medical informatics.		
Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
Department of Statistics and medical epidemiology of cancer objectives is limited to storing medical data from various medical departments in the Institute and analysis statistics and follow-up results from the analysis of data on increasing diseases and their geographical distribution and age groups and some causes of importance according to the required analysis, and work periodicals such statistics. This main objective of the section and the second some goals like learning objective where section granted a Master Degree in medical statisticians and cancer epidemiology. Section consists of four units as follows Biostatistics Cancer epidemiology Cancer prevention Computerized information system. but functions of this department is poor potential technological weaken the work of this section which makes it very difficult to implement the above activities.	Collecting medical data and doing biostatistics, and publish the biostatistics result to anode and prevention the diseases, second objective in learning in biostatistics. Section consists of four units as follows Biostatistics Cancer epidemiology Cancer prevention Computerized information system. but functions of this department is poor potential technological weaken the work of this section which makes it very difficult to implement the above activities	Collecting medical data and use it in biostatistics, this department includes the computerized information system unit. but functions of this department is poor potential technological weaken the work of this section which makes it very difficult to implement the above activities.

Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
There are no special unit or specialized in medical research, but there is part of the activities of Department of Medical Statistics and Cancer Epidemiology graduate students of interest such as the provision of medical information and provide statistics precedent and so on.	No medical research system available, but the medical research activities are a part from the Department of biostatistics and Cancer Epidemiology, and provide the postgraduate students the medical data.	No medical research system available.
Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
Provide statistics medical progress of cancer and the most important reasons for proliferation and it has a very big role in prevention of medical and early detection of disease, and to make plans and to provide strategies for future work, but frankly weak potential technological weaken the work of this section which makes it very difficult to implement the above activities.	Provide the important information for the future vision for the cancer progress and determined the most cancer reasons, the work in this department take a long time to execute the prepare the biostatistics analysis and reporting, because the technology infrastructure is weak no system manage and control the huge medical data from different hospital departments .	Provide the important information for the future vision for the cancer progress and determined the most cancer reasons, no system available to manage the department activities.
Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
In fact, there is no research system available; this is gap of in medical research in our hospital. Therefore we rely on	No system for the medical research system, and the available medical data is not accurate, most studies in our	No system for the medical research system, and the available medical data not accurate. most studies in our

external studies to develop remedies of illness. In terms of the medical research of the Institute, the individual researchers rely on medical data; however there is a lack of accuracy in the medical data hence has to rely on real cases.	hospital depend on real cases.	hospital depend on real cases.
Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
There are a lot of databases at the Institute, where each partition uses a particular system in the management of medical data for patients receiving the treatment, as each department works individually and in a different way from the other sections.	There are a lot of databases at our hospital, independent units and works.	More than one DB at the hospital, independent unit's internal database.
Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Patient data are divided as administrative and therapeutic information, and financial transaction. Pharmacy and medicine details are stored. The information stored is simple and often inaccurate because of the difference in the time of data entry at a time.	Patients data includes administrative and therapeutic information, and financial transaction, simple information, sometimes this data is not accurate because different data types and employee data entry.	Simple patient's data and administrative information, available data not accurate
Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
We need big medical system to be integrated between various sections of the institute, where	Integration of data from all hospital departments, if there is information in the system	Centralized database includes integration of data from different hospital departments

the information we need in this system must include the different sections, the medical staff of each department, medical data for patients, so that it separates patient information and medical history and therapeutic at the institute and give uniform information in all sections. The managerial and financial, department displays medical data per sections and display rates of the disease and the number of patients at the institute at any given time, which means it gives a information about patient, based on a strong knowledge base to help the process of scientific research and give high quality and reliable of information reflecting the reality of the situation.	estimated based on a strong knowledge base to help in the process of scientific research and give high quality and reliable of information reflecting the reality of the situation.	and available data is accurate.
Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
There is no connection among the sections of the institute, each department works independently and individually.	No connection and sharing data, units function independently.	No connection and sharing data.
Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Sad to say, no share in any of its forms, whether at the level of doctors, experts or students of scientific research, the work that we have characterized by individualism.	No collaboration among the medical staff (experts, physician). Individualism work	No collaboration lead to weak right medical decision making decision.

Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
None, or protocol agreements to maintain the confidentiality and privacy of data and this one of the most important factors in the lack of participation, whether at the level of treatment or medical research or expertise.	Privacy preserving protocol not available, this gap lead to lack (share or collaboration) (skills or data).	Privacy preserving protocol not available, this gap lead to lack share medical data.
Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Factors that affect the privacy of medical data or privacy of medical staff are: the misuse of data by unauthorized parties, lack of control in managing the HISs. These factors significantly impact the data privacy, which hinders the medical experts from entering valuable information in the systems and there are chances that the details of patients falling into unauthorized people.	The data privacy is affected by misuse of system by unauthorized parties, lack of control in managing the HISs.	The data privacy is affected by misuse of system by unauthorized parties.
Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
If it is possible to integrate the database, and if the data accurately describes the percentage of the success of treatment, and the health profile are regularly updated, then the trust of patients will be	Establishing integrated healthcare information system.	Necessity of having integrated healthcare information system.

improved towards hospital healthcare services, and also lead to support the medical research studies.		
Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?		
Response	**Initial Coding**	**Focussed Coding**
The presence of a medical research at the hospital are helpful in carrying out a lot of functions, increases the level of health and medical services for patients and medical staff, because such systems, operate on the analysis of the problems and gaps on the ground, process and get accurate and reliable scientific results of their application, in addition to the provision of accurate medical information, it increases the quality of the information extracted, which leads to quick medical decision and healthy life for patients and add new experiences for medical staff. These system in research unit provide cooperative work environment, leading to extract results from different studies from different case studies from many directions and different dimensions and this leads to raise the level of scientific research and this has a significant impact in improving the level of treatment and efficiency of scientific research. In conclusion these systems	The presence of a medical research at the hospital increases the level of health and medical services for patients and medical staff, because such systems operate on the analysis of the problems and gaps on the ground, process and get accurate and reliable scientific solutions based on their application. In conclusion these systems improve quality in work, tasks can complete in less time, and HISs improves the healthcare services and medical research studies.	Necessity of having medical research in hospital in order to improve the medical collaborative to increase the quality in healthcare services and right medical decision. In conclusion these systems improve quality in work, tasks can complete in less time, and HISs improves the healthcare services and medical research studies.

improve quality in work, tasks can complete in less time, and HISs improves the healthcare services and medical research studies.		
Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
The presence of health systems in hospitals itself are useful and has a clear impact in assisting patients and medical staff and units of scientific research, these systems can provide complete database and help the medical staff conduct work and research studies with less time and effort. However there is a lack of cooperation between the different sections at the level of the institute, or at the level of the growth of the hospitals it will serve and benefit the patients and medical staff in getting the best and inexpensive treatments of the best cadres specialized in the treatment of different cases in less time at the level of the patient and at the state level for government hospitals, which will increase the chance of collaborative scientific research that has a positive impact and is very good at the level of public health and scientific research in the country.	Collaborative healthcare information system is very useful when used according to the needs of the medical organization, this process helpful to integration among different medical organization units , centralized data provider, these systems can provide complete database and help the medical staff conduct work and research studies with less time and effort , helps to understand and easy to diagnose the condition in less time this for patients on real life time . from the medical research perspective it will provide medical database real reliable thus increasing the quality of results joint medical research and will be very encouraging if it is based on the protection of privacy on two levels for patient data and medical staff data, researchers and certainly increase the level of medical decision right which leads to a healthy life.	Necessity having the medical research based on information system to manage and control medical data, this system store accurate data helps in scientific research, and raise the level of public health. These systems increase the chance of collaborative scientific research that has a positive impact, these systems can provide complete database and help the medical staff conduct work and research studies with less time and effort, and is very good at the level of public health and scientific research in the country.

Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?		
Response	**Initial Coding**	**Focussed Coding**
Complete patient data, medical staff available in every hospital, medical specialties, different medications and treatment provided by each hospital or each unit, from my point of view this data will increase the success rate of treatment in less time and cost less for the patient and physicians.	Patient's data and details of medical staff, basic information related to better the treatment.	Share basic data related to better treatment and important in collaborative medical research.
Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		
Response	**Initial Coding**	**Focussed Coding**
In the case of providing a system for the unity of medical research, it is the most important processes required to provide a database of patients and medical staff and administrative information and therapeutic, and medicines used in the treatment, and medical expertise available with male disciplines. Provide a copy of all this information for graduate students, taking into account the confidentiality and privacy of the different data used.	Provide a database of patients and medical staff and administrative information and therapeutic, and medicines used in the treatment and medical expertise available with male disciplines, based on protecting data privacy.	Comprehensive medical database, accurate data useful and helpful in medical research studies.
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
In fact, from my personal experience, the existence of a	Provision the medical data needs in medical research, less	Reliable sources of the medical data through the web

system, serves graduate students in the provision of their needs of medical data necessary, to conduct research with less time and effort, and encourages conducting research and share ideas between researchers, and will greatly benefit for researchers. Furthermore, it could be beneficial if the systems allow us to access the data online, which might enable the research students and medical staff to perform their functions Effortlessly, especially in getting data very quickly. However, it is essential to maintain the privacy and confidentiality.	time and fees, and catalyzing the collaborative research through the share database based on privacy preserving.	application, easy access to this data based on privacy preserving.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
Medical cooperation in itself a great benefit in the medical sector and public health, it will enable us to develop plans and strategies in the management of diseases in the country and determine the causes of the different points of view and multiple instances All these have an impact on the early detection and prevention and raise the level of public health and scientific research and reliable results and to be adopted in different destinations.	Medical cooperation a great benefit in the medical sector, and prepare plan for the future health vision.	Necessity collaborative in medical sector to improve the healthcare services and medical research studies.

Interviewee Code: DNCI03
Date: 2/8/2011
Time of Interview: 1 pm -2.30 pm
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Female
Age: 63
Qualification: PhD in Medicine
Personal: Medical
Year of employee: More than 10 years
Experience with computers: between 4 to 6 years
Perceived experience: Low

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?		
Response	**Initial Coding**	**Focussed Coding**
I think the most important activities carried out by the health information system are medical data storage and retrieval, in the institute a number of systems are available, but their use is very weak, due to weak technological background knowledge and the lack of training and specialists in this field.	The HIS in hospital facilitates the storage and retrieval of medical data, different systems are adopted in hospital to manage various medical functions. The adoption of HIS in hospital is very weak, due to the lack of technological background knowledge and the lack of training and specialists in this field.	Limited HIS activities in hospital for medical data storage, the manage medical data in hospital difficult function because hospital adopt different system, this reflect weak technology background and lack medical informatics staff.
Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
The department that deals with medical data and processing is the Department of biostatistics and Epidemiology cancer.	Department of biostatistics and Epidemiology cancer, interesting to collecting data from different in NC, and used in second purposes.	(BiOSCED) collecting data and use it in second purposes such as biostatistics.

Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
Storing medical data from various departments and analyzing and extracting the results of cancer diseases in the country and future action plans, for the prevention and identification of the most important reasons for the spread of disease at the regional level.	Collecting medical data and use it in biostatistics, the data analysis in biostatistics department help to build the future plan and strategies to prevention from disease.	(BiOSCED) manage and share the biostatistics to other parties to prevention the disease.
Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
There is no specific medical research unit, within the activities of biostatistics attention to scientific research. However, if established, the medical research unit will be one of the most important units that focus on the study of diseases and epidemiology scientific means, to reflect the reality of the situation and realistic cases, raising the level of medical awareness and increase the quality of scientific research.	Medical research unit is not available in hospital. if established, the medical research unit will be one of the most important units that focus on the study of diseases and epidemiology.	Necessity having the medical research system in hospital to manage research activites.
Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
Dissemination of medical statistics and it helps to make future plans for the prevention and control of the reasons for the spread of disease.	Publish of medical statistics, this analysis help to helps to make future plans for the prevention and control of the reasons for the spread of disease.	Publisher of medical statistics, without refer to the raw data, this not help researchers to make more analysis from different perspective depend on different studies.

Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Naturally there is no health information system for scientific research; hence there is a lack of scientific research unit at the hospital.	No system to manage the medical research unit.	No system available to manage and control the medical research activities.
Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
In the database of biological department the patient information is stored, which is independent from the rest of sections, providing the database for medical tests carried out by the patient and the outcome, but it is not accurate because not all the tests and results are recorded due to the lack of time, staff and technology in the department.	The database of biological department includes the patient's data and medical tests, but not all of them are accurate because all the tests and results were properly recorded due to the lack of time, staff and technology in the department.	Limited database, data not accurate because lack of time and medical informatics staff.
Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Patient data, and information management and the required tests and the results.	Patient's data and administrative and therapeutic information.	Patients' data and administrative and therapeutic information.
Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
Data that we need in the department of medical statisticians are divided into	Integration data from all hospital departments.	Centralized database includes all hospital departments' data.

several sections, including medical data of private patients and their medical history and operations and medicines used therapy and related activities with information about the patient, a special section with information related to managerial private institute, including medical staff, embodied disciplines and medical operations, the number of patients processed by each doctor, and a section containing medical data from all sections where each patient must have a unified medical record number for all categories, and a special section for scientific research and topics that are traded, researchers and their specialties and backgrounds scientific and other relevant information.		
Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
No connection is available between the systems in hospital, where the systems are not linked with a network.	No connection and sharing among hospital departments.	No connection and sharing is available among the hospital departments, the systems work independently.
Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Experiences are not shared due to the weakness of time constraints and the large number	No collaboration among the medical staff. Lack of technology infrastructure of	Lack collaborative and share among the researchers (physicians, expert).

of patients to be treated by doctors; hence they do not have enough time to share their experiences, the lack of participation or database system to facilitate medical cooperation.	participation or database system to facilitate medical cooperation.	
Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
There is no roles or convention for the protection of medical data for patients and medical staff and this is one of the factors, hence there is lack of confidence in using these systems.	Privacy preserving protocol not available.	Privacy preserving protocol not available, this gap leads to lack collaborative.
Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Factors that affect the privacy of medical data using data in second's purposes not related to medical treatment and scientific research. Lack of a system to ensure the confidentiality and privacy of patient-level data and medical data used.	Factors that affect the privacy of medical data using data in purposes not related to medical treatment and scientific research.	Misuse data from non trust parties
Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
By publishing the percentage of the treatment success rate, updating the health profile will	Create the collaborative healthcare system to help in provide accurate data and	Necessity of having collaborative healthcare information system.

improve the patients trust in hospital healthcare services, and also lead to support the medical research studies.	publish data analysis , all this activities reflect the hospital healthcare services ,lead to support the medical research studies.	

Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?

Response	Initial Coding	Focussed Coding
Surely the presences of medical research systems at the hospital increases the quality and efficiency of medical treatment services, because these systems considers the reality of the situation and diseases on the ground and draws reliable conclusions and have a positive impact on the level of public health and help in management medical data in hospital.	The research medical systems will improve the healthcare services, this unit helps in controlling, investigating and actively conducting epidemiological surveillance and the preparation of contingency plans to prevent diseases.	Necessity of having medical research systems to improve the medical collaborative among healthcare provider in order to improve healthcare services.

Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?

Response	Initial Coding	Focussed Coding
Yes, the existence of these systems is very useful, if built and equipped, according to the needs of medical institutions. It will ensure confidentiality and privacy of data and staff, it will have an impact in the provision of accurate medical data from different units, to provide centralized medical database, which can be invoked in scientific research and extract information and medical knowledge, raising the level of medical decision right and raise	The provision of accurate medical data from different departments, to provide centralized medical database in scientific research and extract information and medical knowledge, raising the level of medical decision right and raise the level of public health.	Necessity having the medical research based on information system to manage and control medical data, this system store accurate data helps in scientific research, and raise the level of public health.

the level of public health.		
Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?		
Response	**Initial Coding**	**Focussed Coding**
All medical data, both at the level of patients or medical staff and information related to treatment and medicines available and medical devices available therapeutic units.	All information related to patients, medical staff available, medical specialties available, medical devices available. These data will be helpful to improve patients' treatment and scientific research	All information related to patients, medical staff available, medical specialties available, medical devices available. These data will be helpful to improve patients' treatment and scientific research.
Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		
Response	**Initial Coding**	**Focussed Coding**
One of the most important functions of scientific research management systems is to provide a database of patients and medical staff and administrative information, treatment, medications used in the treatment, and medical expertise available. Moreover, we need to generate report based on own needs in treatment or research.	Report generator based on own needs in treatment or research.	Report generator based on own needs in treatment or research.
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
A research system inductively helps students search for reliable medical information as reflecting real cases. However, providing this data it is one of the most important problems faced by the research students,	This system will be helpful in finding information among researchers and from the common areas of their research, leading the exchange of experiences and important studies. Also we need search	This system will be helpful in finding information among researchers and from the common areas of their research, leading the exchange of experiences and important studies. Also we need search

and they have to spend a long time in getting approvals and measures to use this data for the purposes of their study. This system will be helpful in finding information among researchers and from the common areas of their research, leading the exchange of experiences and important studies. Also we need search about the patients' information by departments or physicians in order to improve research findings.	about the patients' information by departments or physicians in order to improve research findings.	about the patients' information by departments or physicians in order to improve research findings.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
Cooperative in the medical field is very important; the unified medical decisions by a group of specialists leads to different areas in medical decision properly and lead to good health and cure, and raise the level of public health.	Medical cooperation a great benefit in the medical sector, and prepare plan for the future health vision, and right medical decision.	Necessity collaborative in medical sector to improve the healthcare services and medical research studies.

Interviewee Code: DNCI04
Date: 7/8/2011
Time of Interview: 12 am -1.30 pm
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Male
Age: 63
Qualification: PhD in Medicine
Personal: Medical
Year of employee: More than 10 years
Experience with computers: between 4 to 6 years
Perceived experience: Low

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?		
Response	**Initial Coding**	**Focussed Coding**
The health information system is used to store, organize and retrieve data. Generally the use of this system among the doctors is very weak due to the lack of training and technological knowhow, and don't forget the age effect for technology with deal. Furthermore, the weakness in the adoption of HISs in our hospital is mainly due to the lack of expertise to use the system.	HISs in hospital have limited activities, which include storing and organizing medical data, but the adoption of HISs in our hospital is weak, due to the weakness of the background of medical technology and the lack of training in this area.	HISs in our hospital have limited activities (store, organize) medical data, adoption is weak. Due to the weakness of the background of medical technology and the lack of training in this area.

Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
Department of Biostatistics and Cancer Epidemiology is more focused on the data collected from various departments in the hospital.	Department of Biostatistics and Cancer Epidemiology collect data from different hospital departments, and store to use for other purposes, such as medical research.	Department of Biostatistics and Cancer Epidemiology collect data and use for research purpose.

Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
Store the medical files of cases recorded in the medical institute, and analyze current and extract ratios of cancer and its spread, if medical information is recorded correctly, it will help in future work plans for controlling and treating the disease in the country and to identify new ways of treatment.	Analyze the store medical data, and extract the current ratios for cancer and its spread.	Analyze the medical data, and extract the current ratios for cancer and its spread. This is helpful to build future plan and strategies, to control cancer and management of medical data.
Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
There is no exclusive medical research unit; however, research activities are carried out within Department of Biostatistics and cancer Epidemiology. The research activities provide the data necessary for graduate students and students of scientific research.	No medical research unit available, research activities are carried out within Department of Biostatistics and cancer Epidemiology.	Medical research unit not available in hospital.
Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
The BiOSCED involves in analysis of data recorded at the institute and the concludes the current proportions of the disease in the country, and publishes the results, broken down by geographic areas and age groups and other factors of	Analyze the available medical data in hospital, to identify the ratio of cancer in the country, this ratios help to build strong future plan, to control cancer disease and management medical data .	Publish cancer statistics without referring the raw data used in analysis, this is helpful for gaining the medical knowledge, but can’t help the researchers to do another medical analysis, limit activities and results.

importance, and all these helps making plans in the fight against the disease at the regional level.		
Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No system is available to manage the medical research unit activities.	No system is available to manage and control the medical research unit activities.	No system is available to manage the medical research unit activities, and medical data.
Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
Yes, in the Department of Physiology we have a database, where the names of patients and some demographics data are stored. The available database very simple and not all the cases are stored in the database, due to the limitation of time and increased number of patients, and lack medical informatics staff to organize the technology activities. The work in our department depends on paper work, to facilitate the work of the medical unit for fast delivery.	Physiological database is very simple and not accurate, due to some factors such as, tight time, increase in the number of patients, lack medical informatics staff to organize the technology activities. The work in this department depends on paper based system.	Limited database, inaccurate data, factors affecting is lack of time, increase the number of patients, and medical informatics staff.
Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Patient data and administrative data, and medical examinations carried out, and tests that are required to be do.	Patient data, administrative data, patient profile (medical history).	Patient data, administrative data, patient profile (medical history).

Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
This is an interesting question, because the data types that are needed for stored at the biostatistics department must be comprehensive, including the all medical data, starting from, the patient data and describe the medical history, and data of medical staff available with scientific specialization and the number of patients and medical conditions and the degree of treatment and parity of healing, drug information used in the treatment, and the number of patients who used it, similarities and difference in treatment, and comprehensive management, financial transaction information. A special section stores the details of scientific research students and the types of studies and data who needed to complete the study. All these data will be very helpful in giving better treatment to patients.	Collaboration data from all hospital departments.	Centralized database includes all hospital departments' data.

Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
There is no connection between the existing systems at the institute. The existing systems and computers are not connected to the internet or internal networks.	No connection available among hospital departments.	No connection available, lack data sharing among different hospital departments.

Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No collaborative /sharing experiences, they are very weak due to time constraints and the large number of patients' ratio per doctor.	Lack of collaboration among medical staff, because the time constraints and the large number of patients to be treated by each doctor.	Lack of collaboration, and no system to manage the activities among the medical staff.
Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No, protocol to protect the confidentiality and privacy when using medical data systems, this reflects weak reliability of these systems, on the other hand, the lack of laws or rules that protect privacy could lead to a violation of personal data, whether at the level of patients or medical staff, who may exposed to the data damage, violation, such as using personal data and medical records for non-scientific purposes or medical.	Privacy preserving protocol not available.	Privacy preserving protocol not available, this gap leads to lack collaborative.
Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
One of the most important factors that affect privacy, the use of medical data available for non-scientific purposes, which may expose us to legal issue in the detection and violation of data privacy, and controlling the	Use the medical data in non-scientific purposes.	Misuse data from unauthorized parties.

use of these data, the lack of rules in use and share medical data.		
Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Yes, medical researchers can improve the healthcare by addressing the gaps and problems in medical sector, and try to study and find the better solutions for the health problems. By publishing the percentage the treatment success and updating the health profile improve the patients trust in hospital healthcare services.	We need a collaborative healthcare information system to provide the data for the medical research, and extract accurate result.	Necessity of having collaborative healthcare information system.
Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?		
Response	**Initial Coding**	**Focussed Coding**
The presence of a medical research at the hospital will have a clear impact and tangible quality of medical services and the results of scientific research, because these units focus on the problems that affect the patients, the problems that exist on the ground, and if the results of these researches are reliable it might impact the level of services, scientific research and the level of public health, and help in management medical data in hospital.	The presences of medical research systems at the hospital have a clear impact and tangible quality of medical services and the results of scientific research and control medical data in hospital.	The presences of medical research systems at the hospital have a clear impact and tangible quality of medical services and the results of scientific research and control medical data in hospital. In order to improve the collaborative activities among medical research in hospital environment.

Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Yes, these systems will be very useful if built and equipped according to the needs of medical institutions and its use would ensure confidentiality and privacy of data and staff, it will have an impact in the provision of medical data minutes from different healthcare providers, the centralized database can be invoked in scientific research and extract information and medical knowledge, which might enhance the level of taking right medical decisions.	The provision of accurate medical data from different departments and storage in centralized database, easy to extract information and medical knowledge. Raising the level of medical decision right and raise the level of public health.	Necessity of having the medical research unit depends on the information system to manage and control medical data, this system store accurate data help in scientific research, and raise the level of public health.

Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?		
Response	**Initial Coding**	**Focussed Coding**
Medical data for patients, and available medical staff and medicines as well as medical devices in various scientific departments.	All medical data, both at the level of patients or medical staff and information related to treatment and medicines available and medical devices available therapeutic units.	Share basic information related to the patient attributes and treatment, and medical devices.

Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		
Response	**Initial Coding**	**Focussed Coding**
Providing a database of patients and medical staff and administrative information and therapeutic, and medicines used	Provide accurate medical database includes comprehensive data helpful in treatment and medical research.	Provide accurate medical database includes comprehensive data helpful in treatment and medical research.

in the treatment and medical expertise available with the disciplines, and existing medical devices.		
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
Graduate students will enjoy huge benefits in the availability of such systems, the first benefit to them will be in the availability of medical data, as getting appropriate data is one of the biggest problem faced by the students, where they have to spend a lot of time and have to follow a lot of procedures. The next benefit will be a shared database between researchers, which helps to know the kinds of studies that are under discussion, which may help and encourage the participation of research among researchers. Furthermore, these systems must be available on line, which can be accessed from anywhere and at anytime.	Provision of accurate medical database, easy to access for researchers such as, web application, and catalyzing the collaborative research through the shared database based on privacy preserving.	Reliable sources of the medical data through the web application, easy access to this data based on privacy preserving.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
Collaboration among physicians supports the right medical decisions this in order to improve the patients' treatment. Moreover the collaboration are	Collaboration among physicians supports the right medical decisions this in order to improve the patients' treatment. Moreover the collaboration are	Necessity of collaboration in medical sector to improve the healthcare services and medical research studies. Moreover the collaboration are helpful in

helpful in enhance the quality of services and management healthcare activities. Furthermore, collaboration is valuable in medical field, for example, if case is being studied by many experts, there is a chance to get diverse opinions and they can have healthy discussions to come up with novel ideas for treating the case. However, a decision support system for the medical field could be more helpful in enhancing the quality of services and controlling the spread of the diseases. In fact cooperative research will be more beneficial than the individual research; furthermore it is also recommended and supported by the public Health Organization (WHO).	helpful in enhance the quality of services and management healthcare activities.	enhance the quality of services and management healthcare activities.

