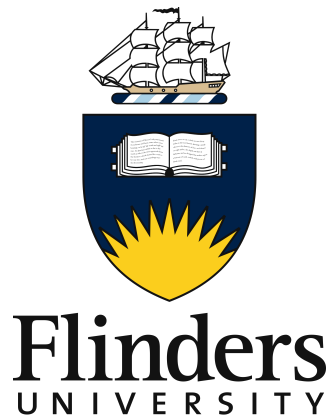


**Strength and Weakness with the Adoption of EHR
Around the Globe with Recommendations for Australian
My Health Record System**



Submitted to the School of Computer Science, Engineering, and Mathematics in the Faculty of Science and Engineering in partial fulfilment of the requirements for the Master's degree program of Computer Science at Flinders University South Australia, Australia

By Sultan Alharbi

Alha0300

Academic Integrity Declaration

I certify that this work does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that, to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date.....

Acknowledgements

I am very grateful to my mother Mariam for all her support until the end of this thesis. Also, I would like to extend my heartfelt thanks to my wife Jwaher Alfrydi for her support and for her patience while I was at the Flinders library writing this thesis. I want to dedicate this work to the spirit of my father, my family and to my little daughter Alghanad.

Table of Contents

1. Introduction.....	10
1.1 Background of Electronic Health Record Systems	10
1.2 Historical Perspective of Electronic Health Record Systems	12
1.3 The development of the EHR	14
1.4 The characteristics and role of EHR	17
1.5 EHR Functionality	21
2. Thesis Methodology.....	22
2.1 Problem Statement	22
2.2 Methodology	23
2.3 Theoretical Framework	24
3. Review of existing EHR systems at international level	26
3.1 Benefits of EHR systems at international level.....	26
3.2 Problems and solutions with experiences at international level	30
3.2.1 UK.....	30
3.2.2 US	31
3.2.3 Germany	33
3.2.4 Canada	34
3.2.5 Denmark.....	34
3.2.6 Sweden	35
3.3 Barriers to Successfully Implementing EHR at international level	37
3.4 Strategic Factors Affecting the Adoption of the EHR.....	38
4. Australia Context.....	40
4.1 PCEHR system overview and issues	41
4.2 My Health Record.....	43
4.3 Confidence in government institutions and their programs.....	43
4.4 Problems in Australia with EHR implementations.....	46
4.4.1 Confidentiality and Security of EHR in Australia.....	46
4.4.1.1 Lack of Registration	47
4.5 Comparison and Analytic.....	50
4.5.1 Sweden	50
4.5.2 UK and Germany.....	50
4.5.3 US and Canada.....	51
4.5.4 Denmark.....	51
5. Recommendations	52
5.1 Cyber security	52
5.2 Accuracy of information.....	53
5.3 Opt out	53
5.4 Scope of the system	53
5.5 Financial incentives and rating.....	54
5.6 Reduce risk.....	55
6. Conclusion.....	56
7. Future Work	59
7.1 Cyber security	59
7.2 Scope of the system	59
7.3 Financial incentives and rating.....	60
8. References	61

List of Figures

Figure 1.....	12
Figure 2.....	28
Figure 3.....	45
Figure 4.....	48
Figure 5.....	49

List of Tables

Table 1	37
---------------	----

Abstract

Electronic Health Record System (EHR) is a computerized, medical information system that collects, displays and stores a patient's information. It is an evidence base that addresses issues of patient's paper record. Implementing such a system will have a high positive impact on healthcare quality and healthcare services. For example, an EHR is an electronic record that chronologically stores a citizen's medical data, from their GPs whom connected with EHR system, from approximately the first months of gestation until their death and can bring those record anytime and to any authorized physician. As this study discovered there is a lack of enrollment in My Health Record system in Australia (Chapter 3), My Health Record needs more than 15 years to enroll all citizens in Australia, the objectives of this study are to investigate the present status of EHR implementations around the world and to identify the best practice solutions. Also, the study focuses on how to adopt the best practice in Australia. The methodology of this thesis' recommendations is on conducted through an academic research that included electronic books, journal articles, politician speeches, and websites. This thesis obtained all information from a search strategy using PubMed, Google Scholar and Google of the best practices that have been applied in many countries including the US, Canada, Europe. Ranges of documents have been chosen randomly, while others were searched for as they were mentioned as reliable and recent ones. In some cases, key words, such as electronic health care system, were used. With more than 75 references used that provided the recommendations to adopt the best practices solutions for Australian My Health Record System while implementation. This thesis has been exposed the problems in EHR systems as implemented globally. The recommendations that are being handled as the most relevant can be summarized

as following: Improve the overall awareness of the stakeholders, have training sessions for stakeholders on My Health Record System, pay for physicians if they used the system, achieving ongoing technical and systems security integrity and compliance, implement a response plan if there is a breach of the EHR system and implement easy graphical user interface to make it easy for stakeholders. There are more recommendations in recommendations chapter. The research concluded that by adopting these best practices solutions, Australia would be able to have a stable healthcare system that will ensure a higher level of healthcare quality patients or to healthcare alike.

Keywords:

Australia, Healthcare, Health science, Digital health, Recommendation, Electronic Health Record, My Health Record.

Definition

Implementation: it means the roll out of the execution of the My Health Records system in Australia or EHR systems until the execution is completed. Also means, after launching an EHR system and it became a live and allowed to use by public.

Investigation: this thesis will investigate during the roll out of the implementation of the My Health Records system in Australia by looking at the numbers of citizens and GPs enrolled in the My Health Records system. Then, compare it with other countries that had a successful enrolled for their citizens and GPs. This will lead to identify challenges of My Health Records system and come with recommendations to have a successful enroll for all.

Chapter 1

1. Introduction

1.1 Background of Electronic Health Record Systems

An electronic health record (EHR) system is a computerised medical information system that collects, displays and stores patient information (Ajami and Bagheri-Tadi, 2013). According to Health IT (2016), an EHR is a patient's paper records and information in digital format, available directly and securely to any authorised users. EHRs have received a great deal of attention in developed countries, as well as among health care providers. They are currently extensively used as they are expected to provide a significant saving in health care and enhance health care quality and reduce medical error (Bracco & Labeau 2015). The main idea of an EHR is for it to work as a collection of constantly updated information associated with a patient's health. The EHR can be an effective electronic record that chronologically stores citizen's medical lifetime data. EHRs are built to keep all of a patient's information available to other health care providers and organisations (Nematollahi et al., 2015). It is seen that the electronic health record can include a patient's medical account, identity, treatment schedule, immunization, allergies, test outcomes as well as immunization dates (Ludwick and Doucette, 2009). It is clear that one of the main characteristics of an EHR is that it allows health data to be formulated and handled by sanctioned providers in a digital design capable of being shared with different external health providers to the primary health care organization. For example, laboratories, specialists, admissions in hospitals, doctors, pharmacies, emergency facilities require have information from a clinician involved in a patient's care to provide appropriate services (Bracco and Labeau, 2015). The medical and treatment histories comprise all of the primary organizational clinical information of

patients. EHR is a system that aims to provide significant improvement of care delivery between organizations with high quality of patient care and acceptable outcome (Best et al., 2012). Thus, this information is considered to be appropriate to that individual's care under any certain provider. The broader definition of the EHR can be seen as a digital report of a patient's paper chart (Bracco and Labeau, 2015). Moreover, EHR system is a new version of patient data in digital record format that can be stored and exchanged with several authorized users in a secure way (Häyriinen et al., 2008).

Study Purpose

The aim of this thesis is to investigate and analyze the best practice solutions adopted with EHR systems implemented around the world to adapt the relevant solutions to Australian My Health Record system issues. In addition, the work will investigate in the current system in Australia, the "My Health Record System", to illustrate the barriers that have prevented successful implementation. Afterward, recommendations will involve encouraging stockholders to participate in a successful system implementation, plus avoiding the problems other countries have experienced in the EHR systems implementations.

1.2 Historical Perspective of Electronic Health Record Systems

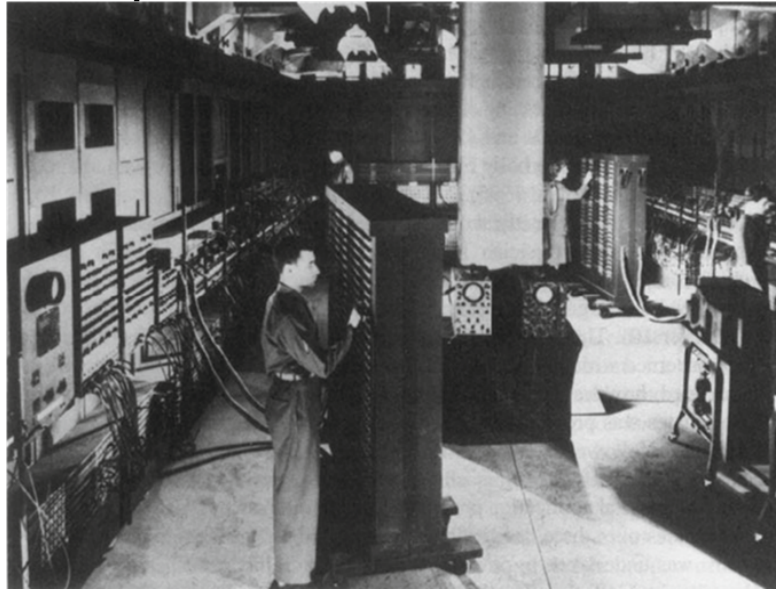


Figure 1 ENIAC computer (Shortliffe and Cimino, 2006)

The first application related to medicine was found by Herman Hollerith (Shortliffe and Cimino, 2006). It was based on the punched card data processing technique and was created for the 1890 census in America. The methods in his technique adapted to epidemiologic and health surveys (Shortliffe and Cimino, 2006). The same technique was then adopted in the development of hospital systems in 1920s, 1930s, and 1940s (Shortliffe and Cimino, 2006). After that, the first modern digital computer systems were developed in America during the Second World War. In 1946 the first release of ENIAC, and it became common in the marketplace in 1950s, mentioned in **Figure 1** (Shortliffe and Cimino, 2006, HOYT et al., 2009). Ledley and Lusted in the 1950's recognized that computers could be useful for medical diagnosis and treatment. They reasoned these because computers could process and archive information more rapidly than humans (HOYT et al., 2009). Dr Barnett, "Dr Barnett is the founder and first Senior Scientific Director of the Laboratory of Computer Science at Massachusetts General Hospital also, he is recognized as one of the founding of medical informatics"(Mghlcs, n.d.).

Dr Barnett started working for hospital information system in 1960s and created many hospital application programs for about thirty years (Shortliffe and Cimino, 2006). In 1962 BBN, a firm in Cambridge named Bolt Beranek and Newman, established a time sharing technology that had online database. BBN had a vision of this system which would have a beneficial impact while information processing needed in hospitals (Barnett, 1990). Then during 1964 to 1966, G. Octo developed medications ordering system, lab reporting system and admission discharge census system. The main development principle being used in the lab by that time was “modular approach” (Barnett, 1990). The development of Hospital Information Systems (HIS), increased in 1970s. For supporting all the applications, one efficient computer was required which could run the integrated of designing a time-shared computer, a large and single computer would be used to support a collection of applications. In 1970s, another technology of “biomedical computing activity” was introduced (Shortliffe and Cimino, 2006). The standardized facilities to the individuals, less time training, was provided by the general purpose software tools (Shortliffe and Cimino, 2006). Today, the healthcare practitioners can install the variety of applications related to clinical research and patient care in their personal computers that can easily be accessed. In the article “HISTORY OF MEDICINE; Development of the Electronic Health Record”, Jim Atherton described the history of development of The Healthcare Information and Management Systems Society (HIMSS). He published his paper in “American Medical Association Journal of Ethics” in March 2011. In 1968, G. Octo Burnett put forth his research about the historical perspective of EHR system in his article, “History of development of medical information systems” at the laboratory of computer science at Massachusetts General Hospital (Barnett, 1990). According to this article the actual

development of electronic health record system was started in 1960s and 1970s (Atherton, 2011). In that era the health centers started developing their own health record systems. The very first and most efficient electronic health record system present at that time was called a clinical information system. Then a clinical decision support system, called a “Health Evaluation through Logical Processing” was created by 3M and the University of Utah (Atherton, 2011). In 1968, at the Massachusetts General Hospital, the Computer Stored Ambulatory Record system was implemented. In the 1970s the use of “Decentralized Hospital Computer Program” was started by the federal government (Atherton, 2011). By that time the medical students and the healthcare practitioners used to use “Computerized Patient Record System”. In these systems' database, some features like recognized several terms of the same disease. This feature allowed patient to recognize any condition across the health system notwithstanding the differences in terminology at different organizations (Atherton, 2011). Then further investigations and research was done to add to the existing properties of EHR. The electronic health record system was incorporated in American Recovery and Reinvestment Act of 2009, by President Obama, as a part of the Health Information Technology for Economic and Clinical Health Act (Atherton, 2011). The electronic technologies became more attractive and affordable for the implementation in the healthcare systems due to their ability to access and store information.