Interviewee Code: DNCI05
Date: 9/8/2011
Time of Interview: 10 am -12 am
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Male
Age: 51
Qualification: PhD in Medicine
Personal: Medical
Year of employee: less than 10 years
Experience with computers: 1 to 3 years
Perceived experience: Mediocre

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?		
Response	**Initial Coding**	**Focussed Coding**
Data storage and retrieval are the main activities of the HIS in hospital. The systems facilitates the data storage and retrieval processes, however the adoption of the system are very weak, due to the lack of expertise.	HISs activities in hospital are limited to storage the medical data, reliability of these systems is weak.	HISs has limited activities to storage medical data , reliability of these system in hospital weak , most work depend on paper based system.
Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
Biostatistics and cancer epidemiology department is interested in medical data, aggregated from all hospital departments.	Biostatistics and cancer epidemiology department.	Biostatistics and cancer epidemiology department.
Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
The main task carried out by the Department of Biostatistics is collection and storage of medical data from different	(BiOSCED) objectives include collection of medical data from different hospital departments and used for other purposes	Collect medical data and used in second purpose such as biostatistics and medical research.

departments of the hospital and stored on a centralized database and use this data in medical statistics.	such as, Biostatistics and research.	
Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
Medical research unit is not available in hospital, but it is among the activities carried out by the Department of Biostatistics and Epidemiology Cancer attention to scientific research and provides the data necessary for graduate students.	Medical research unit in hospital not available.	Necessity of having medical research unit, to manage and control the research process.
Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
An analysis of medical data recorded at the hospital and concludes the current proportions of the disease in the country and offers the disease reasons.	Provide the important information for the future vision of the cancer progress and determine the reasons for cancer.	Provide the important information for the future vision and build strategy to control the cancer progress and determined the most cancer reasons.
Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No system is available to manage the medical research unit activities.	No system is available to manage the medical research unit activities.	No system is available to manage the medical research unit activities.

Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
Database is available in the Department of Biological Chemistry, where patient data and tests and materials available in the department are stored, simple data and I do not have experience in dealing with reality.	Simple database include the patients data and tests and materials available in the department.	Simple database and its adoption are weak (not accurate).
Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Patient data, administrative management, and medical examinations conducted by doctors.	Patient data, administrative management, and medical examinations conducted by doctors.	Patient data including administrative data, and medical history.
Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
Good question and very reasonable, the data contained in the database medical statistics must include all medical data in various sections of the hospital and the medical staff available, which means that comprehensive data on the status of the institute administrative and treatment in general and accurate.	Comprehensive data on the status of the institute administrative and treatment in general and accurate.	Comprehensive data on the status of the institute administrative and treatment in general and accurate.
Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
There is no connection among different departments in hospital.	No connection and sharing available among hospital departments.	No connection and share available among the hospital departments, independently work.

Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No, there is no such activity of sharing experiences and generally this is due to the tight schedule of doctors, as they have to deal with a lot of patients, hence they do not find time to share their experiences. Furthermore lack of technology and infrastructure is yet another reason for the non sharing activity.	No collaboration among the medical staff. Lack of technology infrastructure of participation or database system to facilitate medical cooperation.	Lack of the collaborative and share among the researchers, lack database system to facilitate medical cooperation.
Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
There is no protocol to protect the confidentiality and privacy when using medical information systems. For this reason No privacy protocol available to manage the collaborative activities.	No protocol available to manage the collaborative activities.	No protocol available to manage the collaborative activities.
Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
The use of medical data and personal data available for non-scientific purposes is the one of the biggest issues of data privacy.	Factors that affect the privacy of medical data using data in purposes not related to medical treatment and scientific research is the one of the biggest issues for data privacy.	The use of medical data and personal data available for non-scientific purposes is the one of the biggest issues for data privacy.

Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Yes, publishing the percentage of the successful treatments and updating the health profile, improves the patients trust in hospital healthcare services, which lead to support the medical research studies, and this is important for the achievement of health equity and for increasing the quality of a healthy life for everyone.	Developing collaborative healthcare system to help in provide accurate data and publish data analysis, all this activities reflect the hospital healthcare services, lead to support the medical research studies.	Necessity of having collaborative healthcare information system.
Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?		
Response	**Initial Coding**	**Focussed Coding**
Yes, definitely a scientific research unit at the hospital will have a significant positive effect on the level of medical services and the exact level of scientific research document on real cases.	Necessity of having medical research unit to improve the medical research and will have a significant positive effect on the level of medical services.	Necessity of having medical research unit to improve the medical collaborative among healthcare provider for good health.
Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
The presence of these systems in health institutions is very useful, because they help to strengthen cooperative relations between the members of a single institution at all levels and to provide a single source of data in one, the systems also help to understand the functioning of processes accurately and easily. But the	The provision of medical data correctly from different departments to provide medical database centralized in scientific research and extract information and medical knowledge, raising the level of medical decision right and raise the level of public health.	Necessity having the medical research based on information system to manage and control medical data, this system store accurate data helps in scientific research, and raise the level of public health.

problem faced by the application of these systems is manly the financial aspect, followed by the need of training of cadres and experts from the medical informational domain, where we lack such expertise, so that it would have been used in ways that are true and we will have a scientific impact and benefit of using these large systems and exploitation of all the activities and events offered		
Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?		
Response	**Initial Coding**	**Focussed Coding**
The healthcare data we need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings such as Medical information for patients, medical staff available, lab, and medicines as well as medical devices in various scientific departments.	Medical information for patients, medical staff available, lab, and medicines as well as medical devices in various scientific departments.	Medical information for patients, medical staff available, lab, and medicines as well as medical devices in various scientific departments.
Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		
Response	**Initial Coding**	**Focussed Coding**
We expect the system to provide a central database and comprehensive information to the data at the level of medical diseases, patients and staff therapist and specialties	Important functions of scientific research management systems to provide accurate medical database includes comprehensive information help in treatment and medical	Provide accurate medical database include comprehensive information help in treatment and medical research.

available and medicines used in the treatment.	research.	
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
The researchers need to use and access the research database to get the necessary medical data. We need to integrated information for the patients' case, which leads to the improvement the decision in treatment, and same case if I conduct research study.	Provision accurate medical database, easy to access for researchers such as web application, and catalyzing the collaborative research. which leads to the improvement the decision in treatment, and same case if I conduct research study.	Provision accurate medical database, easy to access for researchers such as web application, and catalyzing the collaborative research. which leads to the improvement the decision in treatment, and same case if I conduct research study.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
Cooperation in the medical field and sharing experiences on the level of a single institution or regional level is important, because it leads to post and collaborative expertise and different disciplines in the treatment of medical conditions, which have an impact on health in general and the resolution of medical right, and levels of scientific research and the results more accurate.	Medical cooperation a great benefit in the medical sector, and prepare plan for the future health vision, and right medical decision.	Necessity of collaboration in medical sector to improve the healthcare services and medical research studies.

Interviewee Code: DNCI06
Date: 19/8/2011
Time of Interview: 10 am -10.45 am
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Male
Age: 48
Qualification: PhD in Medicine
Personal: Medical
Year of employee: less than 10 years
Experience with computers: 1 to 3 years
Perceived experience: Mediocre

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?		
Response	**Initial Coding**	**Focussed Coding**
The activities of the health information system include data storage of the hospital according to its divisions, whether therapeutic or administrative in an orderly manner, and retrieve this data when needed. Most of the works in hospital depend on the paper based system for quick process, with the large numbers of patients; the hospital technology infrastructure is very weak.	HIS limited activities in hospital, storage data and retrieve in another time. The hospital technology infrastructure is very weak .	Limited HIS activities and the hospital technology infrastructure is very weak, lack depend work on the HIS.
Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
The biostatistics and cancer epidemiology department is interested in medical data at the hospital. It collects data from the patient files and saved in medical unit archive.	Biostatistics and Cancer Epidemiology Department collected patient's data from all hospital departments through the patients file.	Department of Biostatistics and Cancer Epidemiology collect data and used in another purpose, such as Biostatistics and medical research.

Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
The main task carried out by the Department of Biostatistics is collection and storage of medical data from different departments of the hospital and stored on a centralized database and use this data in medical statistics.	Analyze the stored medical data, and extract the current ratios for the cancer and its spread. Data store not accurate because different format patients files.	Analyze the medical data, and extract the current ratios for the cancer and its spread. This helpful to build future plan and strategies to control the cancer disease and management medical data
Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
There is no medical research system. Events happen within the Biostatistics and Cancer Epidemiology Department (BiOSCED), and provide the data necessary to conduct their studies for the graduate students.	No medical research system, BiOSCED attention of medical data.	Medical research system not available in hospital departments.
Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
This department analyses the medical data recorded at the hospital and concludes the current proportions of the disease in the country and offer the reasons of the disease.	Publishes scientific statistics on cancer, so it helps to work future plans, whether therapeutic or preventive.	Medical data and statistics published.

Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No system is available to manage the medical research in hospital.	No system is available to manage the medical research in hospital.	No system is available to manage the medical research in hospital.
Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
In hospital there is more than one database, where each section has a system, which manages data of patients and medical care, however, the information available in the database is simple and often inaccurate, due to the lack of serious follow-up in recording all cases completely.	In hospital different databases are available, to store the medical data, the data are simple and not accurate.	Simple data storage and sometimes not accurate.
Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Medical data for patients and administrative information and financial transaction and other relevant data.	Patients' data, administrative information, and financial transaction.	Patients' data, administrative information, and financial transaction.
Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
The database of the Department of biostatistics must contain comprehensive medical data of the hospital and at all levels and therapeutic management ,because all have an impact on statistics, these statistics must be accurate, because based on it the	Collaborative data from all hospital departments.	Centralized database includes all hospital departments' data.

future plans in the prevention and treatment of cancer in the country.		
Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
There is no connection between the existing systems at the Institute. Every unit list their work individually. In this context we need to new system to connect all hospital departments in order to provide complete patient information and used for the research studies.	No connection available among the hospital DB, Individually work.	No connection available among the hospital DB, No share and individually work. need to new system to connect all hospital departments in order to provide complete patient information and used for the research studies
Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No, there is no such activity of sharing experiences and generally this is due to the tight schedule of doctors, as they have to deal with a lot of patients, hence they do not find time to share their experiences. Furthermore lack of technology and infrastructure is yet another reason for the non sharing activity.	Lack of collaboration among medical staff, and lack technology infrastructure in hospital.	Lack of collaboration, and not available system to manage the activities among the medical staff.
Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
There is no protocol to protect	No privacy protocol available to	No privacy protocol available to

the confidentiality and privacy when using medical information systems.	manage the collaborative activities.	manage the collaborative activities.
Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
One Of the most important factors that affect privacy, is the misuse of medical data and personal data available for non-scientific purposes.	Misuse medical data including the patients' identifier and used in non- scientific purposes.	Misuse medical data including the patients' identifier and used in non- scientific purposes.
Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Yes, sure, by publishing the percentage of the successful treatments and updating the health profile, we can improve the patients trust in hospital healthcare services, which will eventually lead to support the medical research studies, and this is important for the achievement of health equity and for increasing the quality of a healthy life for everyone.	We needed to collaborative healthcare information system to provide the data for the medical research, and extract accurate result.	Necessity of having collaborative healthcare information system.
Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?		
Response	**Initial Coding**	**Focussed Coding**
The existence and systems of scientific research at the institute or any health institution is very important, which makes these institutions and units more reliable, because studies	Necessity having medical scientific research systems in any health institution. The presences of a medical research at the our hospital have a clear impact and tangible quality of	Necessity having medical scientific research systems in any health institution. The presences of a medical research at the our hospital have a clear impact and tangible quality of

conducted within these institutions reflect the reality of the situation and address the conditions or problems faced by the institution in a scientific way neat and with sound solutions, which have has a positive impact on the health services and the level of scientific research. These systems assist in improve medical procedures quickly and effectively.	medical services, the results of scientific research, and improve medical procedures quickly and effectively.	medical services, the results of scientific research, and improve medical procedures quickly and effectively.
Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
The presence of these systems in health institutions is very useful, because it helps to strengthen the cooperative relations between the members of a single institution at all levels and to provide a single source of data in one, they help to take medical procedures quickly and effectively. In addition to Research systems useful to conduct medical research in order to improve patients' treatment	The presence of these systems in health institutions is very useful, because it helps to strengthen cooperative relations between the members of a single institution.	Support and strengthen cooperative relations between the members of institution.
Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings?		
Response	**Initial Coding**	**Focussed Coding**
Medical data of patients, and medical staff and medicines, as well as medical devices in various scientific departments.	Patients' medical data, Medical staff available, Medical devices.	Share basic information related to the patient attributes and treatment, medical staff available, and medical devices.

Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		
Response	**Initial Coding**	**Focussed Coding**
Of course we will expect the system to provide a central database and comprehensive information to the data at the level of medical diseases, patients and staff therapist and specialties available and medicines used in the treatment.	Provide accurate medical database includes comprehensive data helpful in treatment and medical research.	Provide accurate medical database includes comprehensive data helpful in treatment and medical research.
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
The researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities to get scientific data from a rich source of information and exchange information within different hospital departments and provide accurate and timely information, in order to improve the research activities we need to web based system to conduct earlier activities.	Provide scientific data from a rich source of information and reliable health and the accuracy of the information, and the exchange of experiences through a database gathering. , in order to improve the research activities we need to web based system to conduct earlier activities.	Provide scientific data from a rich source of information and reliable health and the accuracy of the information, and the exchange of experiences through a database gathering. , in order to improve the research activities we need to web based system to conduct earlier activities.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
Cooperation in the medical field and sharing experiences on the level of a single institution or regional level is important, because it leads to post and collaborative expertise and	Medical cooperation a great benefit in the medical sector, and prepare plan for the future health vision, and right medical decision.	Necessity collaborative in medical sector to improve the healthcare services and medical research studies

different disciplines in the treatment of medical conditions, which have an impact on health in general and the resolution of medical right, and levels of scientific research and the results will be more accurate.		