1.3 The development of the EHR

Diverse kinds of EHR have been developed by several administrations, and hospitals with the objective of assembling the patient's information so that they can be viewed readily and administered in one place. It is clear that the development of EHR can be partitioned into two primary time periods. In the early 1980's, stakeholders observed the gains (fast process, data availability) of health systems

and started creating information systems that could handle the wider problems that could help in the general use of the electronic health formation (Shortliffe and Cimino, 2006). The earliest EHR systems employed the title of clinical information systems. Around the mid-60s, Lockheed created a hospital information system (HIS) which was later presented to the Technicon Data Systems (TDS), and after that this system was part of Eclipsys, Inc. (Shortliffe and Cimino, 2006). At that time, there was a collaboration between the University of Utah and 3M to develop the earliest clinical decision support system, which is Health Evaluation through Logical Processing (HELP) (Shortliffe and Cimino, 2006). HELP was a system used by hospitals to aid decision-making that also provided reminders and alerts for upcoming appointments, it was revolutionary back then. In 1968, The Computer Stored Ambulatory Record (COSTAR) started at Massachusetts General Hospital (Atherton, 2011). COSTAR was an EHR system available to societies via public domain supported product (Barnett, 1990). It was formulated in partnership with Harvard; thus, it was seen that COSTAR contained of some new features compare with HELP system like automated appointment scheduling, clinical reminders, a tumor registry, storage and retrieval of data. It also provided clinical reporting, patient record inquiry (Dick et al., 1997). Since the 1980's, more concentrated attempts have been made to augment the use of EHR. In the 1980's, the Institute of Medicine (IOM) announced their needs to evaluate the paper health records (Atherton, 2011). In 1991, they published their reported results and in 1997 there was a 2nd edition of their report containing recommendations to improve patient records. The published results indicated that by employing the EHR, patient's records were much safer as compared to the manual way of doing things like critical role of needs of instant information especially when doctors need decisions instantly (Menachemi and

Collum, 2011). The IOM, reported problems and technical barriers like interface issues, text processing and security. Moreover, the report mentioned there were some non-technological barriers related to missing data (Dick et al., 1997). From 2000 until 2016 there were several of EHR systems that overcome most of the issues mentioned above. For instance OpenEHR, OpenEHR is a collection of open specifications for EHR, Electronic Health Record architecture, but it is, however, not software. Its design purpose has been to allow the semantic interoperability of health information within and between EHR systems, avoiding vendor lock-in data. OpenEHR gained international momentum as it can be seen in high implementations of the OpenEHR specifications, for instance, as in the UK National Health Service program. The system is an intellectual property for OpenEHR Foundation, and it was created through the partnering of Ocean Informatics (Leslie, 2007, Chen and Klein, 2007). Leslie stated that though there have been many EHR models, OpenEHR has survived time because of many differentiating factors such as:

Open source initiative - OpenEHR is available freely to everyone under open licensing (Chen and Klein, 2007, Leslie, 2007).

Language independence - Archetypes, which are used in OpenEHR, are independent of language. They can be created in one language and be translated in any language. As such, they are available in any country. The separation of the clinical and technical sectors - The design of OpenEHR is such that its technical constituents can be separate from the dynamic clinical knowledge (Leslie, 2007).

Easily implemented - There is little infrastructure required to implement OpenEHR due to and the archetypes that can be separately developed from the software application and the use of the object-oriented model (Leslie, 2007).

Knowledge-enabled-capturing – It captures the complex and dynamic state of health information. Medical practitioners can easily and actively contribute to the development of the clinical knowledge base through the archetypes. These archetypes can then be revised to reflect the changing clinical knowledge (Leslie, 2007).

1.4 The characteristics and role of EHR

The EHR system is the system that involves the electronic documentation of the patient's health records in the healthcare centers (Knox et al., 2015). It is aimed at improvement of health care provision. It is observed that when the EHR system is implemented in the clinical settings, the quality of care improves to the greater extent. For example, previously 47% of patients had influenza vaccinations and this number increased after implemented an EHR system to 65%. Also, pneumococcal vaccinations increased implemented an EHR system from 19% to 41% of patients (Menachemi and Collum, 2011). The medical errors are reduced due to the use of appropriate sections for drug interaction and the drug profiles in the EHR system (Menachemi and Collum, 2011). Now many developments have been made and its scope is enhancing day by day. Those additional functions are really working well to support the good quality of patient care (Knox et al., 2015). However, even with the continuous improvements there still present are many drawbacks and shortcomings in the system. The reason is that some of the strategies applied are ineffective and need other systems to work properly. (Knox et al., 2015). EHR system is known to improve the safety of the patient, effectiveness of the health regime and efficiency of the services provided to the patient, in the clinical settings. EHR system approach is mainly patient centered (Menachemi and Collum, 2011). The EHR system is in fact very much efficient comparing with patient paper records and is proven to improve the clinical outcomes and it helps to improve the former strategies to bring about

good clinical outcomes. For illustration, formerly, many cases of the non-adherence to best practice guidelines were observed, which were mainly due to the reasons like the best practice guidelines were unknown to the clinician or the clinician's did not know that which guideline is to be applied to which patient.(Menachemi and Collum, 2011). Moreover, they usually have no time to consult to the guidelines during the patient visit. EHR systems have overcome all those issues with no needs to fill admission forms (Menachemi and Collum, 2011). EHR system improved the clinical outcome because it is involved in many operations running at clinical settings, for example, patient ID and registration details record keeping, keeping laboratory test data of the patient, keeps orders and results of the patients' visits and managing disease classification and indexing (Parikh, 2015). The computer alerts also helped the clinicians to improve the prophylactic treatment for example in deep vein thrombosis. For instance, while using computer alerts they found 19% increase in anticoagulation prophylaxis, this explained into 41% reduced the risk of deep vein thrombosis (Menachemi and Collum, 2011). It also was found that EHR system avoidance of medical errors to about 86% with fully using of EHR system where more than 60% of prescriptions errors in hospitals were found with poor handwriting (DesRoches et al., 2008, Hoover, 2016). The same study found that the 86% of physicians reported a positive effect, while using EHR system, on the quality of clinical decisions. Also, 97% found the EHR systems provide good communications with other providers (DesRoches et al., 2008). another research showed that 75% of participants were satisfaction, were no errors, with using EHR system rather than handwritten papers (Duffy et al., 2010). EHR system improved the healthcare system in under developed countries as well (Katiyar, 2014). In India, the overall improvement in the access to records in terms of timely access to the medical

records was found out to be 97%. It also helps more prescription re-filling more than 95% (Katiyar, 2014, DesRoches et al., 2008). While discussing the organizational outcomes of the EHR systems, it is known to improve the operational and financial performance of the organization (Katiyar, 2014, Zlabek et al., 2011). As far as the patients and clinicians are concerned EHR system provides satisfaction to them about computerized physician reminders services (Menachemi and Collum, 2011). It really helped in achieving the better population health by letting research organizations investigate in data to improve monitoring of potential biological threats and diseases (Menachemi and Collum, 2011). The main goals of any healthcare organizations are to improve the patient's health and their own revenues (Menachemi and Collum, 2011). The EHR system helped the healthcare organizations on the grounds of profits. Their revenues enhanced dramatically due to the potential improvement in the cash flow, elimination of the inaccurate coding and reduction in billing errors. It helps the organization to submit patient's charges in time (Menachemi and Collum, 2011). The EHR system is known to improve the regulatory and legal compliance of the organization with reducing the costs of printing papers and supplies devoted to patients' management (Menachemi and Collum, 2011). It increased job satisfaction for the healthcare practitioners. The example of job satisfaction, a study examined 53 practitioners after using EHR system, they were 90% agree that EHR system increased their job satisfaction by less time doing their tasks and improve their work-life balance (Dastagir et al., 2012). By reminders of EHR system alert patients and the health care practitioners about the routine health visits. This is also going to improve revenues (Menachemi and Collum, 2011). Major portion of the increased revenue is due to the fact that the EHR system offers patient's information electronically accessible, it reduces the costs

related to paper supplies, helps reducing the staff for patient management and decreased transcription costs. EHR system helps easy communication between the practitioners (Menachemi and Collum, 2011). The electronic health record system is found to be helping in many ways. It helps the researchers in conducting the more efficient research. As on EHR system the patient's data is stored electronically, so it can be searched easily by the researchers and helps them to run the quantitative analysis which is surely the evidence based. This finally helps to improve the practice (Menachemi and Collum, 2011). The electronic availability of the clinical data assists the public health researchers to make evidence based conclusions and make that information useful to society. The clinical data that can be accessed by the EHR system is like purchases of over the counter medicines, which helps the researchers to find out the disease outbreaks (Menachemi and Collum, 2011). It is concluded that the EHR systems have brought many positive changes to the whole healthcare system whether it is related to the patient or to the organizations responsible for the healthcare. It improved the businesses as well. It helped easy bill payment for the patients and alarms patients about their routine checkups. Patients can easily access their data and alerts on the applications installed in their phones. Managing the patient's health records and organization's business records on the paper, was very difficult to store after period of the time. But now the patient whole record can be easily searched and accessed anytime and anywhere. It is evident that the doctors who had adopted EHR constantly accounted for more positive opinions when it comes to the ability of the computers on the health care of their patients (Kasiri et al., 2012). The EHR system improved the appropriateness of care in the patients. Patient's quality of care involves doing the right thing to the right

person, at the right time, in a correct way and getting the best results (Menachemi and Collum, 2011).

1.5 EHR Functionality

A team of the Institute of Medicine of the National academics has recognized a group of main functions that the EHR system should be capable of performing so as to encourage greater security, efficiency and quality of health care (Kasiri et al., 2012). Thus, the main functions do comprise the result administration, request management, health data and information, choice support, government procedures and reporting, electronic communication along with linkage (Kasiri et al., 2012). According to various studies on key capabilities as well as the adoption of EHR system, technology and consequently positively impacted health care provision practices (Kasiri et al., 2012). The adoption of novel IT choices has been able to lessen the prices with augmenting the efficiencies of healthcare (Kasiri et al., 2012). It is also clear that health experts are now turning to numerous patient centric technologies which comprise the Computerized Patient Records (CPR), point-of-care applications along with the information warehouses so as to offer them with the data that they need.

Chapter 2

2. Thesis Methodology

2.1 Problem Statement

Australian health care providers have passed a long way towards effective implementation of EHR system. The first system that was called Personal Control Electronic Health Record System (PCEHR) was being implemented 2012. Regardless of the fact that the system was highly promising, the statistics were far from demonstrating success. According to the national data, approximately two million people have been enrolled into usage of the system for the period of two years. Such number of people was not acceptable nor for the government were neither for the process of adaptation of the system, especially taking into account the fact that more than \$ 699 million spent to support the initiative. In 2016 the government has made a decision to rename the PCEHR system to be My Health Record system. As the authorities and health care administration teams recognized it, the system is currently being under the process of improvement as it still has numerous problems, including the one of enrolling more citizens. According to calculations in this thesis, the system will need more than 15 years to enrol all citizens of Australia. Such situation cannot be considered effective neither for health care provision of the nation nor for the economy of the country. This means that urgent measures must be taken to improve the process of implementation of the system and facilitate the process of patient enrolment. Thus, the main problem of the study is lack of knowledge of Australian EHR developers about innovative means of improvement of the system to enrol more citizens. Targeting the problem, the study tends to find the information on success of the system in other countries and also develop a strategy that would introduce the found chances to the Australian EHR

system without any significant stress for health care practitioners, people who already use the system and also those who only have such opportunity.

2.2 Methodology

The problem of the current study and its aim has determined methodology applied to conduct the research. Since the two are about assessment of My Health Record system that is applied in Australia, implementation of qualitative research methods became the main means to identify challenges of the system, as well as its advantages and failures. Computer science vision of the problem and aim of the research has played a critical role in terms of the study conduction. Review of the recent literature that is related to the issue has been developed due to availability of reviews and records to be observed. This means that the study was carried out on the basis of analysis of documents that were chosen from hospitals and national EHR systems, demonstrating both failures and advantages of it. Based on successful enrol of people and a broad experience; a higher level of objectivity requires random choosing of hospitals and national systems to study their EHR systems. National EHR systems of the United States of America, Canada, and Europe were chosen due to their broad experience in terms of using EHR systems, as well as high level of development of the countries which ensures the fact that their citizens are more likely to use EHR systems of the highest possible quality. Taking the above approach as grounds, the current paper investigates a range of criteria that are taken by the above-mentioned countries to make the EHR systems adapted to the needs of their patients and requirements of their health care practitioners to ensure successful enrolment. Discussion of the factors allows judging on success or failure of the systems and concluding about further actions to be taken to contribute to enrol citizens. The study involves progress covering of enrolling citizens in various

countries as a factor that allows measuring advantages and disadvantages of the system, providing reasons for claiming them effective or not. It is important to pay attention to the fact that methodology of the current study considers the high level of security, as well as opt level in to EHR system. Reaching objectivity in terms of results of the study requires considering not only countries that enrol all their citizens into usage of the system, but also the locations where EHR are still not popular. Moreover, the research focuses both on systems that are considered secure and advance, as well as on those requiring urgent improvement for safety of the patients. The research strategy, used for the current study, included several main stages. The first one was choosing a research topic, turning it into a question and identifying keywords like EHR, Healthcare, Health science, Digital health, Recommendation. Gathering background information from reputable and reliable sources of information from PubMed, Google Scholar and Google of the best practices that have been applied in the countries mentioned above. These included electronic books, journal articles, politician speeches, and websites. Evaluation and comparison were the next stages to identify usefulness of EHR systems in terms of improvement of the Australian one. Discussion and conclusion were the closing stages of the research strategy.

2.3 Theoretical Framework

Studying EHR of different countries is highly advantageous for the Australian health care system. The reason is the fact that highly developed countries have reached a high level of EHR systems. The strategies, applied and used by them must be adopted by the Australian EHR systems to provide local health care practitioners with better opportunities and at the same time contribute to the process of treatment of the patients. At the same time, it is important to study history of the development of the EHR systems for careful analysis and consideration of all mistakes and

failures that took place in practice. This can allow modern health care practitioners avoid the same mistakes. Thus, review of relevant literature and careful consideration of developed countries past practices as well as current ones, their comparison, and analysis are beneficial for the Australian system as it allows developing recommendations on avoiding a wide range of failures and at the same time facilitates EHR progress. The following are some of the activities that need to be put in place for better adoption of an EHR system.

1- Basic Information Communication Technology (ICT) infrastructure

A large investment needs to be made in terms of hardware and software in the public hospitals and dispensaries that have very little ICT (Srivastava, 2016).

2- Free and open source EMR

Due to the number of people who are normally treated in private healthcare facilities, the government should work to make them adopt the technology. It includes making good quality software available to individuals and all hospitals (Srivastava, 2016).

3- Training the staff members - When the staff members are well trained with the introduction of a new system, they are able to understand it and use it more. If they are not trained, they lack the understanding of its capabilities and may avoid using it (Cresswell et al., 2013).

Chapter 3

3. Review of existing EHR systems at international level

The execution of Electronic Health Record system in the health care organization highly depends upon the “Target” and the “Mission” of the organization. Moreover, the procedure of implementation is affected by stakeholders as well. In fact, the stakeholders have different tasks to perform, for which they want high quality performance. So, they need to implement different types of techniques. The professional performance of the organization enhances if the owners and stakeholders are well educated about the operation of the whole system of organization and the maximum output they could get out of the existing system (Chao et al. 2013; Lluch 2011). Health Care Provision Practices of Estonia, Denmark, Sweden, Spain, America, Canada, England, Austria and The Netherlands have proposed this concept. Although, the education, training and awareness of the employees about the appropriate and effective use of the system is the major and basic factor that affects the outcome of organization but another chief factor that is going to play the vital role in the best outcome and the success of the system is “constant improvement”. It is thought to be effective because patient’s needs are changing with the passage of time, so system has to change (TUTEN, 2012).

3.1 Benefits of EHR systems at international level

There are significant benefits of using the EHR in the health industry. The main of them are listed below:

- The EHR system makes work very easy because patient health history information is presented in a summarized way, highlighting major illnesses, medication, allergies or surgeries to make quick and better decisions (Menachemi and Brooks, 2006).

- Since the patient information is readily available, there are reduced cases of medical errors and general improvement of health welfare (Hoover, 2016).
- EHR helps capture patients' data in real time, and can be viewed by different healthcare providers at the same time and from various locations (Menachemi and Brooks, 2006).
- The availability of health information on a real time basis creates efficiency and effectiveness of health services (Menachemi and Brooks, 2006).
- The EHR systems are designed to integrate with barcode in general for all activities that occurs in the hospital, such as billing and the codification of test results (Hoover, 2016, Menachemi and Brooks, 2006).

EHR system is also very important since it improves the quality of decisions that are made meanwhile they have important health information when it is needed to attend to a patient. The system can be set to create reminders and alerts by health professional and individuals to remind them of important things that need to be attended to. As of the advantages of the EHR, the gains do augment to both the practitioners along with the patients. It can be pointed out that EHR can be accessed on request and can possibly save the lives of people (Chao et al. 2013; Lluch 2011). Several studies on EHR show that EHR systems make significantly fewer mistakes as compared to paper records with improving overall efficiency, duplicate tests and with more than 50% of reduced adverse drug events (Hoover, 2016). Communication among the physicians can be enhanced greatly by employing EHR; permitting every party the complete permission to a patient's medical account rather than a snapshot-type impression from a present visit. It is seen that this access does permit for a more in-depth assessment, and allows doctors to get an accurate diagnosis promptly (Hoover, 2016). Also, it is evident that EHRs can make it simple

for doctors to track patients and progressing care, mutually under the guidance of the doctors. EHR systems save time in the course of a doctor’s visit (Hoover, 2016). When there is a crisis, these records can offer significant, life-saving data to an emergency care provider (Hoover, 2016). In Denmark, they adapted an EHR system and for approximately 98% of primary care physicians, there is access for all hospital pharmacists and physicians. Also, doctors save an average of 50 minutes a day (Harrell, 2009). Additionally, Denmark have an electronic database since 1977 and basic records since 2000 (Harrell, 2009). It is clear that Information Technology is employed in all stages of health systems as a section of a national plan assisted by the National Agency for Health in Denmark. Moreover, in Estonia, from December 2008 they have fully implement of an EHR system (birth to death) (Doupi et al., 2010). The Estonian Government obliged all healthcare providers to send numbers of agreed electronic information notes and medical documents, electronic medical documents to the system. (Doupi et al., 2010). Furthermore, Finland has shown possibly the greatest significant success in adopting EHR systems in all hospitals (Castro, 2009). In 1999, only 4 of the 21 of hospitals in Finland had adopted EHR systems but by 2008, the EHR systems were used in all 21 hospitals (Castro, 2009).

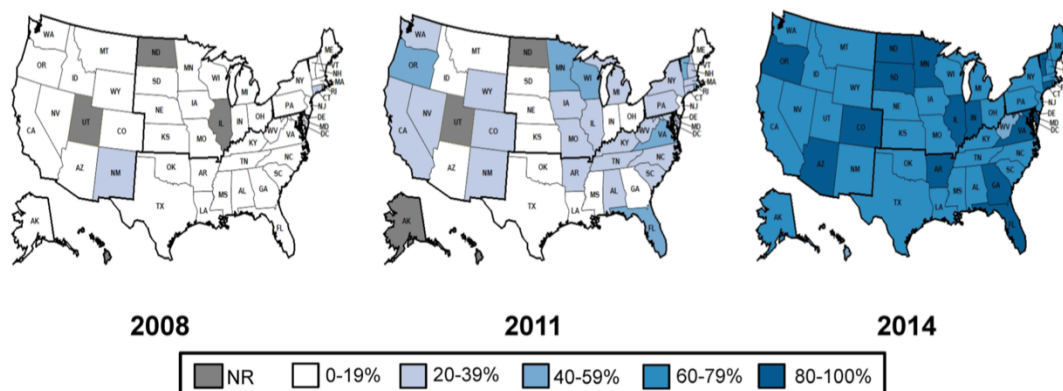


Figure 2 Usage of EHR in Europe for the period of 2008-2014 (Charles et al., 2013).

In US, there was a significant increase of state adoption EHR from 2008 to 2014 (**Figure 2**). In 2008, hospital adoption of the EHR system was above 20%, in only two states as shown in (**Figure 2**) (Charles et al., 2013). According to a data brief 2015 of the National Coordinator for Health Information Technology (ONC), they mentioned that in 2014 there was more than 80% EHR adoption in 17 states (Charles et al., 2013). In Sweden, EHR system was used in more than 96% of hospitals and 100% of primary care clinics in 2011 (Gray et al., 2011). Also, in Sweden, in 2011 more than 79% of prescriptions were written electronically, called electronic prescribing (Gray et al., 2011). In 2016, 100% of hospitals care and emergency departments in Sweden adopted EHR system (Skyttberg et al., 2016). In Sweden, all laboratories are computerized and all radiologists have access to EHR system. Furthermore, nearly all States and Territories have a system for access to summaries of scheduling of visits and renewal of prescriptions of electronic exchange of all hospitals around Sweden(Gray et al., 2011). As a result, the Swedish government covers and works well in EHR systems. Such high rates of being used with no doubts prove effectiveness of the system. Unfortunately, regardless of this fact health care practitioners in many countries, including Australia, continue facing a range of challenges that occur due to usage of the system. Moreover. EHR are not likely to be trusted by many patients, especially senior citizens, so the rates of being used are impacted not only by performance of the system, but stereotypes as well. With no doubts that are cases when failure of EHR was dangerous for lives of the patients, so the system needs urgent improvement (Gray et al. 2011).

3.2 Problems and solutions with experiences at international level

3.2.1 UK

In the UK, there were several technical challenges with the EHR system, The Epic EHR system was realized in October 2014. According to Hirsch, there is a report that mentioned major issues while implementing EHR in Addenbrooke's hospital and the Rosie Hospitals like generated prescription errors, system delayed, produced not accurate data and problems with data collection (Hirsch, 2015). After five months, the result of implementation was insufficient to get the successful level of implementations (Hirsch, 2015). For example, there was an issue with the outcomes of some patients' care, and treatments were not monitored or even collected correctly. Additionally, Hirsch stated that there are data collection issues with the system. Moreover, there were significant numbers of delays in the system, while requesting for a participation that caused a limited participation of patients. Hirsch stated that in some cases the system did not produce accurate data. The last two issues Hirsch had mentioned that had a seriously high impact on patients' records were about the EHR system generating prescription errors and some information seemed to disappear from patient records. Discussing the national EHR system of the UK, one fundamental challenge of the ePCS system is the lack of adoption by the members of the practicing group. There are problems related to bringing it to the medical practice consciousness as a beneficial approach to making the updates of the out of hours' data. It has been said to be a left out when major attempts have been made to make people aware of it. People using it are not automatically doing so but have been coerced. The solution for this problem would be the continuous introduction of the system to practitioners and to enable them to understand its importance (Hall et al., 2012). Furthermore, the Individual Health Records (IHR)

there have been concerns in relation to the accuracy of data and its reliability when it is entered and updated into the system. When a few of the web-based systems were evaluated in a study, they were identified as not providing guidance to the consumers through abstraction of relevant information from prescription labels. The solution to this problem is to have improved design IHRs that can incorporate the use of criteria-defined radio buttons or color-coding to enhance data accuracy (Kim and Nahm, 2012). Additionally, There are physical impairment issues that are limiting to various population groups, for instance, 21 percent of the population (whom 65 years and older) have a visual impairment and are not able to use computer screens (Lober et al., 2006).