Interviewee Code: MIENCI01
Date: 22/8/2011
Time of Interview: 11 am -1 pm
Place: Selected Egyptian Hospital - Cairo - Egypt.
Gender: Male
Age: 45
Qualification: Master Information Systems "Healthcare information Technology"
Personal: Information Systems
Year of employee: less than 10 years
Experience with computers: More than 6 years
Perceived experience: High

Question (1): I understand that, there is huge interest in health information system (HISs) in your hospital, Can you tell me something about your background in HISs activities and level of HISs use through your work?		
Response	**Initial Coding**	**Focussed Coding**
The activities of the health information system include data storage of the hospital according to its divisions, whether therapeutic or administrative in an orderly manner, and retrieve this data when needed. Most of the works in hospital depend on the paper based system for quick process, with the large numbers of patients; the hospital technology infrastructure is very weak.	HIS limited activities in hospital, storage data and retrieve in another time, the hospital technology infrastructure is very weak.	Limited HIS activities and the hospital technology infrastructure is very weak, lack depend work on the HIS.
Question (2): Can you tell me about, which unit or department in your hospital is interested in research activities and collected healthcare data?		
Response	**Initial Coding**	**Focussed Coding**
The biostatistics and cancer epidemiology department is interested in medical data at the hospital. This department gathers data from the patient files and saved in medical unit archive.	Biostatistics and Cancer Epidemiology Department collected patients' data from all hospital departments through the patients file.	Department of Biostatistics and Cancer Epidemiology collect data and used in another purpose, such as Biostatistics and medical research.

Question (3): What are the objectives of Biostatistics and Cancer Epidemiology Department (BiOSCED)?		
Response	**Initial Coding**	**Focussed Coding**
The objective of Department medical statisticians is to collect medical data from patients' files from different sections and store them in database, then investigate these data and extract statistics and ratios for cancer at the level of the institute in general, but generally these statistics have errors, due to the human errors made by nurses and lack of experience.	Analyze the stored medical data, and extract the current ratios for the cancer and its spread. Data store not accurate because different format patients files.	Analyze the medical data, and extract the current ratios for the cancer and its spread.
Question (4): Can you explain about the activities of medical research activities in your hospital.		
Response	**Initial Coding**	**Focussed Coding**
There is no medical research unit. Events happen within the Biostatistics and Cancer Epidemiology Department (BiOSCED), and provide the data necessary to conduct their studies for the graduate students.	No medical research unit, BiOSCED attention of medical data.	Medical research unit not available in hospital.
Question (5): What are the benefits of the (BiOSCED) activities?		
Response	**Initial Coding**	**Focussed Coding**
This department examines the medical data recorded at the hospital and concludes the current proportions of the disease in the country and offers the reasons of the disease.	Publishes scientific statistics on cancer, so it helps to work future plans, whether therapeutic or preventive.	Medical data and statistics published.

Question (6): Are there any health information systems to manage medical research activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No system is available to manage the medical research in hospital.	No system is available to manage the medical research in hospital.	No system is available to manage and control the research unit activities in hospital.
Question (7): Is there any database in your hospital, can you tell me something about it?		
Response	**Initial Coding**	**Focussed Coding**
In hospital there is more than one database, where each section has a system, which manages data of patients and medical care, however, the information available in the database is simple and often inaccurate, due to the lack of serious follow-up in recording all cases completely.	In hospital different databases are available, to store the medical data, the data are simple and not accurate.	Simple data storage and sometimes not accurate.
Question (8): What are the elements of this database?		
Response	**Initial Coding**	**Focussed Coding**
Medical data for patients and administrative information and financial transaction and other relevant data.	Patients' data, administrative information, and financial transaction.	Patients' data, administrative information, and financial transaction.
Question (9): What kinds of data are stored in the (BiOSCED) database?		
Response	**Initial Coding**	**Focussed Coding**
The database of the Department of biostatistics must contain comprehensive medical data of the hospital and at all levels and therapeutic management ,because all have an impact on statistics, these statistics must be	Collaborative data from all hospital departments.	Centralized database includes all hospital departments' data.

accurate, because based on it the future plans in the prevention and treatment of cancer in the country.		
Question (10): Are there any connections between HISs in your hospital departments?		
Response	**Initial Coding**	**Focussed Coding**
There is no connection between the existing systems at the Institute. Every unit lists their work individually.	No connection available among the hospital DB, Individually work.	No connection available among the hospital DB, No share and individually work.
Question (11): Do medical staff (i.e. physicians, researchers) sharing healthcare information using HISs in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
No, there is no such activity of sharing experiences and generally this is due to the tight schedule of doctors, as they have to deal with a lot of patients, hence they do not find time to share their experiences. Furthermore lack of technology and infrastructure is yet another reason for the non sharing activity.	Lack of collaboration among medical staff, and lack technology infrastructure in hospital.	Lack of collaboration, and not available system to manage the activities among the medical staff.
Question (12): Are there any privacy preservation protocol when using and sharing healthcare data (hard copy or soft copy) among physicians and researchers in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
There is no protocol to protect the confidentiality and privacy when using medical information systems.	No privacy protocol available to manage the collaborative activities.	No privacy protocol available to manage the collaborative activities.

Question (13): Can you explain the privacy concerns when sharing patients' healthcare information in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Privacy concerns when sharing patients', is the misuse of medical data and personal data available for non-scientific purposes.	Misuse medical data including the patients' identifier and used in non- scientific purposes.	Misuse medical data including the patients' identifier and used in non- scientific purposes.
Question (14): Can confidence of patients and public be improved in terms of healthcare services, through researches activities in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
Yes, sure, by publishing the percentage of the successful treatments and updating the health profile, we can improve the patients trust in hospital healthcare services, which will eventually lead to support the medical research studies, and this is important for the achievement of health equity and for increasing the quality of a healthy life for everyone.	We needed to collaborative healthcare information system to provide the data for the medical research, and extract accurate result.	Necessity of having collaborative healthcare information system.
Question (15): What extent does the work of medical research system in your hospital increases the quality and improvement of healthcare services, scientific research?		
Response	**Initial Coding**	**Focussed Coding**
The existence and unity of scientific research at the institute or any health institution is very important, which makes these institutions and units more reliable, because studies conducted within these institutions reflect the reality of the situation and address the	Necessity having medical scientific research unit in any health institution. The presence of a medical research at the hospital has a clear impact and tangible quality of medical services and the results of scientific research.	Necessity having medical scientific research unit in any health institution.

conditions or problems faced by the institution in a scientific way neat and with sound solutions, which have has a positive impact on the health services and the level of scientific research.		
Question (16): In what ways do you think collaborative healthcare information system would be helpful in your hospital?		
Response	**Initial Coding**	**Focussed Coding**
The presence of these systems in health institutions is very useful, because it helps to strengthen the cooperative relations between the members of a single institution at all levels and to provide a single source of data in centralized DB, these systems stored data orderly manner, and retrieve this data when need it ,they help to take medical procedures quickly and effectively.	The presence of these systems in health institutions is very useful, because it helps to strengthen cooperative relations between the members of a single institution. Provide a single source of data in centralized DB, these systems stored data orderly manner, and retrieve this data when need it, they help to take medical procedures quickly and effectively.	Support and strengthen cooperative relations between the members of institution. Addition to provide a single source of data in centralized DB, these systems stored data orderly manner, and retrieve this data when need it, they help to take medical procedures quickly and effectively.
Question (17): What kind of healthcare data do you need to store in your hospital research system in order to enhanced the collaboration among specialist in healthcare, and improve the research findings		
Response	**Initial Coding**	**Focussed Coding**
Medical data of patients, and medical staff and medicines, as well as medical devices in various scientific departments. In sum we need Comprehensive patients, physicians, and hospital information might have a useful in patients' treatment and medical research.	Comprehensive patients, physicians, and hospital information might have a useful in patients' treatment and medical research.	Comprehensive patients, physicians, and hospital information might have a useful in patients' treatment and medical research.
Question (18): If you have research system in your hospital, what are the healthcare information and functions do you need from the system?		

Response	Initial Coding	Focussed Coding
We will expect the system to provide a central database and comprehensive information to the data at the level of medical diseases, patients and staff therapist and specialties available and medicines used in the treatment.	Provide accurate medical database includes comprehensive data helpful in treatment and medical research.	Provide accurate medical database includes comprehensive data helpful in treatment and medical research.
Question (19): why researchers need to use and access the research database of the hospital that contains the patient information and the hospital activities?		
Response	**Initial Coding**	**Focussed Coding**
Provide scientific data from a rich source of information and exchange information within various departments and provide accurate and timely information.	Provide scientific data from a rich source of information and reliable health and the accuracy of the information, and the exchange of experiences through a database gathering.	Provide scientific data from a rich source of information and reliable health and the accuracy of the information, and share through the system.
Question (20): How would you describe the collaboration among specialist and researchers in healthcare sector in general?		
Response	**Initial Coding**	**Focussed Coding**
Cooperation in the medical field and sharing experiences on the level of a single institution or regional level is important, because it leads to post and collaborative expertise and different disciplines in the treatment of medical conditions, which have an impact on health in general and the resolution of medical right, and levels of scientific research and the results will be more accurate.	Medical cooperation a great benefit in the medical sector, and prepare plan for the future health vision, and right medical decision.	Necessity collaborative in medical sector to improve the healthcare services and medical research studies.

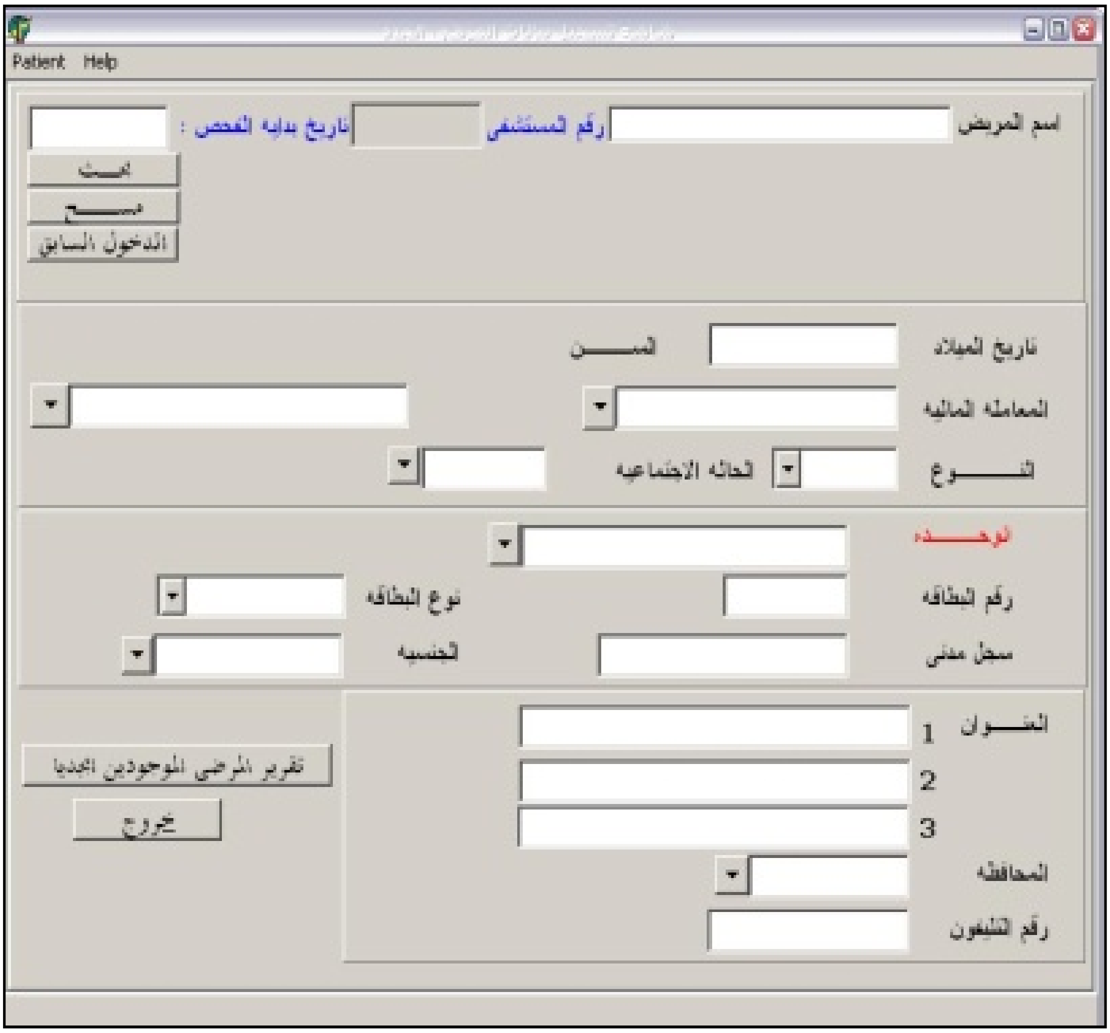
Appendix D

Healthcare Information Systems in the Selected Egyptian Hospital.