3.2.2 US

In the US, most health care providers have needed more information about EHR system implementation (Øvretveit et al., 2007). Anderson declares that in the US over 70% of physicians state that the overall lack of the EHR system in US with the lack of technical implementation plans and appropriate Information Technology staffs to assist such their system (Anderson, 2007). Additionally, around 50% of the physicians declared that there was a lack of technical understanding at personal level. This has caused a main barrier to EHR system implementation (Anderson, 2007). Therefore, regardless of the possibility of technologies and budget exist to execute an EHR system, occasionally end-users' issues, like lack of knowledge or unfamiliarity with the system, will have a significant impact on a system's implementation (Bhagat, 2010). One study found that over 70% of primary care physicians who are using an EHR system saw a reduction of commonly occurring errors and increased the productivity (Anderson, 2007). The study found two reasons for this: one is that primary care physicians were realising that the high IT concept is

possible to increase their productivity; the other is an acceptable product with easy IT tools will enhance primary care physicians to have adoption of EHR system (Anderson, 2007). In general, studies conducted by the Office of the National Coordinator for Health Information Technology (ONC) showed that the major motivation for adopting the EHR was the encouraging payments along with avoiding the financial fines originating from the governments (Heisey-Grove and Patel, 2014). With lose productivity, the study also explained that the major cause for not adopted the EHR was the shortage of resources. Thus, in both situations, it is seen that the core motivating issue was financial and second rate. Money has been perceived as being the most influential motivator. Financial incentives along with penalties have motivated physicians to adopt the EHR system. Studies conducted to examine the efficiency of the EHR incentive plan showed that EHR adoption has expanded dramatically since financial incentives started to be offered (Heisey-Grove and Patel, 2014). The studies went further to show that 77% of physicians are intending to adopt the EHR system (Heisey-Grove and Patel, 2014). Other incentives described by the physicians comprise of board certification necessities, approvals from relevant colleagues as well as the potential to swap over data electronically with other doctors (Heisey-Grove and Patel, 2014). According to a recent research, only 1.5 % of American hospitals use a comprehensive EHR system. Despite its widely known advantages, administrations of the hospitals that do not use the system still find that it has more disadvantages. Financial support is the biggest problem for some hospitals, especially those rural, while other issues that are stated as factors to be improved are interoperability, technical support, and also training of the staff to use the system (DesRoches et al., 2008).

3.2.3 Germany

In 1994, Germany was the first country to use a magnetic card around the world with limited significant patients' information (Marschollek and Demirbilek, 2006). After the Lipobay scandal in 2001, The Lipobay scandal in 2001 that caused to deaths due to rhabdomyolysis with subsequent kidney failure, it was one of the reasons which pushed Germany to have an EHR system to avoid perceptions mistakes and control the patients' records (Gall et al., 2016). In 2001, the German government planned to have an EHR system by 2006. They decided to include any documentations for each medical product that the patients had (Gall et al., 2016). Nearly, by build their own EHR systems locally with their practice information system, all physicians in ambulatory care in Germany adopted EHR systems (Duennebeil et al., 2010). Furthermore, a national telematics initiative, which connected with other medical institutions, aimed to achieve integrated care by connecting with other local medical information systems through a common nationwide telematics infrastructure (Duennebeil et al., 2010). In Germany, the main implementation problem related to matters associated with the privacy of the patients' records stored within the systems was the privacy (Rezaeibagha et al., 2015). Privacy is one of the key challenges highlighted when dealing with these systems since the nature of information stored within the systems is private, thereby prompting its sensitivity (Rezaeibagha et al., 2015). Currently there are no unique identifiers of the patients and the interoperability is limited. Moreover, safety of the data also remains an issue. Drug therapy also needs improvement, as patients who have more than two drugs prescribed at a time do not have an opportunity to have their individualized medication plan in their health care record.

3.2.4 Canada

The major problem that is faced in terms of implementation of EHR systems in the country is not sufficient compatibility with the general requirements to the system development nature (Gagnon et al., 2009). In other words, most health care establishments are likely not to accept the systems because these cannot provide the effective service platforms. With EHR projects failures and while talking about implementation of an EHR system, a study found the Canada was placed behind other industries countries in this field (Gagnon et al., 2009). Although, it is a high priority for the Canadian government to have a suitable EHR system cross country (Gagnon et al., 2009). In one questionnaire, Canadian citizens were asked; “Why is Canada lagging behind other countries in the adoption of electronic health records?” (Rozenblum et al., 2011). The study found there was a significant insufficiency of engagement of clinicians; also, there was a lack of flexibility in integrating changes; and the system not focused on regional interoperability though there was a focus on national interoperability (Rozenblum et al., 2011). The authorities of the country work towards development of EHR systems in order to develop efficient guidelines to be implemented to the system.

3.2.5 Denmark

In Denmark, the biggest problem experienced is fear attributed to lost productivity through the implementation of EHR systems focused on maintaining better avenues for recordkeeping (Bhagat, 2010). There are worries among clinicians that they may lose approximately 25% of their productivity during the first three months of implementation of the system (Bhagat, 2010). All primary care physicians in Denmark have fully functional EHR system (Bhagat, 2010). All EHR systems around Denmark are connected together is operated by a private non-profit organisation called MedCom (Protti et al., 2008). The network allows GPs to send clinical

information with professionals, pharmacies, any hospital, health providers and any laboratories. Most communication between these service providers happens electronically (Bhagat, 2010, Gray et al., 2011). In the early 1990s, supportive policies had facilitated an increase in interoperability, with immediate payment for physicians who used EHR system and there will be a financial incentive to any practice consultations via telephone and emails by primary care. Also, there is a public perception by rating whom using or not using the EHR system in Denmark and Physicians who did not use EHR system were they will be in a second rate of encourage people to deal with them (Bhagat, 2010, Gray et al., 2011). Denmark government have e-prescribing and good communications between doctors along with patients (Protti et al., 2008). As a result, the adoption of EHR has increased the efficiency and improved coordination of physicians' care for patients in Denmark (Protti et al., 2008). Another improvement was made by MedCom, which developed the national infrastructures, technical assistance and set standards. Also, patient can change GPs and their record will be transferred electronically from the previous GP to the new GP (Protti et al., 2008). EHR system will be allowing physicians access to the medication profiles of patients. On the another hand, there is an issue with all other health professionals that they must get patients' approval before looking at their health information (Protti et al., 2008). As a result, the authorities of the country try to undertake programs of the pilot type for specific facilities. Such activities are expected to increase confidence in the users of the system by means of improving productivity.

3.2.6 Sweden

In early 1990s, and by development of EHR systems led by local clinical supporters and strong administrators there were more than 27 system used in Sweden. Today,

however, there are four different EHR providers in the Swedish market (Gray et al., 2011). Decentralized to own their EHR system allows every county council to be responsible to select and obtaining their own health IT systems (FALAN, 2016). Thus, on 2012, county councils succeeded to had fully implementing EHR systems in all hospitals, primary care and psychiatry with various databases (FALAN, 2016). The system that is applied in Sweden is also not based on any proper national policies. Moreover, there is no effective technology to be used (Gray et al. 2011). Consequently, health care providers cannot use the system effectively to achieve positive results and improve their work (Gray et al.2011). One more problem is represented by development and implementation of new policies in terms of implementation of EHR systems to gain success in the future (Gray et al. 2011).

On a regional level, electronic transfers and exchange of clinical data across county councils are difficult because national standards for interoperability are lacking. By 2020, and in order to have more usability in the EHR system Ann Soderstrom, a director of Healthcare Services in Västra Götaland region in Sweden, promised to solve the two main issues which are the difficult layout and the interface of the EHR (FALAN, 2016). Firstly, the difficulty of layout prevents any practitioners from finding which record they have to fill with the information they have. Secondly, the interface of EHR obliges practitioners to deal with many mouse clicks while searching for information (FALAN, 2016). As result, by solving these issues it will help Sweden government and Sweden citizen to deal with EHR system implementation.

Taking into account all the above information, it is possible to develop a table (see **Table 1**) to outline the main problems of EHR implementation in the above-mentioned countries. The table is also useful for further consideration of barriers that do not allow the system become effectively implemented at the international level.

Country	Major issues of concern
UK	Prescription errors, system delay, lack of data accuracy, data collection problems.
USA	Lack of technical support, low familiarity of the staff with the system, financial support in the cases of rural hospitals.
Germany	Low security level, no unique identifiers for the patients, limited interoperability, individual plan issue.
Canada	Lack of compatibility, integrating change flexibility lack, not sufficient clinician engagement.
Denmark	Low productivity, low security level
Sweden	Lack of guidelines on usability and reliability, lack of national interoperability standards, layout and interface issues

Table 1 Main problems of EHR implementation in countries

3.3 Barriers to Successfully Implementing EHR at international level

Several barriers are preventing the adoption of EHR in the health industry. One of the most important reasons is an intense fear from individuals toward security and privacy (Chao et al., 2013, Menachemi and Collum, 2011). People are afraid of the way their confidential information will be used if unauthorized people accessed it (Chao et al., 2013). There is a general fear that Information Technology is vulnerable to attacks such as a virus or hacking that can cause a lot of damage when the medical information is stolen or lost in the process (Menachemi and Collum, 2011). Physicians and doctors are also resisting change because they are used to the paperwork system and they do not want to move away from that facilitate their daily work (Chao et al., 2013). Some medical practitioners fear that their influence and

autonomy might be reduced since they will no longer be an authority in their field of specialization (Chao et al., 2013). Some of the physicians do not have fully computer skills and therefore are opposing the EHR system because to embrace the system would require them to have enough training in that area. The adoption of EHR system requires training for all participants, and medical staff have to take the time to understand the electronic system; time they do not have as they are often overwhelmed with work (Ash and Bates, 2005). The implementation of the EHR systems is also costly to implement in all health facilities and hence will create confusion since not all practitioners will have the same information (Middleton et al., 2013).

3.4 Strategic Factors Affecting the Adoption of the EHR

There are various factors that affect the strategic adoption of the EHR system in the health industry. Taking into account all the above information it is possible to suggest that the first reason is the weak or poor hospital information system that is put in place. There are different information systems adopted by different hospitals, and they are concerned about exchanging information between them. Moreover, patient information is stored in different databases that will make it very hard to streamline the information into the EHR system. Regardless of usefulness of the system it is necessary to pay attention to the fact that EHR system cannot be introduced to replace human capital and therefore this confusion has been affecting the adoption of EHR system in the hospital (Kruse et al., 2015). Apart from this, patients do not know of the benefit of adoption the EHR systems and hence they are not willing to register and give information concerning their health history. Some of the patients are very afraid of their level of security and of their privacy being violated (Menachemi and Collum, 2011, Lluch, 2011, Chao et al., 2013). Improvement of the situation requires educating the patients so there can be an easy integration to the

EHR system where individuals will have the confidence to share their information without fear of it being used maliciously (Kruse et al., 2016).

Chapter 4

4. Australia Context

Based on recommendations from National Health and Hospitals Reform Commission 2008 (NHHRC) the Australian government announced the national plan to start Personally Controlled Electronic Health Record (PCEHR) system. Thus, on the first of July 2012, the Australian government launched PCEHR system (Pearce and Bainbridge, 2014). The Australian government, invested \$466 million to commission the PCEHR in the 2010/2011 budget (Xu et al., 2013). The PCEHR system was an “opt-in” system to capture health data electronically (Lehnbom et al., 2012). It was further funded by the government in May 2012 with \$233.7 million. The EHR pilot program began in 2011, and was rolled out using the National Broadband Network. Nine implementation sites were funded by the government with over \$55 million to help the patients and health care providers to sign up for the PCEHR (Budde, 2016). The Australian Senate passed legislation in 2012 for the institutionalization of PCEHR as one part of the Australia’s health system (Budde, 2016). The program was well rolled out and by mid-2013 had more than 520,000 registered patients and over 5000 general practitioners (Budde, 2016). The EHR system has facilitated efficient patient care and treatment from different health practitioners, and has enabled patients to have an access and control to their individual health records together with their professional health care providers to increase the quality of care (Standing and Cripps, 2015). Australian government further supported PCEHR system with \$140 million provided in the 2014/15 budget continue the roll-out of the system (Rollins, 2014). Since July 2012 to 2014, PCEHR had 2.5 million patients and approximately 5,100 registered GPs providers (Everingham, 2016). However, it has not been efficient in its usability, governance, clinical utility and operations

(Everingham, 2016). In 2014 PCEHR has been decommissioned from the Australian government because lack of registrations and Ms. Ley illustrates that less than 1 of 10 of Australian registered to PCEHR system (Ley, 2015). However, this system has been renamed in 2016 to My Health Record with rescue package, \$485 million Australian dollars, to support the system (Ley, 2016). The EHR system in Australia strives to ensure that individual privacy is respected by announced fines up to \$500,000 Australia dollars and jail or both for any individual who tries intentionally or miss use to get data from the health record (Ley, 2016). The automation of the health record has facilitated interaction between patients and clinicians (Ley, 2016). Adoption of the EHR in Australia has: enabled the sharing of valuable information among the healthcare professionals; increased efficiencies in the delivery of health care services; and, reduced the cases of hospitalizations.