These Data collected of the selected Hospital website.
http://www.nci.edu.eg/institute_prog.htm

1- Patients Registration Systems

The patient registration system is means for collecting, identifying, and recording patient demographic and eligibility information and its own financial transaction**.**

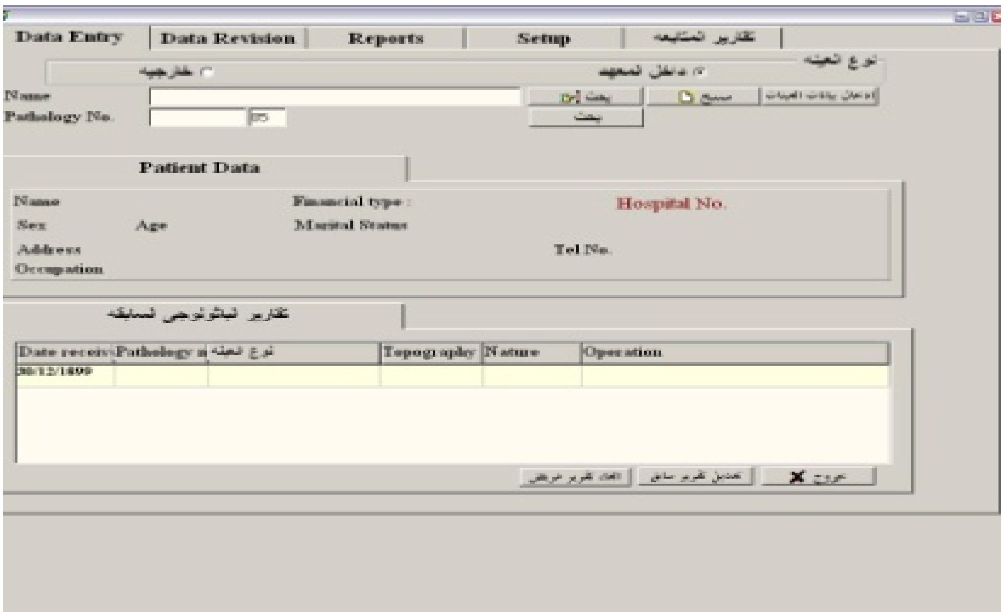


2- IN/OUT PATIENTS SYSTEMS

This system particularly the department's internal Institute from which to trace the entry and exit and transfer the patient to the Department of Interior, as well as provide statistical data on the Institute and internal departments and reports on the number of patients - the family free - death - and report the names of patients who are in the Institute and whereabouts.

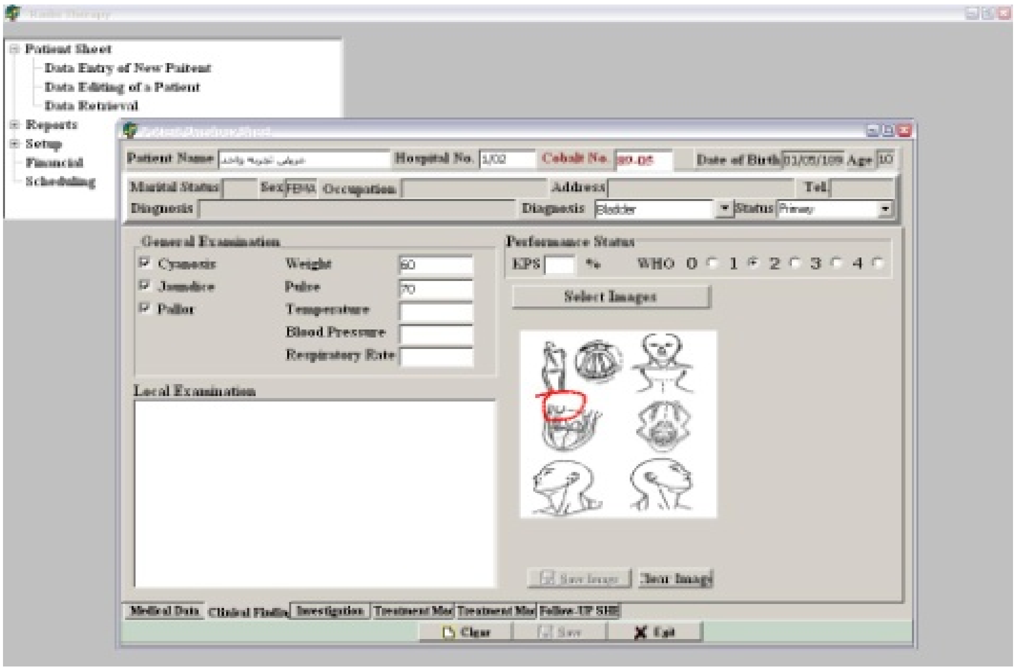
3- PATHOLOGY SYSTEMS

These systems registers the patients' data in labs within hospital and extract report for patients results. Collect all the reports are logged Pathology for patients as well as the work of statistics and reports on the numbers of each case.



4- Therapeutic radiology system

This system keep track of all treatment steps which exposed the patient, such as treatment plan - which dealt with the patient doses - track patient visits to the hospital reports aggregate data that have been entered.

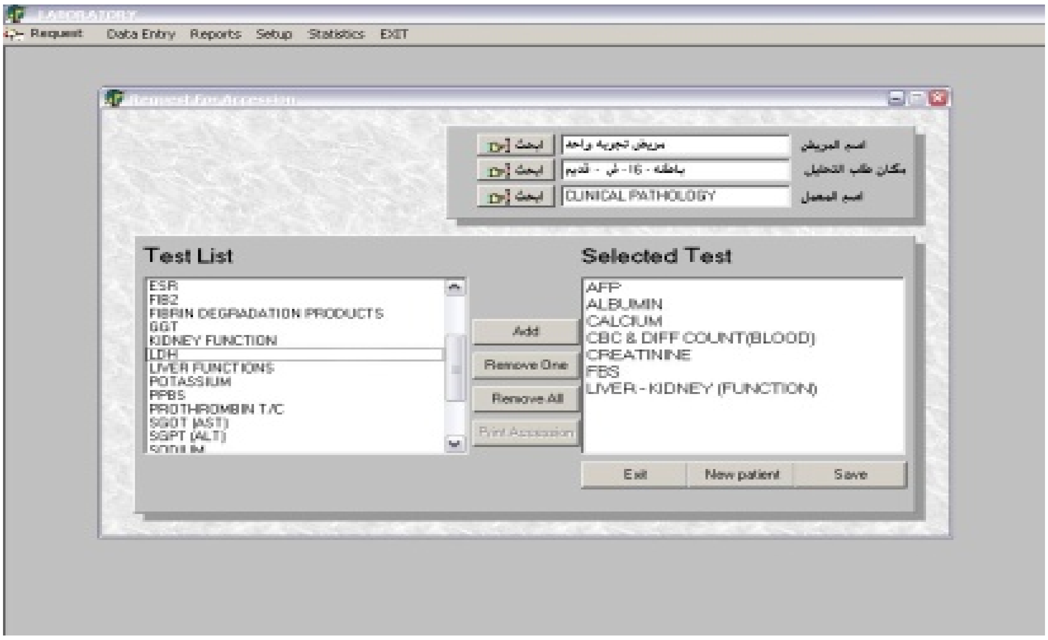


5- Pharmacies and stores system

This system track the movement of the drug to and from the store - Tenders and tracking companies supply the required quantities of the Institute and supply companies late in - Simulation notebook Institute - dispensing from the store for pharmacies - tracking the movement of pharmaceutical drugs to patients.

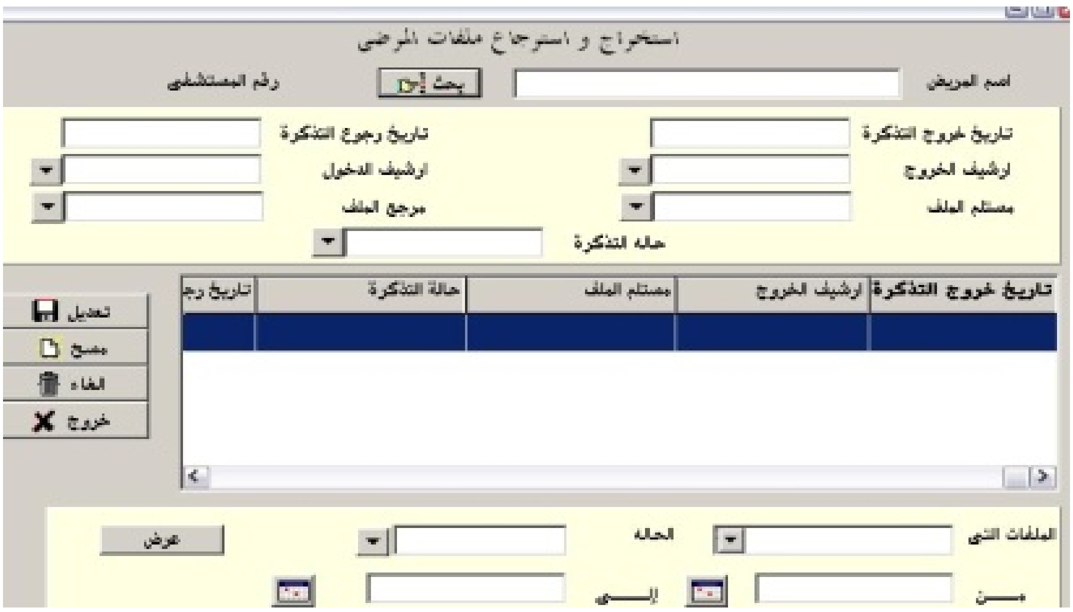
6- Lab system

This system is divided into two parts. The first special roles where doing analyzes requests for patients of roles and print special reports and roles of patients at any time. The second special labs where he records the data analysis which are either devices directly to databases or in writing, writing and printing reports private patients or units within the lab.



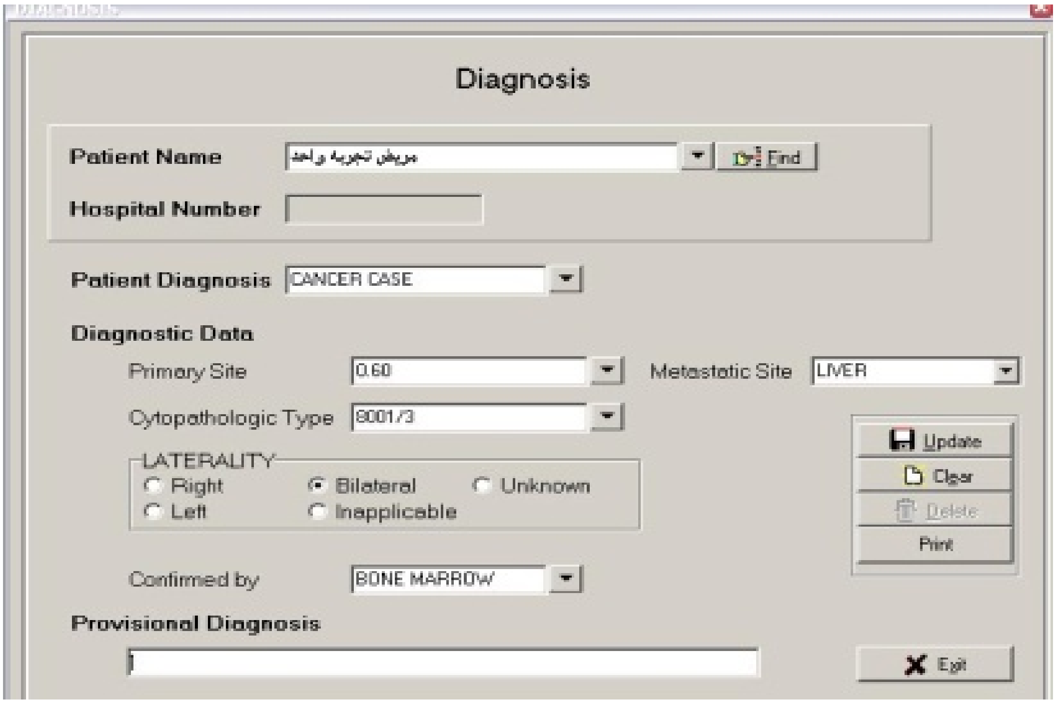
7- Monitoring System

This system where the follow-up medical files for patients and its work within the hospital and reports to find out the whereabouts of overdue medical files.



8- Diagnostic system

The registration of diagnosis for each patient, using special codes IDCO (INTERNATIONAL CLASSIFICATION OF DISEASES FOR ONCOLOGY). The diagnosis of the tumour is entered whereabouts and morphological nature to him whether it is benign or malignant is an annual statistics for each work that proves diagnosed cases and publishes these statistics on the Institute's web site.

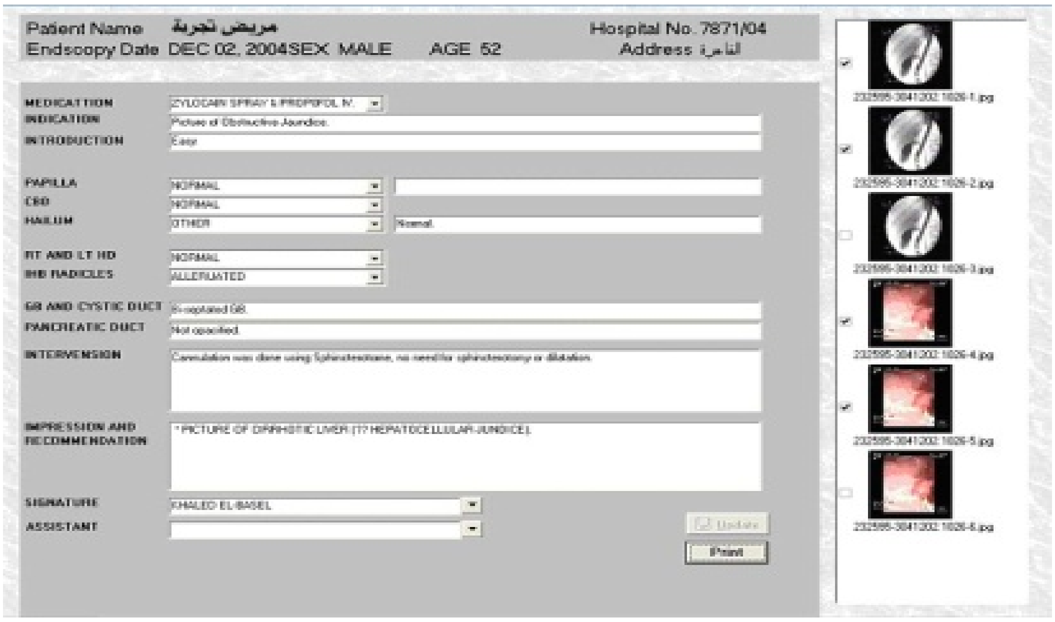


9- Stomie – Ostomy System

The record of the outgoing and Stomie – Ostomy kits outgoing and follow-up for each patient.

10- Endoscopy system

This system records and follow up of six types of endoscopes different recording each telescope or record videos of those perspectives can also program the doctor of the work reports for each telescope pictures thereto at a cost small and the software will work statistics on patients and perspectives and doctors working laparoscopically.

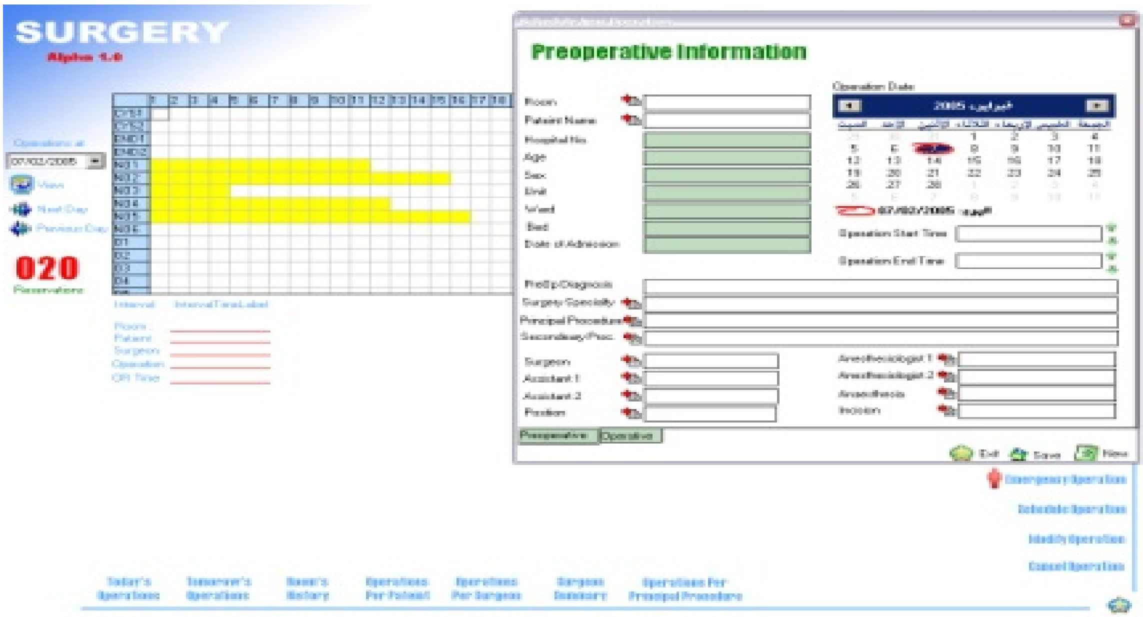


11- Billing system

This program issuing bills dealing with patients therapy unit where the wage data that was previously entered on the other programs are assembled inside the patient's bill of automatic as for the other data that are not completed their own programs are entered by the user program.

12- Surgery system

This program is using in the book and follow-up book rooms and data recording processes such as process-specific appointment process and the surgical team and medical diagnosis and prior to the procedure. The process is after the registration process medical reports and medical notes and Views. Are also using this program also issued various reports such as a list of surgery for the next day and the activity of certain operations room and the activity of a particular surgeon and the date of the particular type of operations as well as some statistics.

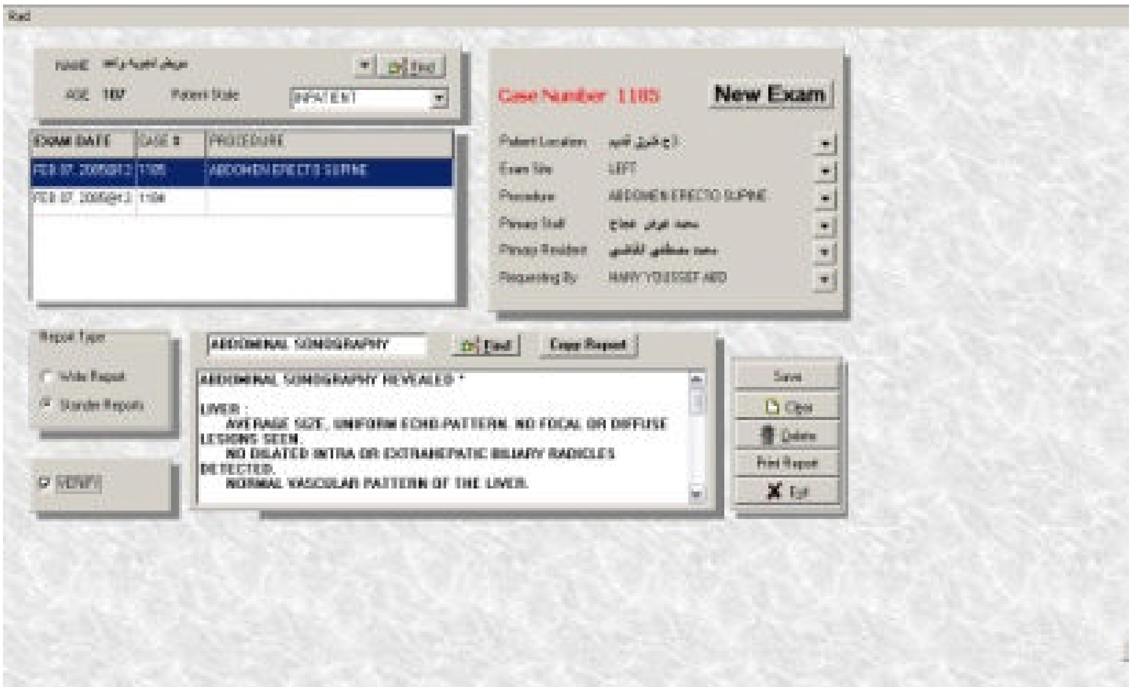


13- Microbiology system

This system registers patient data easily and work lists of antibiotics used to facilitate the entry process.

14- Diagnostic Radiology System

Data is recorded rays and follow-up for each previous reports and is equipped with pre-written reports where this given the ease and speed in writing reports.



15- Security systems

The security system in the hospital use the ACCESS CODE and VERIFY CODE to access to hospital systems based on user privilege.

Appendix E

The Reality of the Situation in the Selected Egyptian Hospital (Hospital A)

1- **Registrar's Office for Patients**

2- Clinics Queue

Appendix F

CHIMS
Evaluation Questionnaire

The goal of this questionnaire is to evaluate rate of the using CHIMS in improve the collaboration among physicians regarding sharing healthcare information based on privacy preservation, with regard each the following?

This questionnaire is divided into four sections:

Section A: Demographic Characteristics of the Respondents.
Section B: Evaluation Rate of the Collaboration among Physicians.
Section C: Use of System.
Section D: General Comments on the CHIMS.

Please answer all questions by ticking (**X**) the appropriate box where applicable.

This questionnaire is meant for research purposes only. All data collected and analysis from it will be treated with the strictest confidentiality. Returned survey forms will duly be destroyed upon completion of the research project.

Thank you very much for participating in this study.

ASMAA HATEM RASHID
PhD Student
Metric No.: WHA100031
Email: asmaarashid@siswa.um.edu.my
Faculty of Computer Science and Information Technology
University of Malaya
50603 Kuala Lumpur
Malaysia

Section A: Demographic Characteristics of the Respondents

Please fill up the information below:

Date:
Email:
Organization:
Age:
Gender:
Educational background:
Personal:
Experience with computers:
Perceived experience:

Section B: Evaluation Rate of the Collaboration among Physicians

Please tick (X) the appropriate box based on the following rating:

	Strongly Disagree **1**	**2**	**3**	**4**	Strongly Agree **5**
1. Using CHIMS has improved my job performance	☐	☐	☐	☐	☐
2. Using CHIMS has made it easier to collect data for research based on privacy preservation	☐	☐	☐	☐	☐
3. Using CHIMS based on privacy preservation have improved my effectiveness on conduct research study	☐	☐	☐	☐	☐
4. Using CHIMS based on privacy preservation in my job has increased my productivity	☐	☐	☐	☐	☐
5. Using CHIMS based on privacy preservation in my job has enabled me to accomplish collect data more quickly	☐	☐	☐	☐	☐
6. I have found CHIMS based on privacy preservation useful in sharing information in own hospital	☐	☐	☐	☐	☐
7. Learning to operate CHIMS was easy for me	☐	☐	☐	☐	☐
8. My interaction with CHIMS was clear and understandable	☐	☐	☐	☐	☐
9. I have become skilful at using CHIMS	☐	☐	☐	☐	☐
10. I have found it easy to get CHIMS to do what I want	☐	☐	☐	☐	☐
11. I have found CHIMS to be flexible to interact	☐	☐	☐	☐	☐

12. I would recommend this software to my friends	☐	☐	☐	☐	☐
13. I have found CHIMS navigation is easy	☐	☐	☐	☐	☐
14. The CHIMS has helped me overcome any problems I have had in using it	☐	☐	☐	☐	☐
15. The CHIMS based on privacy preservation allows tasks to be done more accurately	☐	☐	☐	☐	☐
16. Information I get from the system is clear	☐	☐	☐	☐	☐
17. The system is accurate based on privacy preservation	☐	☐	☐	☐	☐
18. The system provides me with sufficient information based on privacy preservation	☐	☐	☐	☐	☐
19. The system provides me with up-to-date information	☐	☐	☐	☐	☐
20. The system provides reports that seem to be just about exactly what I need	☐	☐	☐	☐	☐
21. Using the system based on privacy preservation saves time	☐	☐	☐	☐	☐
22. The CHIMS improve quality of collaboration in sharing information based on privacy preservation.	☐	☐	☐	☐	☐
23. Working with this software is satisfactory based on privacy preservation	☐	☐	☐	☐	☐
24. The organization of the menus or information lists seems quite logical	☐	☐	☐	☐	☐
25. The CHIMS has easy and understandable presentation	☐	☐	☐	☐	☐

Section C: Use of System

Functionality of the Modules

Please tick (**X**) the appropriate box based on the following rating:

1. Very Poor
2. Poor
3. Satisfactory
4. Good
5. Excellent

How would you rate the overall functionality of:	**1**	**2**	**3**	**4**	**5**
1. Manage Research	☐	☐	☐	☐	☐
2. Collaboration based on privacy preservation	☐	☐	☐	☐	☐
3. Monitor Research	☐	☐	☐	☐	☐
4. Search	☐	☐	☐	☐	☐
5. Report	☐	☐	☐	☐	☐
6. View List	☐	☐	☐	☐	☐
7. Export Data based on privacy preservation	☐	☐	☐	☐	☐

Section D: General Comments on the CHIMS

1- **What was your overall impression of CHIMS?**

2- **What, if any, were the best features of CHIMS?**

3- **What, if any, were the worst features of CHIMS?**

4- **Please give your comments and recommendations (if any) on other issues that would help to improve the use of the Tool.**

Thank You For Your Participation In This Research

Appendix G

SOFTWARE REQUIREMENTS SPECIFICATION

FOR

COLLABORATIVE HEALTHCARE INFORMATION MANAGEMENT SYSTEM

(CHIMS)

PREPARED BY

ASMAA HATEM RASHID

DEPARTMENT OF INFORMATION SYSTEM

FACULTY OF COMPUTER SCIENCE

AND INFORMATION TECHNOLOGY

UNIVERSITY OF MALAYA

KUALA LUMPUR

2014

1. Introduction

a- Document Purpose

The purpose of the current document provides overview regarding CHIMS proposed system in healthcare sector. The CHIMS model is proposed to provide an integrated collaborative HIS environment for improving collaboration among specialist in sharing healthcare information using HISs based on privacy preservation in collaborative research in the selected Egyptian hospital environment.

b- Product Scope

The CHIMS system aims to improve collaboration among medical staff in sharing healthcare information in hospital services such as provide healthcare information for researchers based on privacy preservation in order to improve the research findings, which will enhance patient treatment and healthcare services. The CHIMS is developed based on the anonymization model and its features . This system is selected to provide an open and flexible collaborative HISs to improve collaboration among physicians in sharing information in the hospital environment. The CHIMS consists of centralized and anonymization process units using generalization technique and retrieves data and provides necessary information to researchers. Therefore, the CHIMS is designed based on Web applications for managing and controlling healthcare information, and quickly and accurately disseminating this information among researchers within the same hospital and between different ones.

c- Definitions, Acronyms and Abbreviations

1. HISs: Health information systems refer to any system that captures, stores, manages or transmits information related to the health of individuals or the activities of organisations that work within the health sector. This definition

incorporates things such as district level routine information systems, disease surveillance systems, and also includes laboratory information systems, hospital patient administration systems (PAS) and human resource management information systems (HRMIS). Overall, a well-functioning HIS is an integrated effort to collect, process, report and use health information and knowledge to influence policy and decision-making, programme action, individual and public health outcomes, and research. Sound decision-making at all levels of a health system requires reliable health statistics that are disaggregated by sex, age and socioeconomic characteristics. At a policy level, decisions informed by evidence contribute to more efficient resource allocation and, at the delivery level, information about the quality and effectiveness of services can contribute to better outcomes.