4.1 PCEHR system overview and issues

The PCEHR system is an important part of health sector reform in Australia. It started as a government agenda to build a standard healthcare system suitable to serve the Australian people in the 21st century. Such a system must be an accountable, sustainable, and affordable system that will ensure quality and safety in Australia. This system enables the secure sharing of individual medical information with healthcare professionals. The PCEHR system is a national program that aims to enable personal and general healthcare providers to share important information, when it is needed, to improve healthcare in Australia. The government invested \$466.7 million in launching the PCEHR system to enable sharing of information between health care providers and for access of individual patient health histories (Budde 2016). The PCEHR system places people in the center and handles their health information. Individuals can access their important information in any place, when it is needed by themselves or their preferred healthcare provider. The PCEHR

is an “opt-in” system in which individual were at liberty to join or not. When they chose to join the PCEHR, they were able to set up privatized access control. When the individual authorized their account, health care providers from different healthcare settings and locations could view their summarized medical history. The system draws individual information from different sources to a single view. The system is standardized and conformant with different systems (Budde, 2016).The participants, once they are registered, will take control of their accounts and health organizations will be able to access individual information efficiently via the PCEHR system. Sensitive health information will be shared, including allergies, medication, and a brief medical history. The healthcare organizations must be registered with the healthcare organization identifier (HPI-O) to participate in the PCEHR system. The PCEHR system became functional in July 2014 and was subject to expansion through the help of ICT industry and healthcare providers. The system was breached twice between December 2013 and Oct 2014. In the first case, several unauthorized healthcare providers accessed patient records. Six months later, there appeared an unauthorized option to link a MyGov account to PCEHR records. Suddenly, this option linked to a second account, and there were two “Open Your EHealth Record” icons on the home page of a user’s MyGov account (Cowan, 2014). Moreover, Kate McDonald wrote about two drugs prescriptions were written on March 12, 2012 and added to EHR PCEHR account by unauthorized users. Additionally, there was a number of repeats for each drug. She mentioned she had not taken those drugs before and had not had medical conditions for any of those drugs. She also said that when she tried to contact the PCEHR help desk to rectify this issue, they could not verify EHR identity over the phone (McDonald, 2013). This issue raised by McDonald

clearly suggests that better control over input of data for external systems is required.

4.2 My Health Record

My Health Record is a digital platform formed by the Australian government to provide patients' information to healthcare providers online. My Health Record provides the major aspect of individuals' health information summaries, such as allergies, medical prescription, and reactions if any. My Health Record was previously called the PCEHR system (MyHealthRecord.gov.au, 2016b). It permits different individual doctors, healthcare centres, and hospitals to access and view patients' health information as the access control features permit (Ley, 2016). Individuals can access their health records online whenever they want. My Health Record system is an online "opt-out" system where individuals in Australia can register for the system and opt out of the system online. They are responsible for their health information, which they can communicate to healthcare professionals. The individuals have a choice to opt out of the system whenever they feel unsafe and opt out from the system (Ley, 2016). The My Health Record is regulated by the My Health Record Act, which stipulates how individuals' health information can be collected, how it will be used, and its disclosure. Therefore, any form of an unauthorized collection of individual health information, use, or disclosure of information contained in My Health Record breaches the My Health Record Act, and concurrently interferes with an individual's privacy (Ley, 2016).

4.3 Confidence in government institutions and their programs

In 2014, Mr Cubrilovic, an Australian technologist and developer with a background in information security, wrote on his website about how he was able to copy a

victim's cookies through a fake link, then login to the victim's MyGov account (Grubb, 2014). In addition, he was able to access all services in MyGov such as child support and all health services (Grubb, 2014). Mr Cubrilovic sent an email to MyGov support team and waited a long time to get a response to this issue. Finally, this issue was fixed (Cubrilovic, 2014). According to Dr Williams and security expert Steve Wilson, Dr Williams an associate professor and eHealth research group leader at Edith Cowan University's School of Computer and Security Science and chair of HL7 Australia, even though the issue was fixed, we can see that the MyGov site was not built with a good security level (McDonald, 2014). Dr Williams said, *"It is not necessarily your log-in details but some of the connection details. Cross-site scripting code uses known vulnerabilities in web-based applications. A cookie is just a text file so it doesn't do anything on its own. However, cross-scripting allows malicious content to capture and use this information"* (McDonald, 2014). Also, on 9 Aug 2016 there was a live test for the digital infrastructure and electronic systems capability of one of the government online projects. Australian citizens saw the Census of Population and Housing website down when they need it, which caused the Australian government to apologize for this issue (**Figure 3**); they subsequently announced the problem had been a cyber-attack from overseas. After one day, Mr. Malcolm Turnbull sought to ensure that all Australians' data was in a safe place and then announced that the issue was caused by a huge number of citizens trying to complete their census online at the same time.

Moreover, he mentioned there was a hardware failure. From the perspective of caution, the ABS had closed down the census website to make sure no infringements for any data were submitted. Mr. Turnbull said there were no data lost or compromised. The government apologize about this issue (CensusAustralia,

2016). Consequently, the government knew about the consequences that would appear after the failure. Senator Nick Xenophon said the government program was a failure (LEWIS, 2016). Also, “worst-run” for the 2016 Census of Population and Housing website in Australian history was a commended of Andrew Leigh, a member of the Australian House of Representatives. Mr. Shorten said “It takes more than 100 years to build confidence in the census. It has taken Malcolm Turnbull one Tuesday night to see this weak work and project undermine confidence in government institutions.” He also said; “It is humiliating when the government asks millions of Australians to fill out the census and the government can’t even get that task right.” (LEWIS, 2016).

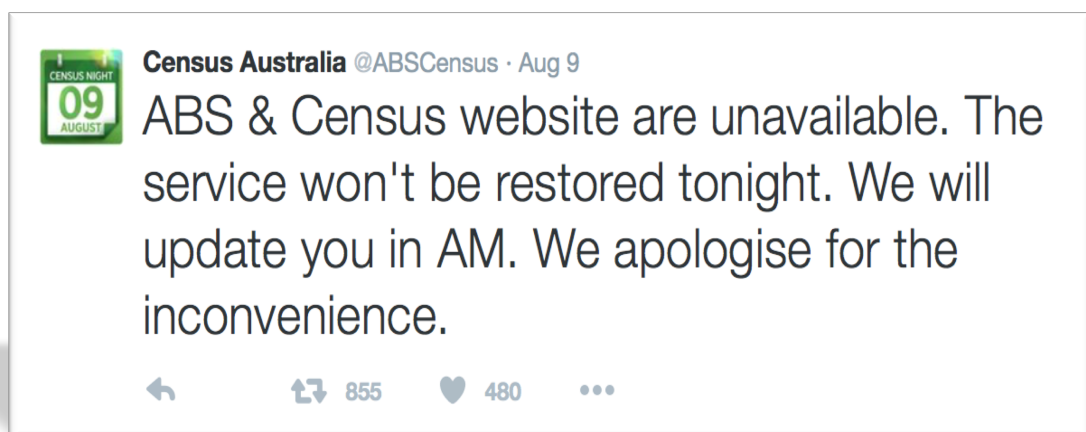


Figure 3 **ABS & Census website unavailability screenshot** (CensusAustralia, 2016)

All these issues will impact any government project especially with My Health Record system implementation. Australian citizens will not trust any government promises for the privacy and security. These issues need to investigate if it is one of the reasons that led of lack of registration in My Health Record system that discussed in the section 3.4.1.1. Due to the growing acceptance of the requirement for sharing information in some circumstances, there is permission for disclosure of information. It takes place when the doctor feels that there is a need to disclose the information so as to reduce or eliminate a threat to health, lives, and the safety of relatives. The

guidelines that were established in 2009 were restricted to private practitioners, but after the March 2014 amendment, there was the introduction of the Australian Privacy Policy, which covers the use of information that is personal. The Australian Privacy Principles (APPs) and Act of Privacy have been extended to be used by the commonwealth-employed practitioners, but not state and territorial public hospitals' practitioners or other unauthorized access and infringements (Otlowski, 2015).

4.4 Problems in Australia with EHR implementations

Searching for the reasons of low enrollment it is necessary to turn back to the first EHR system and find out whether they are the same as those current or vary. The first implementation with PCEHR opt-in system had some barriers to engage with it. All healthcare providers were asked to describe their understanding about PCEHR; they understood the main idea which is electronic health record; but, they misunderstood the way information was shared (Lehnbom et al., 2012). There was a problem in NSW state with registering citizens, a study found just 0.13% of citizens had registered to PCEHR (Lehnbom et al., 2012). The problem facing implementation of PCEHR in Australia is a low level of trust among health care providers and the patients (Xu et al. 2013). Most health care providers do not have the level of confidence allowing them successfully use the system (Xu et al. 2013).

4.4.1 Confidentiality and Security of EHR in Australia

In Australia, the privacy of health information in the private sector is protected by the Privacy Act (1988) (Rangraz Jeddi et al., 2016). Any implementing of EHR systems has challenges, especially with regards to privacy. Sometimes there are additional problems with privacy of the information and how to maintain patients' information in a secure place (Pearce and Bainbridge, 2014). Consequently, there have been explorations into if the privacy of the EHR in Australia could be trusted. As the personal health information is very sensitive. All Australian citizens should know

since 2014 Australian Privacy Principles and Act of Privacy protected personal information from any unauthorized access or infringements (Otlowski, 2015). In another hand, Government should word to educate citizens how they will protect their information. Until now this issues still remaining. Privacy concerns from legal professionals and individuals is currently the greatest challenge facing the Australian EHR with regard to the adoption and the use of the PCEHR system. Privacy concerns arose since PCEHR is the largest centralized database with private and confidential information in Australia (Chao et al. 2013; Lluch 2011). Therefore, any breach of privacy policy would affect millions of people and provide the opportunity for potential fraud. Safeguarding this sensitive information about Australian citizens remains a great challenge. Privacy and confidentiality risks are well addressed and documented in the Privacy Impact Assessment Report, but many stakeholders are concerned about whether there are adequate measures to safeguard their privacy from unauthorized or malicious access. Many Australians did not sign up in the system due to privacy concerns. According to a survey done by Harris Interactive, approximately 80% of Australian citizens surveyed had no confidence in the PCEHR system regarding their security and privacy terms as the system was stopped being personally controlled (Xu et al., 2013).

4.4.1.1 Lack of Registration

The 21 August 2016 statistics released by the Australian Digital Health Agency (**Figure 4**) demonstrate the number of consumers who have registered for My Health Record. Statistics show only 4,079,339 consumers registered, which is 17% of the Australian population. Furthermore, by looking into the “Clinical Document Uploaded”, 898,011 have been uploaded. By dividing this number of the documents with the 4,079,339 consumers registered, it is clear that there are only 0.22 documents for each consumer registered. There are several questions to consider:

how many consumers registered actively on the My Health Record System? Does each health provider upload new documents for a patient?

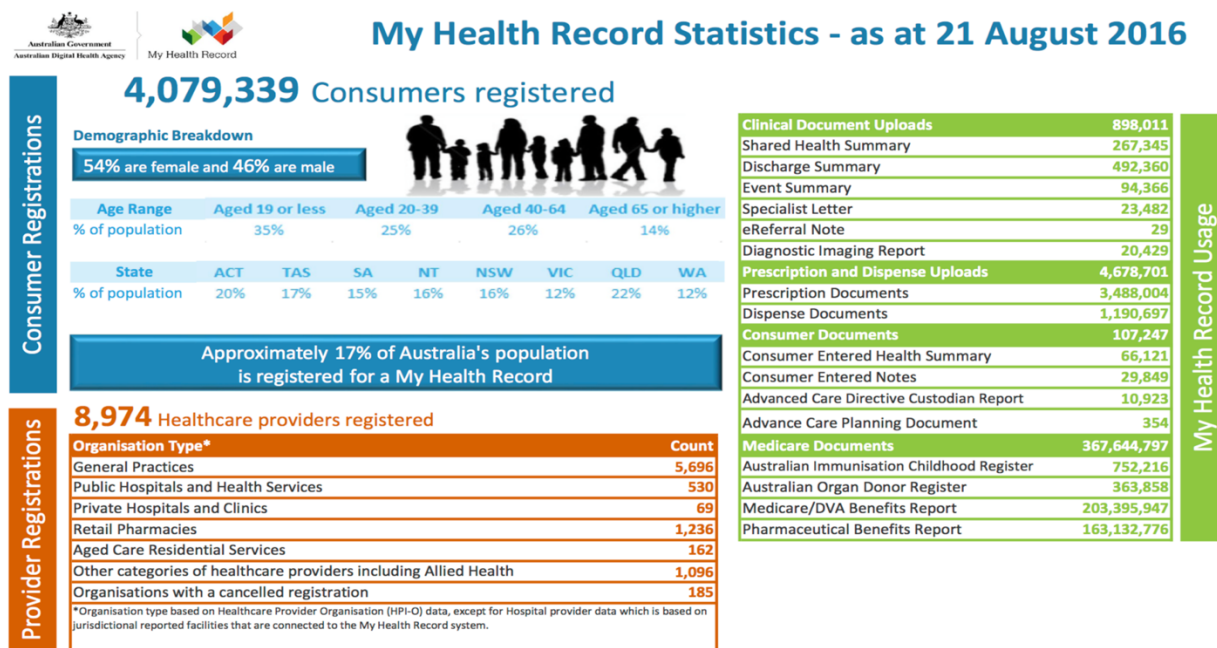


Figure 4 My Health record Statistics – as at 21 August 2016 (Myhealthrecord.gov.au, 2016a)

The second set of statistics from the Australian Digital Health Agency website on 2 October 2016 (**Figure 5**) shows that the number of consumers registered so far are 4,218,970. By comparing this number with the consumers registered in 21 August (**Figure 4**), we find an increase of 139,631 consumers, who had registered in the period between 21st of August and 2nd of October of the year 2016. This means 3247.23 consumers registered every day for this period. Importantly, the population of Australia is 24,239,534 citizens (ABS, 2016). According to the above mentioned figures, 20,020564 citizens are not yet registered in the system, and, if the registration flow maintains a similar rate, it could take more than 15 years. However,

these with the current population, without taking in mind the increase rate of the population.

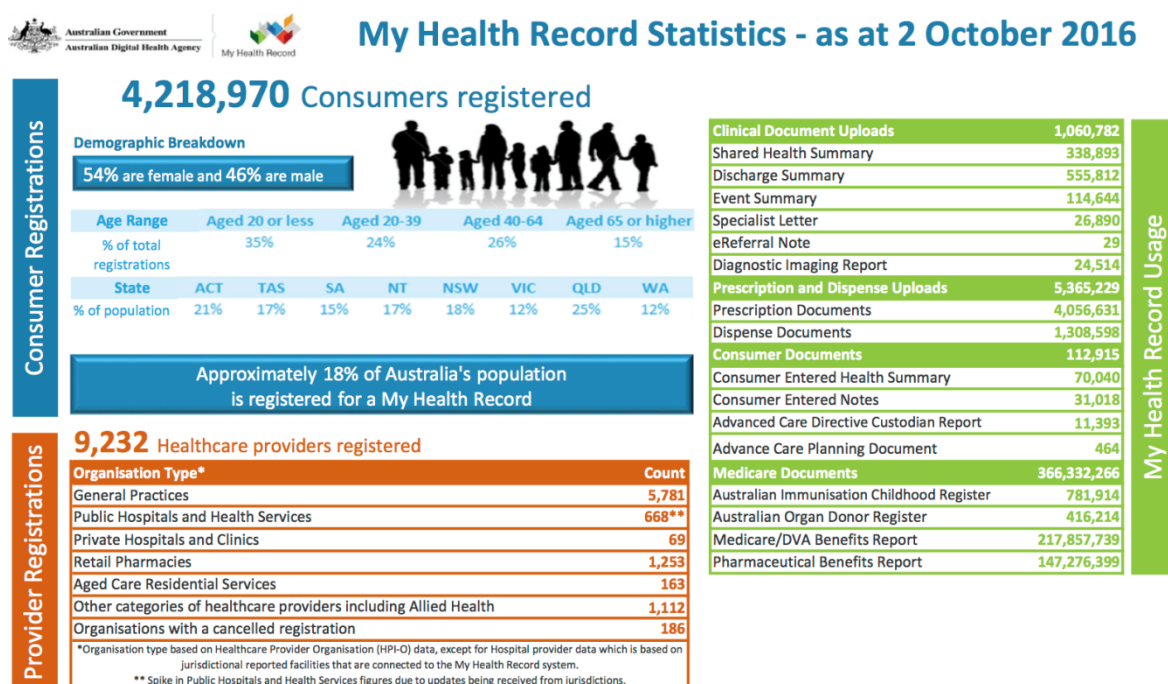


Figure 5 My Health record Statistics – as at 2 October 2016 (Myhealthrecord.gov.au, 2016a)

4.4.1.1.1 Enhancing concerns of losing patient's history data

According to the My Health Record website, there is a warning to medical practitioners that they cannot trust their patients' history data; "Clinical information you find within your patient's My Health Record should be interpreted in much the same way as other sources of health information. It is safest to assume the information in a patient's My Health Record is not a complete record of a patient's clinical history, so information should be verified from other sources and ideally, with the patient." (MyHealthRecord.gov.au, 2016b). This comment creates difficulties in encouraging citizens to continue in this system and it will certainly increase the concerns.

4.5 Comparison and Analytic

Taking into account all the above information it is possible to conclude that implementation of EHR across the countries has a range of faults. Most of them are related to security of the information, while in some cases, such as the one of UK, health care staffs have to deal with errors of prescription and no accuracy of the data. Such issues as not sufficient technical support, no unique identifiers for the patients, low level of compatibility, limitation of interoperability results into low productivity and reduction of the national standards. As this thesis found lack of registration in My Health Record system, this section trying to find good solutions that adapted by other countries.

4.5.1 Sweden

In Sweden there is a strategy of decentralized their EHR systems, which allows every county council to be responsible to obtaining their own EHR systems. As result, county councils succeeded to have fully implementing EHR systems in all Sweden. To adopt this strategy, Australia should separate their system to their seven states. In each state, jurisdiction will be responsible to ensure to enroll all their citizens in the My Health Record system.

4.5.2 UK and Germany

Australia can learn from the UK to keep the system simple for the citizens. As this thesis mentioned the reason of the UK EHR system failure was a complexity in their system as their experts reported. Simple interface will interactive citizens to interactive with those systems. From Germany, the privacy is an issue that impact participate citizens with their system. Australia should take the privacy in high demand, as citizens faced a faulty online government project in the last census date. At citizen level, a breach and cyber security to a government project could mean for a citizen losing his or her data or it could be shared with the public.

4.5.3 US and Canada

Primary care physicians in US, the training and IT tools were facilitated usage of their system. In overall, financial fines played a significant role to have a successful implementation of the EHR system. For individuals in US, as 80 percent of hospitals adopting EHR systems the people highly cooperated to have an enrollment. In other hand, Canada did no provide effective service platforms for primary care physicians that led to not participate in their system.

Back to Australia, as this thesis mentioned 0.22 document for each consumer registered in the period between 21st of August and 2nd of October of the year 2016. This means there is a lack of using the My Health Record system by health providers. In this case, for health practitioners and health providers training and improve the tools of the system would increase the chance of participate of health practitioners and providers with My Health Record system. Additionally, as there are no financial fines in Australia as it is in the US this can clearly illustrate the missing point to encourage health practitioners, providers and hospitals to participate in the system.

4.5.4 Denmark

As this thesis stated that rating increased the efficiency and improved coordination of physicians' care for patients in Denmark. In Australia, no rating for whom began to use the My Health Record system or not. The rating technique can increase participate of GPs and health care practitioners to involve in the Australian My Health Record system.

Chapter 5

5. Recommendations

The above review of globe EHR systems, after it was implemented, supported the following recommendations for My Health Record System with identification of few challenges and recommendations on how to tackle these issues to improve the use of the system.

5.1 Cyber security

One of the challenges faced by the current Australian digital electronic data system is the issue of cyber security. The fear among individuals regarding whether their health records will be safe from unauthorized access keeps them from fully embracing the system. Healthcare data attacks are on the rise, with healthcare data being more and more lucrative to cybercriminals. This is augmented by the fact that technology in the healthcare systems is often not as advanced as in other sectors, like business and finance, thus making it vulnerable to being outdated and consequently easier to hack (Lluch 2011). Furthermore, a breach in health data security is often not detected as quickly as a credit card breach, for example. Thus, the protection of My Health Record healthcare data is paramount to ensure uptake of the system as the data will be perceived safe from unauthorized access (Ferguson, 2016). The use of proactive messages and fingerprint scanners reduce the risk of cyber security. The messages are necessary as they allow exercising greater control over the system and preventing a range of mistakes. As for the fingerprints, they ensure higher level of security, allowing only certain users access information in the system.

5.2 Accuracy of information

As it is seen from the above analysis, accuracy of information and cyber security are the issues that need urgent addressing. Australian patients are highly concerned about the first one. Patients can restrict information and files from others that they do not wish to share. My Health Record Patients can also choose to either share or not share the EHR records with their practitioners. From a health perspective, this is not beneficial to the health practitioners as they cannot rely on the data in the system for clinical judgment. Such data cannot be trusted, and this makes the system useless to the medical practitioners, who were meant to benefit most from shared information regarding a patient's health to ensure adequate and appropriate treatment to the patient at all visits to a clinician (Partel, 2015). Consequently, Australian health practitioners must see all their patients' information in any time and the My Health Record System will provide a log of who visited the patient record.

5.3 Opt out

Citizens of Australia have the option to opt out of the system. This creates a challenge as only a fully accessible and fully inclusive health database is beneficial to the health sector. However, concerns about security of My Health Record system make supporting a user opt out from the system inevitable consequence. Until security is maximized enough for patients to trust the system, this issue remains a problem (Glance, 2015). Today, this option impact enrolls and keeping citizens in the My Health Record system. Our recommendation to avoid this issue is to change the options of opt out to be opt in to the system as the system is a national beneficial.

5.4 Scope of the system

Another challenge identified from My Health Record participant perspective is the fear that marginalized groups of citizens of Australia may not have access to the system. This includes the poor, migrants, the illiterate, and itinerants. These are

arguably the groups who stand to benefit most from such a system, but may find it very difficult to access or use this technology (Fry et al., 2014). Technical expertise may be lacking among various groups of people, and this bars them from exercising control of their health records. There is the need for training and education sessions to be implemented to ensure that all consumers can use the system and also understand its importance and function.

5.5 Financial incentives and rating

Among the medical community, though the EHR would supposedly make doctor's work easier and more efficient with improved patient care, there has been considerable resistance to the system. There is the fear of increased liability for healthcare practitioners with the use of the electronic health systems. Mistakes are bound to occur as the system is installed and utilized for the first time, and many healthcare practitioners fear that these will form the basis for malpractice suits. The electronic time records in such a system would provide evidence against a physician in the event that notes were not recorded at the time of the visit, resulting in the illegal alteration of information. Furthermore, among general practitioners, there is even poorer uptake to the system. These doctors often see the same patients repeatedly and may follow them all their lives. Thus, they have all the information that would be needed regarding the patients past health and see little or no benefit in the system, other than an additional workload to their already busy schedules. This has caused a challenge with implementing the system, as these general practitioners are the ones who hold most of the vital information about their patient's health that would be beneficial to another doctor treating the same patient in another location. This has made some governments issue a financial incentive to doctors to encourage them to upload their patients' records into the system (Cowan, 2016). Therefore, a financial incentive may play a significant role in a successful

implementation for My Health Record System. In addition, by rating who using the system or not will make a difference, especially if the government announces this to the community.