2. CHIMS: collaborative healthcare information management system, CHIMS model is proposed to provide an integrated collaborative HIS environment for improving collaboration among specialist in sharing healthcare information using HISs based on privacy preservation in collaborative research in the selected Egyptian hospital environment. CHIMS system aims to improve collaboration among medical staff in sharing healthcare information in hospital services such as provide healthcare information for researchers based on privacy preservation in order to improve the research findings.
3. K-Anonymization Model: Process defines each of the released record until it becomes indistinguishable from at least $k-1$ of other records when projected on the subset of public attributes, thereby hiding its relationship with the values of the sensitive attribute. As a consequence, each individual may be linked to sets of records of size at least k in the released anonymized table, such that privacy is protected to some extent.

d- Document Conventions

This document follows the IEEE formatting requirements.

e- References and Acknowledgments

The template sources available online.

http://www.uni-obuda.hu/users/boraros-bakucz.andras/2013/srs_template.doc.

2. Overall Description

a- Product Perspective

The CHIMS model is proposed to provide an integrated collaborative HIS environment for improving collaboration among specialist in sharing healthcare information using HISs based on privacy preservation in collaborative research in the selected Egyptian hospital environment. The following Figure1 shows the conceptual framework of CHIMS.

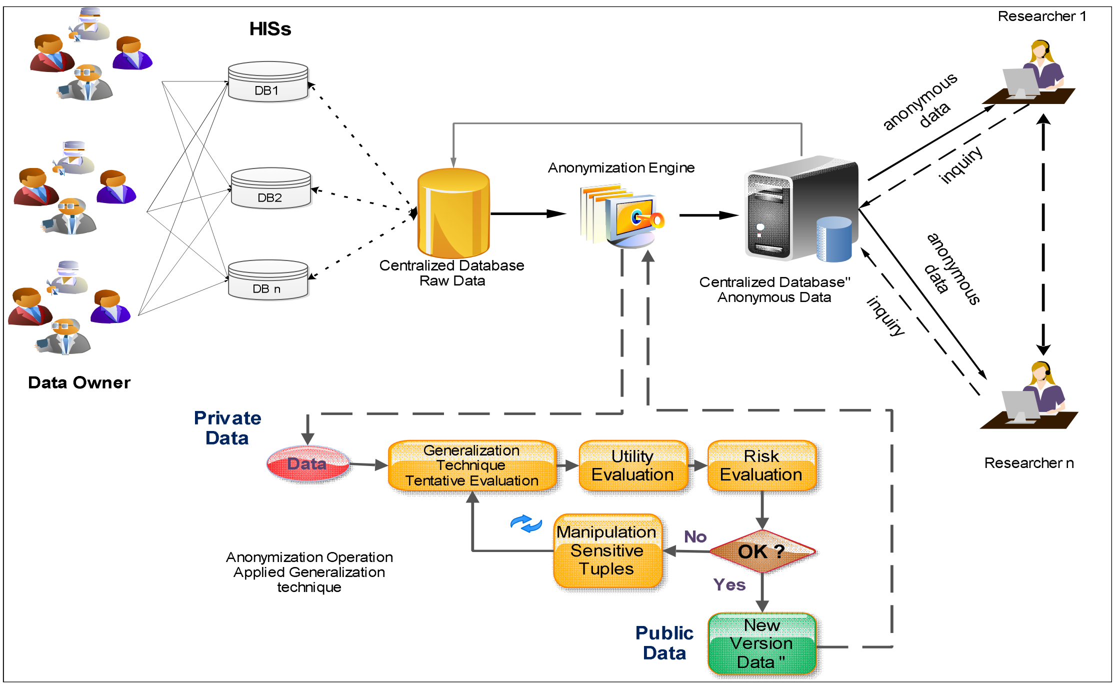


Figure 1: CHIMS using K-anonymization Model in Privacy Preservation Conceptual Framework

b- Product Functionality and system interface

The CHIMS interface comprises modules and their functions. The CHIMS system network diagram describes the functional modules of the CHIMS interface through users (e.g., administrator and researchers) the users can navigation in different hospital departments. A user selects the login type as the administrator or researcher and locally logs into the system. The CHIMS then provides information for users depending on the authentication and authorization characteristics of the security service. In case of a security issue, the administrator and researchers are used as user roles to access information within the CHIMS. Figure 2 shows CHIMS system network diagram. The details of the interface of several main modules are presented in the following subsections.

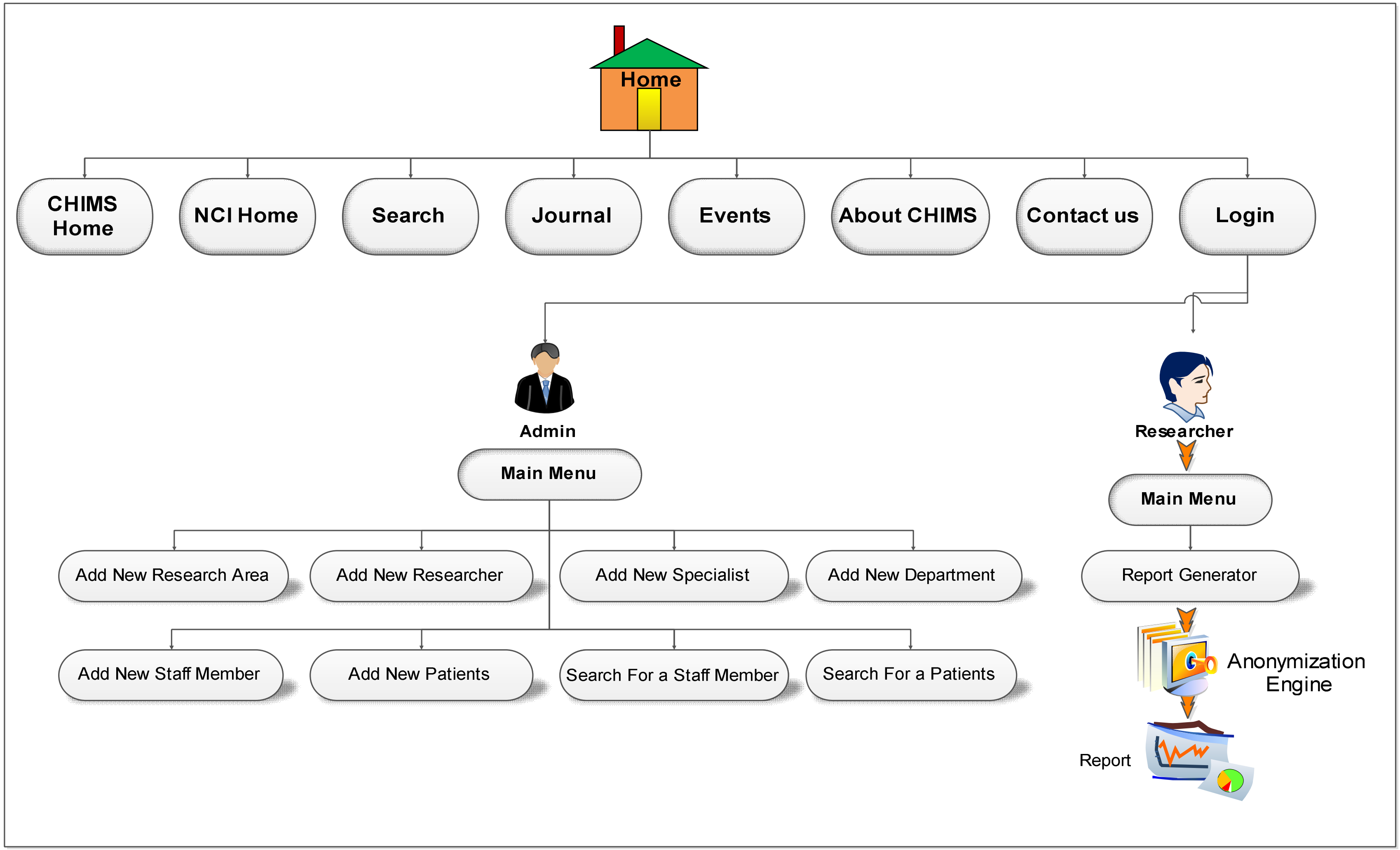


Figure 2: CHIMS System Network Diagram

The CHIMS comprises patient records, medical staff records, department data, and research area. The users can navigate through the system and search for patient information by department, disease type, physicians' name, and research area, then generate the report and export to personal computer. Table 1 summarizes the functions of the main modules of the CHIMS interface.

Table 1: Functions of CHIMS Interface Modules

No.	Interface Module Name	Functions
1	CHIMS Home	This module allows the user to view the main page of the CHIMS and relevant functions.
2	Hospital Home	This module allows the user connect to selected hospital main page and relevant activities.
3	Journal	This module allows the user connect to selected hospital journal and search inside it by topic and authors.
4	Events	This module allows the user to view the selected hospital events as conference, workshop and training.
5	Search	This module allows the user search inside the selected hospital as the general information.
6	Login	To validate the user to ensure authorized access to the CHIMS. Thus, when a user tries to log in, the system will check the authenticity and authority of the user in the local web server.
7	Contact us	This module allows the user to connect to admin for the registration or enquires.

c- Interface

The user interface employs one of the standard interfaces found on the Web. Interface design plays a crucial role in developing the CHIMS. The goal is to enable logical data entry and ease system navigation. The interface has three sections namely, (a) title bar, (b) navigation pane, and (c) main pane. Figure 3 shows the interface layout of the main page of the CHIMS. The title bar is found at the top of each page. The name of the system is displayed on the left side of the title bar. Seven hyperlinks are located at the top left side for global navigation. Two hyperlinks are located at the top right of the login to system and help buttons.

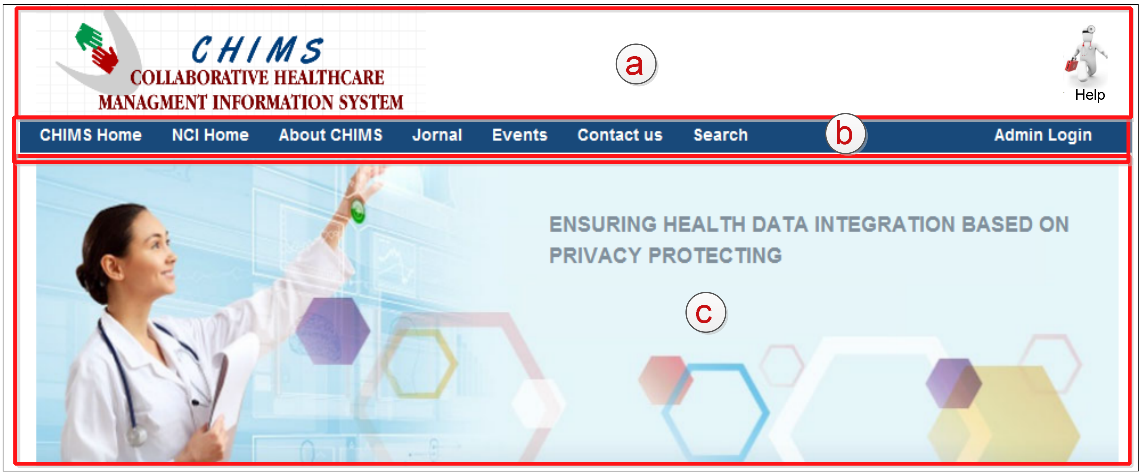


Figure 3 : System interface design consisting of (a) title bar, (b) navigation pane, and (c) main pane

Figure 4 shows the interface layout of the main page of the CHIMS, where one can enter the CHIMS system through the login button. Two types of users can log into the system, the administrator and researchers as depicted in Figure 6.8. The interface layout of the login page checks the authenticity and authority of the user in the local Web server. All particular modules implemented in the CHIMS can be viewed by the user in the interface layout of the home page based on the authority of that user.

Figure 4: Interface Layout of Login Page

1- Administrator view

The CHIMS provides eight main modules for the user CHIMS home, NCI home, about CHIMS, journal, events, contact us, search, and login as the navigation pane through the CHIMS. Users, such as administrators and physicians, need to move from one module to another to obtain particular information. In terms of user role, the user with administrator role can access all main modules. Figure 5 shows the interface layout of the admin login page.