5.6 Reduce risk

There are numerous ways to reduce the risk of sending patient's information to another patient. These include using authentication, encryption, and user interface design (Wilson, 2015). Encryption can play an important part in making sure that any information that goes awry will not see by anyone else. Moreover, the decentralized system to own EHR system allows every jurisdiction in every Australian state to be responsible for selecting and obtaining their own health IT systems as well as monitoring the outputs of the system. also, to ensure to enroll all their citizens in the My Health Record system. Thus, this will add a great value to have a successful implementation like Sweden system.

Chapter 6

6. Conclusion

It is concluded that the adoption of EHR system resulted in very effective and positive outcomes in many settings due to its implementation started all across the world, even in third world but due to the varying settings, the issues and challenges the organizations have to face, are also different. It improved the healthcare practice and made the jobs of healthcare providers more efficient. EHR system offers the sharing of information between the health care professionals, from all over the world. Numerous developments were observed in the field of computer sciences in America when the Second World War was going on. So, EHR system roots back to World War II. And now EHR is helping organizations to increase the revenue, because it is found to remove the inaccurate coding, improve the cash flow and reduce billing errors. So, it is useful for the organization and the consumer both. Stakeholders have to be very conscious about the implementation procedure of EHR system. When it comes to knowledge and the technique for EHR implementation, the selection for members of EHR implementation, must be done strictly and wisely. It is mandatory to train the whole medical staff of hospitals to understand and run the electronic health systems, before the implementation of EHR system in any settings. "My Health Record System" contains all the information about the patient's medical and medication history, since the time of birth so the healthcare provider can access whole history easily without asking the patient and can get an accurate diagnosis promptly and set complete and appropriate medical information for the patient. The decision of Australian government about moving from manual paper-based records to EHR system implementation was proved beneficial. The overall awareness of the stakeholders improves using EHR as different training sessions for stakeholders are

uploaded to My Health Record System. The implementation of the response plan helps to achieve the compliance and integrity of the security of the system. The response plan would easily help checking on the breach in anyone's records on My Health Record system. This is going to improve the overall healthcare system in Australia as it ensures a higher level of healthcare quality to the patients. Although, EHR system is proved to be beneficial in healthcare but there exist certain potential barriers that are actually preventing the EHR system adoption in the health industry. People are reluctant to register for the EHR system due to the privacy and security issues. The implementation of EHR system has more benefits than disadvantages so it is being hugely implemented in different countries. From 1999 to 2007, Finland succeeded significantly in adopting EHR system in hospitals. By the end of 2007, they moved from only 4 hospitals to 21 hospitals. In America, the hospital adoption of "EHR System" was just 20% but it reached more than 80% in 2014. 96% of hospitals in Sweden use EHR system and 79 % of the prescriptions are written electronically there. The laboratories are computerized and radiologists also have access to EHR system. In Australia the EHR system is working efficiently and it enables the patients to have access and manage their medical records together with their physicians and pharmacists. PCEHR system of Australia has registered 5,100 general practitioners and 2.5 million patients but it is not that efficient and has less clinical utility. Efforts are being made to make the currently existing EHR system of Australia to be more secure and its privacy is ensured. It provides the platform to the medical practitioners to share information among the staff which makes the delivery of health care service more efficient. A huge reduction in the hospital cases is observed. As My Health Record System has been made much secure, so the Australian citizens should get registered. The privacy of health information in the private sector was

protected by the Australian Privacy Act 1988. As the personal health information is very sensitive, so, governments should protect it. There is an issue in the My Health Record system that is the loss of patient's history data that is also the major cause of lack of registration. As patients themselves have access to their My Health Record system and they can restrict access their account and documents. The patients have the option to opt out of the system as well. So, there is a big need to not only train healthcare practitioners or health staff about EHR System but also the patients to make them understand the importance of function of EHR system. As EHR system increases the efficiency of the medical professionals so it will be no fear of increased liability of healthcare practitioners on it. The appropriate time is given to the establishment of the system. Moreover, by accept this thesis's recommendations it will be beneficial for all.

Chapter 7

7. Future Work

While this thesis has demonstrated the potentials, weaknesses and efficiency of My Health Records System in Australia, there were variabilities while implementing EHR in Australia. Nevertheless, there remain many opportunities to extend the scope of this thesis. This section presents some of these directions.

7.1 Cyber security

My Health Record system is based on the effective and working security policy. It ensures the cyber security as it is reviewed regularly after a year. This policy manages user accounts whether they are patients or authorizing staff to access the My Health Record system. If any document is to be destroyed, the codes are recorded in protected manner. The security risks in patient's My Health Record system can easily be identified and reported. The unique user accounts are provided to the individuals. The passwords are regularly checked. In the case of staff members of organization, the user account is inactivated after leaving the organization. Should be a reporting system for individuals with the help of which they can inform the management about the privacy breach to their "My Health Record System" records.

7.2 Scope of the system

The awareness about the use of My Health Record system can be easily spread by employing electronic health literacy tutors. They develop the delivery model for electronic health programs. The digital literacy programs convey the knowledge about the use of My Health Record System and solve the problems faced by people who cannot access it.

7.3 Financial incentives and rating

It is necessary to add policies gives financial incentives to enhance practitioners and providers to use the My Health Record system in order to have a successful implementation. Also, the rating policy should be allowed to increase practitioners and provider's registration in the My Health Record system.

Chapter 8

8. References

- ABS. 2016. *Population clock* [Online]. Online: Australian Bureau of Statistics. Available: <http://www.abs.gov.au/ausstats/abs%40.nsf/94713ad445ff1425ca25682000192af2/1647509ef7e25faaca2568a900154b63?OpenDocument> [Accessed 12 Oct 2016].
- AJAMI, S. & BAGHERI-TADI, T. 2013. Barriers for adopting electronic health records (EHRs) by physicians. *Acta Informatica Medica*, 21, 129.
- ANDERSON, J. G. 2007. Social, ethical and legal barriers to e-health. *International journal of medical informatics*, 76, 480-483.
- ASH, J. S. & BATES, D. W. 2005. Factors and forces affecting EHR system adoption: report of a 2004 ACMI discussion. *Journal of the American Medical Informatics Association*, 12, 8-12.
- ATHERTON, J. 2011. Development of the electronic health record. *Virtual Mentor*, 13, 186.
- BARNETT, G. History of the development of medical information systems at the Laboratory of Computer Science at Massachusetts General Hospital. A history of medical informatics, 1990. ACM, 141-153.
- BEST, A., GREENHALGH, T., LEWIS, S., SAUL, J. E., CARROLL, S. & BITZ, J. 2012. Large=system transformation in health care: a realist review. *Milbank Quarterly*, 90, 421-456.
- BHAGAT, S. 2010. *Danish Healthcare Information Technology-An Analytical Study of Consumer Issues*. Worcester Polytechnic Institute.
- BRACCO, D. & LABEAU, F. 2015. Electronic health record: what do you expect from them? *Critical care medicine*, 43, 1342-1344.
- BUDDE, P. 2016. *Australia - Digital Economy - E-Health - Electronic Health Records* [Online]. Online: BuddeComm. Available: <https://www.budde.com.au/Research/Australia-Digital-Economy-E-Health-Electronic-Health-Records> [Accessed 1 Sep 2016].
- CASTRO, D. 2009. Explaining International Health IT Leadership. *Information Technology and Innovation Foundation, Washington*.
- CENSUSAUSTRALIA. 2016. *ABS & Census website are unavailable. The service won't be restored tonight. We will update you in AM. We apologise for the inconvenience.* [Online]. Online. Available: <https://twitter.com/ABSCensus/status/762996836357419008> [Accessed 9 Aug 2016].
- CHAO, W. C., HU, H., UNG, C. O. L. & CAI, Y. 2013. Benefits and challenges of electronic health record system on stakeholders: a qualitative study of outpatient physicians. *Journal of medical systems*, 37, 1-6.
- CHARLES, D., KING, J., PATEL, V. & FURUKAWA, M. F. 2013. *Adoption of electronic health record systems among US non-federal acute care hospitals: 2008-2012*, Office of the National Coordinator for Health Information Technology.
- CHEN, R. & KLEIN, G. 2007. The openEHR Java reference implementation project. *Studies in health technology and informatics*, 129, 58.
- COWAN, P. 2014. *PCEHR privacy breached twice in 12 months* [Online]. Online: ITnews.com. Available: <http://www.itnews.com.au/news/pcehr-privacy-breached-twice-in-12-months-397331> [Accessed 11 Aug 2016].

- COWAN, P. 2016. Most Australian GP clinics aren't using e-health records. Available from: <http://www.itnews.com.au/news/most-australian-gp-clinics-arent-using-e-health-records-417807> [Accessed 9 Sep 2016].
- CRESSWELL, K. M., BATES, D. W. & SHEIKH, A. 2013. Ten key considerations for the successful implementation and adoption of large-scale health information technology. *Journal of the American Medical Informatics Association*, 20, e9-e13.
- CUBRILOVIC, N. 2014. Multiple Vulnerabilities in myGov, the Australian Government Single-sign-on Solution for Citizen Services. [Accessed 4 Apr 2016].
- DASTAGIR, M. T., CHIN, H. L., MCNAMARA, M., POTERAJ, K., BATTAGLINI, S. & ALSTOT, L. Advanced proficiency EHR training: effect on physicians' EHR efficiency, EHR satisfaction and job satisfaction. AMIA Annual Symposium Proceedings, 2012. American Medical Informatics Association, 136.
- DESROCHES, C. M., CAMPBELL, E. G., RAO, S. R., DONELAN, K., FERRIS, T. G., JHA, A., KAUSHAL, R., LEVY, D. E., ROSENBAUM, S. & SHIELDS, A. E. 2008. Electronic health records in ambulatory care—a national survey of physicians. *New England Journal of Medicine*, 359, 50-60.
- DICK, R. S., STEEN, E. B. & DETMER, D. E. 1997. *The computer-based patient record: an essential technology for health care*, National Academies Press.
- DOUPI, P., RENKO, E., GIEST, S., HEYWOOD, J. & DUMORTIER, J. 2010. Country Brief: Estonia. European Commission, Brussels.
- DUENNEBEIL, S., SUNYAEV, A., LEIMEISTER, J. M. & KRCCMAR, H. Strategies for development and adoption of EHR in German ambulatory care. 2010 4th International Conference on Pervasive Computing Technologies for Healthcare, 2010. IEEE, 1-8.
- DUFFY, R. L., YIU, S., MOLOKHIA, E., WALKER, R. & PERKINS, R. A. 2010. Effects of electronic prescribing on the clinical practice of a family medicine residency. *Fam Med*, 42, 358-63.
- EVERINGHAM, L. 2016. Coalition of National Nursing Organisations report. *Journal of Stomal Therapy Australia*, 36, 31.
- FALAN, S. 2016. *EHR records in Sweden and What the Future Brings* [Online]. Salus Digital: online. Available: <http://salusdigital.net/ehr-records-sweden-future-brings/> [Accessed 7 Aug 2016].
- FERGUSON, R. 2016. *The challenges of securing healthcare data* [Online]. Online: Technology Decisions. Available: <http://www.technologydecisions.com.au/content/gov-tech-review/article/the-challenges-of-securing-healthcare-data-1163683497 - axzz4Jgw2MGAQ> [Accessed 7 Sep 2016].
- FRY, C. L., SPRIGGS, M., ARNOLD, M. & PEARCE, C. 2014. Unresolved Ethical Challenges for the Australian Personally Controlled Electronic Health Record (PCEHR) System: Key Informant Interview Findings. *AJOB Empirical Bioethics*, 5, 30-36.
- GAGNON, M.-P., SHAW, N., SICOTTE, C., MATHIEU, L., LEDUC, Y., DUPLANTIE, J., MACLEAN, J. & LÉGARÉ, F. 2009. Users' perspectives of barriers and facilitators to implementing EHR in Canada: A study protocol. *Implementation Science*, 4, 1.
- GALL, W., ALY, A.-F., SOJER, R., SPAHNI, S. & AMMENWERTH, E. 2016. The national e-medication approaches in Germany, Switzerland and Austria: a structured comparison. *International Journal of Medical Informatics*.
- GLANCE, D. 2015. New name and opt-out policy won't save the personal health record. Available from: <http://theconversation.com/new-name-and-opt-out-policy-wont-save-the-personal-health-record-41601> [Accessed 8 Sep 2016].