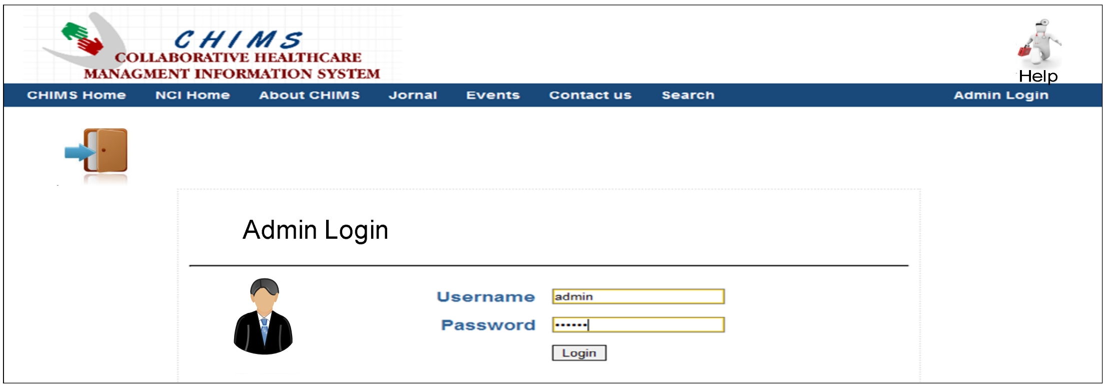


Figure 5: Interface Layout of the Admin Login Page

The administrator menu provides nine modules for the admin CHIMS, such as add new department, add new specialist, add new researcher, add new research area, add new staff member, add new patient, staff member search, patient search, and researcher search. Figure 6 shows the interface layout of admin main menu page.

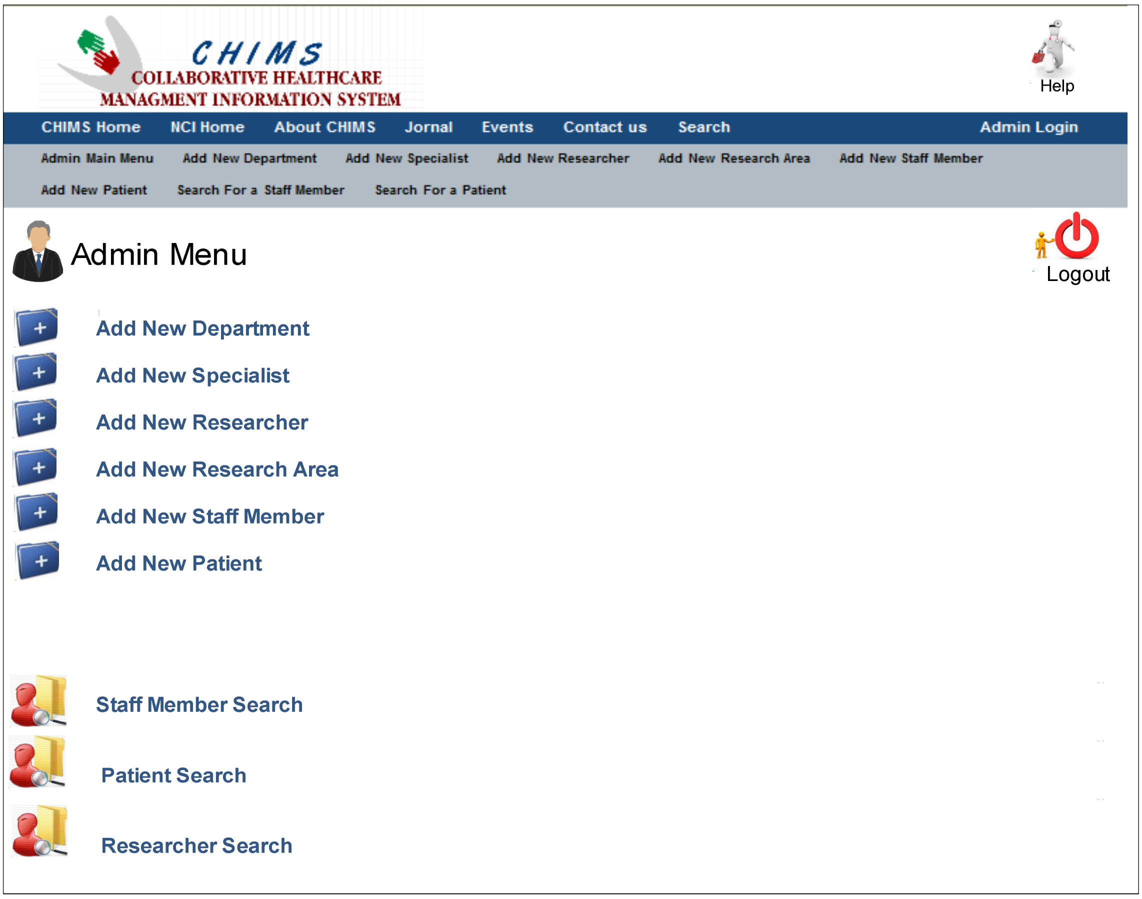


Figure 6: Interface Layout of the Admin Main Menu Page

The admin main menu mentioned above comprises nine modules. Table 2 summarizes the functions of the admin main menu modules of the CHIMS interface.

Table 2: Functions of the CHIMS Interface Modules

No.	Interface Module Name	Functions
1	Add New Department	This module allows the admin to add new department in hospital and inserted within search area
2	Add New Specialist	This module allows the admin to add new Specialist (e.g. new physician) in hospital and inserted within search area.
3	Add New Researcher	This module allows the admin to add new Researcher (e.g. new physician, researcher) in hospital and inserted within research area
4	Add New Research Area	This module allows the admin to add new research area and inserted within search range.
5	Add New Staff Member	This module allows the admin to add new staff member (e.g. expert in medical informatics) in hospital and inserted within search area
6	Add New Patient	This module allows the admin to add new patients in the hospital
7	staff member search	This module allows the admin to search of staff member by name, ID, department and specialist
8	patient search	This module allows the admin to search of patient by name, ID, disease, physician and department.
9	researcher search	This module allows the admin to search of researcher by name, ID, disease, department and research area.

2- Researcher view

The second type of users is researchers. Researchers have limited modules to search for patient, physician, and departments' data as well as research areas, and then generate a report based on the search selected criteria. Healthcare information in this unit based on privacy preservation using K-anonymization model with regard to patient data. Figure 7 shows the interface layout of the researcher login page; Figure 8 depicts the interface layout of the researcher main menu page.

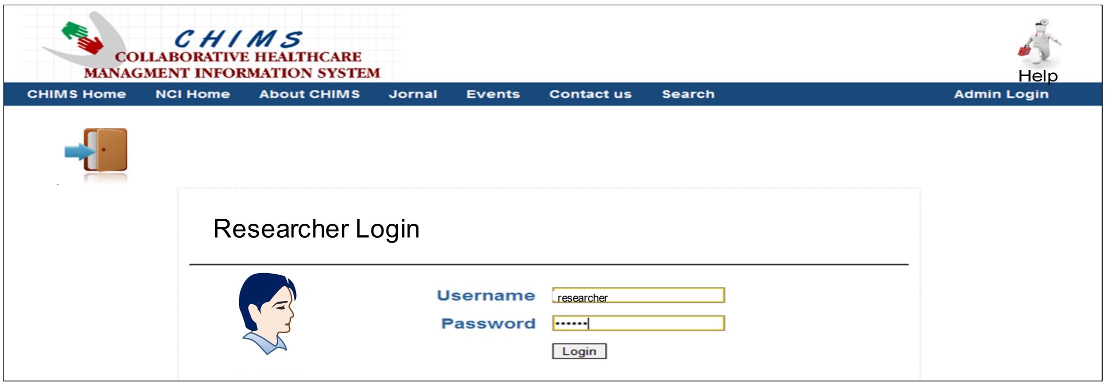


Figure 7: Interface Layout of the Researcher Login Page

Figure 8: Interface Layout of the Researcher Main Menu Page

Report Generator Module: Once the researcher logs into the system, the user can readily navigate around the page to update and view information. Figure 6.13 provides a screenshot view of the report generator module, where researchers can generate reports based on search selected criteria. The CHIMS can be used to search for patient, physician, and department data as well as research areas. The system displays information on all medical staff, departments, physicians, and research areas available in the hospital system. The researcher can export data once the search results are shown. Figure 9 depicts the report generator module.

Figure 9: Interface Layout of the Researcher Report Generator Module

As shown in Figure 9 the generator module in CHIMS allows medical staff to search, collect, and export healthcare information from centralized database (collect data from different hospital departments), sharing these information with other physicians and researchers based on privacy preservation using k-anonymization model to achieve collaboration in research. The CHIMS provided researchers version of healthcare information for the research studies based on privacy preservation of patient information. Sharing these data from different hospital departments with other physicians and researchers based on privacy preservation improve collaboration in research, which made the data-sharing easier among physicians and researchers and at same time privacy preservation of patients information.

d- Users and Characteristics

The CHIMS users consist of medical staff such as physicians, medical school students, reserachers form related sector such as medical informatics, healthcare scincse, and biostatistics in healthcare sector.

e- Operating Environment

CHIMS system operates in selected Egyptian hospital. The selected Egyptian cancer hospital in Cairo City is considered as the leading cancer center in the Middle East and Africa. The hospital is also the largest and best hospital in cancer treatment in Egypt.

The CHIMS structure was developed using the following web-based application tools:

1- CHIMS Programming Language: The CHIMS system was programmed using ASP.NET, a web application framework developed and marketed by Microsoft that enables programmers to build dynamic web sites. ASP.NET is used to create web pages and web technologies, and is an integral part of the .NET framework vision by Microsoft. As a member of the .NET framework, ASP.NET is an extremely valuable tool for programmers and developers because it allows them to build dynamic, rich websites and web applications using compiled languages such as VB and C#. In this study, we used the C# language (MacDonald & Szpuszta, 2007). In addition, the various benefits of working with ASP.NET reinforced the decision to use the program for this study.

2- CHIMS Database: For this study, the researcher chose MySQL, an open-source program supported by Oracle/Sun Microsystems. According to DMW Technologies (2008), MySQL is “a powerful free SQL database, and PHP provides a comprehensive set of functions for working with it.” MySQL is generally considered better than other web database options because this option is a true relational database aside from being the most widely used and best supported database (Pros, 2008). This description implies that “[MySQL] stores data in separate tables rather than putting all the data in one big area. This adds flexibility, as well as speed” (Softpedia, 2008).

3- CHIMS Server: The CHIMS prototype also required web server technology. The researcher chose to use the Windows 2008 Server because it is “now the most-used web server in the world. and ASP.NET can be compiled as a Windows 2008 Server” (Dewson, 2008). In sum, the combination of Windows 2008 Server, MySQL, and ASP.NET is unbeatable, and thus provides a solid, stable, and flexible infrastructure for CHIMS.

Specific Requirements

a- External Interface Requirements

Kindly refer section 2.2 Product Functionality and system interface.

b- Functional Requirements

System analysis aims to determine the requirements of the proposed system. System analysis should establish the parameters in which the system should perform rather than how the system performs. The requirements of the proposed system were derived through observation of existing systems based on the literature review and from the data collected in interviews techniques in this study . This phase of software development is important because inaccurate requirements specification will cause the errors in the requirements to be propagated to the system design and implementation, and consequently resulting in user dissatisfaction. If accuracy is discovered at a later phase, correcting the problem to fulfill the requirements is expensive.

In conclusion, the results of the development of collaboration in the HIS environment based on privacy preservation using K-anonymization model indicated the following points:

a) Developing an online collaborative process requires the provision of a centralized database to collect data from the departments of the selected Egyptian hospital based on privacy preservation using k-anonymization model. Such a system has a flexible and collaborative structure to improving collaboration among physicians in sharing information within the hospital environment.

b) The functional requirements of the CHIMS proposed in this study were extracted from the viewpoints of participants. The CHIMS connects the hospital departments and shares information among them in a timely manner. The information included patient data, activities of physician in patient treatment, and hospital characteristics, such as units, treatments, and available devices. This work could improve the research findings in patient treatment. The following are some of the system activities:

    1) Authentication, Authorization, Access Control and Identification.
    2) Reporting and Queries.
    3) Integration.
    4) Audit Logs and Monitoring of Workarounds.
    5) Personal Health Information, Patient Privacy and Confidentiality.

3. **Other Non-functional Requirements**

a- **Non-functional requirements**

Non-functional requirements pertain to how well the system provides the functional requirements. Non-functional requirements are as important as functional requirements and must be complied to ensure the proper operation of the system. The number of non-functional requirements established for the proposed system is as follows:

a) Security: A security process of the system is important to prevent unauthorized users from accessing any part of the system. An authorized person (administrator) provided system users with usernames and passwords to enable them to access the system. Furthermore, each user has a special privilege based on job level (admin, doctor, researcher, and so on) and authorized information flows.
b) Contents: The system contains only two types of information about the selected Egyptian hospital. The first comprises general information about the selected Egyptian hospital, including the departments, education, journal, mission, vision, and contacts, which could be obtained from the website of the hospital. The second type of information includes administrator and researcher information.
c) Usability: Usability implies that the system should be convenient and practical to use. Ease-of-use requirements address the factors that constitute the capacity of the software to be understood, learned, and used by its intended users.
d) Flexibility: This process is essential to CHIMS system development based on environmental requirements, especially the requirements of physicians on the collaboration issues. Therefore, such a system can be increase or extend the functionality of the software based on new requirements.

4. Summary

This document presented a detailed description of the CHIMS design. In the CHIMS design stage, the details of the design and implementation steps for every unit and module in the CHIMS were described, and screenshots from the CHIMS modules and user interfaces were provided. the CHIMS was ready, it was implemented in the selected hospital as case study, and was used by its physicians and researchers. Moreover, the respondents were able to efficiently use the modules, and the user interface design was sufficiently appropriate and functional to fulfill their requirements.

The CHIMS was also found to require certain improvements based on the requirements of researchers and physicians. Indeed, the respondents found the system to be extremely useful, especially in the facilitation of collaboration research among researchers with regard to sharing data to catalyze collaborative research in the health sector based on privacy preservation.