- GRAY, B. H., BOWDEN, T., JOHANSEN, I. & KOCH, S. 2011. Electronic health records: an international perspective on "meaningful use". *Issue Brief (commonwealth fund)*, 28, 1-18.
- GRUBB, B. 2014. Revealed: serious flaws in myGov site exposed millions of Australians' private information. Available from: <http://www.smh.com.au/it-pro/security-it/revealed-serious-flaws-in-mygov-site-exposed-millions-of-australians-private-information-20140514-zrczw>.
- HALL, S., MURCHIE, P., CAMPBELL, C. & MURRAY, S. A. 2012. Introducing an electronic Palliative Care Summary (ePCS) in Scotland: patient, carer and professional perspectives. *Family practice*, 29, 576-585.
- HARRELL, E. 2009. *In Denmark's Electronic Health Records Program, a Lesson for the U.S.* [Online]. Online: Time. Available: <http://content.time.com/time/health/article/0,8599,1891209,00.html> [Accessed 5 May 2016].
- HÄYRINEN, K., SARANTO, K. & NYKÄNEN, P. 2008. Definition, structure, content, use and impacts of electronic health records: a review of the research literature. *International journal of medical informatics*, 77, 291-304.
- HEISEY-GROVE, D. & PATEL, V. 2014. Physician motivations for adoption of electronic health records. *Washington (DC): Office of the National Coordinator for Health Information Technology*.
- HIRSCH, M. 2015. *Problems with new Epic EHR contributed to U.K. hospitals' drop in care quality* [Online]. FierceEMR.com: FierceEMR. Available: <http://www.fierceemr.com/story/problems-new-epic-ehr-contributed-uk-hospitals-drop-care-quality/2015-09-29> [Accessed 4 2016].
- HOOVER, R. 2016. Benefits of using an electronic health record. *Nursing2016*, 46, 21-22.
- HOYT, R. E., BERNSTAM, E. V. & JOHNSON, T. R. 2009. Overview of Medical Informatics. *Practical Guide for the Healthcare Professional*, 1.
- KASIRI, N., SHARDA, R. & ASAMOAH, D. A. 2012. Evaluating electronic health record systems: a system dynamics simulation. *Simulation*, 88, 639-648.
- KATIYAR, S. 2014. Electronic Health Record Standards For India. *Electronic Health Record - Sujeet Katiyar* [Online]. Available from: <http://ehr-india.blogspot.com.au/> [Accessed 20 Aug 2016].
- KIM, K. & NAHM, E. 2012. Benefits of and barriers to the use of personal health records (PHR) for health management among adults. *Online J Nurs Informatics OJNI*, 16, 1-9.
- KNOX, L., BRACH, C., MITCHELL, M. & TAYLOR, E. F. 2015. *Primary Care Practice Facilitation Curriculum (Module 26)* [Online]. AHRQ Publication No. 15-0060-EF: Agency for Healthcare Research and Quality. Available: <https://pcmh.ahrq.gov/sites/default/files/attachments/pcpf-module-26-ehr-and-mu.pdf> [Accessed 18 Aug 2016].
- KRUSE, C. S., KOTHMAN, K., ANEROBI, K. & ABANAKA, L. 2016. Adoption Factors of the Electronic Health Record: A Systematic Review. *JMIR medical informatics*, 4, e19.
- KRUSE, C. S., MILESKE, M., ALAYTSEV, V., CAROL, E. & WILLIAMS, A. 2015. Adoption factors associated with electronic health record among long-term care facilities: a systematic review. *BMJ open*, 5, e006615.
- LEHNBOM, E. C., MCLACHLAN, A. J. & JO-ANNE, E. B. A qualitative study of Australians' opinions about personally controlled electronic health records. *HIC*, 2012. 105-110.

- LESLIE, H. 2007. OpenEHR-the world's record. *Pulse+ IT*, 6, 50-55.
- LEWIS, R. 2016. *Census 2016: Attack 'not work of hackers' says minister* [Online]. Online: The Australian. Available: <http://www.theaustralian.com.au/national-affairs/census-2016-website-crashes-under-weight-of-demand/news-story/1febee892e1ab043c0e7682c7a3485a4> [Accessed 10 Aug 2016].
- LEY, S. 2015. *Patients to get new myHealth Record: \$485m 'rescue' package to reboot Labor's e-health failures* [Online]. Online: DEPARTMENT OF HEALTH. Available: <http://www.health.gov.au/internet/ministers/publishing.nsf/Content/health-mediarele-yr2015-ley050.htm> [Accessed 10 Aug 2015].
- LEY, S. 2016. *MY HEALTH RECORD GETS ONE MILLION MORE REASONS TO SIGN UP* [Online]. Online: DEPARTMENT OF HEALTH. Available: <http://www.health.gov.au/internet/ministers/publishing.nsf/Content/health-mediarele-yr2016-ley016.htm> [Accessed 6 Aug 2016].
- LLUCH, M. 2011. Healthcare professionals' organisational barriers to health information technologies—A literature review. *International journal of medical informatics*, 80, 849-862.
- LOBER, W. B., ZIERLER, B. K., HERBAUGH, A. L., SHINSTROM, S. E., STOLYAR, A., KIM, E.-H. & KIM, Y. Barriers to the use of a personal health record by an elderly population. AMIA, 2006.
- LUDWICK, D. A. & 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, 22-31.
- MARSCHOLLEK, M. & DEMIRBILEK, E. 2006. Providing longitudinal health care information with the new German Health Card—a pilot system to track patient pathways. *Computer methods and programs in biomedicine*, 81, 266-271.
- MCDONALD, K. 2013. *Pharmacy error probable cause of PCEHR problem* [Online]. Online: Pulse+It. Available: https://www.pulseitmagazine.com.au/index.php?option=com_content&view=article&id=1442:pharmacy-error-probable-cause-of-pcehr-problem&catid=16:australian-ehealth&Itemid=327 [Accessed 30 Aug 2016].
- MCDONALD, K. 2014. "Sleepwalking into catastrophe" with myGov and the PCEHR. Available from: <https://www.pulseitmagazine.com.au/component/content/article?id=1886:sleepwalking-into-catastrophe-with-mygov-and-the-pcehr> [Accessed 4 Apr 2016].
- MENACHEMI, N. & BROOKS, R. G. 2006. Reviewing the benefits and costs of electronic health records and associated patient safety technologies. *Journal of medical systems*, 30, 159-168.
- MENACHEMI, N. & COLLUM, T. H. 2011. Benefits and drawbacks of electronic health record systems. *Risk Manag Healthc Policy*, 4, 47-55.
- MGHLCS. n.d. *G. Octo Barnett, MD* [Online]. Online: mghlcs. Available: <http://www.mghlcs.org/about/team/octobarnett/?&session-id=ba92c829b18f3b85b1030bef2c3b1f6f> [Accessed 12 Aug 2016].
- MIDDLETON, B., BLOOMROSEN, M., DENTE, M. A., HASHMAT, B., KOPPEL, R., OVERHAGE, J. M., PAYNE, T. H., ROSENBLOOM, S. T., WEAVER, C. & ZHANG, J. 2013. Enhancing patient safety and quality of care by improving the usability of electronic health record systems: recommendations from AMIA. *Journal of the American Medical Informatics Association*, 20, e2-e8.
- MYHEALTHRECORD.GOV.AU. 2016a. *My Health Record Statistics* [Online]. Online: Australian Digital Health Agency. Available:

- <https://myhealthrecord.gov.au/internet/mhr/publishing.nsf/Content/news-002> [Accessed 21 Aug 2016].
- MYHEALTHRECORD.GOV.AU. 2016b. *Welcome to My Health Record* [Online]. Online. Available: <https://myhealthrecord.gov.au/internet/mhr/publishing.nsf/Content/home> [Accessed 11 Jul 2016].
- NEMATOLLAHI, M., ABHARI, S. & GARAVAND, A. 2015. Attitudes and behaviors related to introduction of Electronic Health Record (EHR) among Shiraz University students in 2014. *Journal of Health Management and Informatics*, 2, 97-100.
- OTLOWSKI, M. 2015. Disclosing genetic information to at-risk relatives: new Australian privacy principles, but uniformity still elusive. *The Medical journal of Australia*, 202, 335-337.
- ØVRETVEIT, J., SCOTT, T., RUNDALL, T. G., SHORTELL, S. M. & BROMMELS, M. 2007. Implementation of electronic medical records in hospitals: two case studies. *Health Policy*, 84, 181-190.
- PARIKH, H. 2015. *Overview Of EHR Systems In BRIC Nations* [Online]. Online: ClinicalLeader.com. Available: <http://www.clinicalleader.com/doc/overview-of-ehr-systems-in-bric-nations-0001> [Accessed 19 Aug 2016].
- PARTEL, K. 2015. Toward Better Implementation: Australias My Health Record.
- PEARCE, C. & BAINBRIDGE, M. 2014. A personally controlled electronic health record for Australia. *Journal of the American Medical Informatics Association*, 21, 707-713.
- PROTTI, D., BOWDEN, T. & JOHANSEN, I. 2008. Adoption of information technology in primary care physician offices in New Zealand and Denmark, Part 3: Medical record environment comparisons. *Journal of Innovation in Health Informatics*, 16, 285-290.
- RANGRAZ JEDDI, F., AKBARI, H. & RASOLI, S. 2016. Older People Home Care through Electronic Health Records: Functions, Data Elements and Security Needs. *Contemporary Nurse*, 1-14.
- REZAEIBAGHA, F., WIN, K. T. & SUSILO, W. 2015. A systematic literature review on security and privacy of electronic health record systems: technical perspectives. *Health Information Management Journal*, 44, 23-38.
- ROLLINS, A. 2014. Health on the hill: Political news from the nation's capital. *Australian Medicine*, 26, 20.
- ROZENBLUM, R., JANG, Y., ZIMLICHMAN, E., SALZBERG, C., TAMBLYN, M., BUCKERIDGE, D., FORSTER, A., BATES, D. W. & TAMBLYN, R. 2011. A qualitative study of Canada's experience with the implementation of electronic health information technology. *Canadian Medical Association Journal*, 183, E281-E288.
- SHORTLIFFE, E. H. & CIMINO, J. J. 2006. *Biomedical informatics*, Springer.
- SKYTTBERG, N., VICENTE, J., CHEN, R., BLOMQVIST, H. & KOCH, S. 2016. How to improve vital sign data quality for use in clinical decision support systems? A qualitative study in nine Swedish emergency departments. *BMC medical informatics and decision making*, 16, 1.
- SRIVASTAVA, S. K. 2016. Adoption of Electronic Health Records: A Roadmap for India. *Healthcare Informatics Research*, 22, 261-269.
- STANDING, C. & CRIPPS, H. 2015. Critical Success Factors in the Implementation of Electronic Health Records: A Two-Case Comparison. *Systems Research and Behavioral Science*, 32, 75-85.
- TUTEN, T. 2012. *8 Countries Doing Electronic Health Records Right - Soliant Health* [Online]. <http://blog.soliant.com/>: Soliant Blog. Available: <http://blog.soliant.com/healthcare-news/8-countries-doing-electronic-health-records-right/> [Accessed 5 May 2016].

- WILSON, S. 2015. Why the Govt can't simply go opt-out for e-health. Available from: <http://www.itnews.com.au/blogentry/why-the-govt-cant-simply-go-opt-out-for-e-health-403785> [Accessed 10 Sep 2016 2016].
- XU, J., GAO, X., SORWAR, G. & CROLL, P. 2013. Implementation of e-health record systems in Australia. *The International Technology Management Review*, 3, 92-104.
- ZLABEK, J. A., WICKUS, J. W. & MATHIASON, M. A. 2011. Early cost and safety benefits of an inpatient electronic health record. *Journal of the American Medical Informatics Association*, 18, 169-172.