Achieving Personalized Interoperable Patient Information Systems; benefits and challenges in Swedish context.

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ABSTRACT

Due to a rapid increase in aging population, demand for personalized health care increases proportionally. Personalized patient data can be a helpful way of catering the needs and requirements of elderly people staying at home. Indirectly, it can be a manner of providing better eHealth services according to their needs. Another interesting aspect of providing better personalized eHealth services is to make patient information systems interoperable. Interoperability of eHealth systems is an issue of great concern to current research and development but in this study, we focus on patient information systems. Like in some other European countries, introduction of open source platform to achieve interoperability and personalization of patient information system could save money for health care organizations and make the procedure easier in Sweden also.

The purpose of this study is to identify what standards are available for interoperability and what are the benefits and challenges of introducing open source systems for achieving personalized interoperable patient information systems (PIPIS).

In light of this investigation, author has identified the benefits and challenges of introducing OSS for achieving PIPIS. Author has also made several recommendations regarding the challenges identified.

**Keywords:** patient information systems, electronic health care, personalized health, interoperability, open source software, open source initiative.
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In the name of ALLAH, the most gracious and merciful.

I extend my gratitude to the beautiful creator of this beautiful universe that He made for us to conquer.

Without the love of my parents this thesis report could never be possible for me to write. All my love and care is for them which no one else can share.

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INTRODUCTION

With the advent of Internet, human life styles began changing dramatically as the human interaction with computers increased in same fashion. Traditional computer systems were quickly moving to the new paradigm known as World Wide Web. This change took place due to the fact that Internet reduced the development and maintenance costs of those systems, increased accessibility and ease of use. This change was also adopted by health sector in different countries specially the developed countries across the world. Therefore, eHealth (electronic health) is a widely discussed phenomenon in the European Union.

World Health Organization, in its portal for eHealth in Eastern Mediterranean, defines eHealth as “a new term used to describe the combined use of electronic communication and information technology in the health sector” [4]. E-Health system consists of several components for example e.g. E-Health services, E-Health Tools, etc. These eHealth tools and services can be used by medical personnel or patients.

eHealth takes care of interaction between patients and physicians, transfer of patient record from one health care organization to another. Many Information and communications technologies (ICT) based tools and services are already assisting health care organizations in disease prevention, diagnosis, treatment and health monitoring. [3]

One of the major tools of E-Health is Patient Information Systems (PIS). A lot of work is being done on getting personalized and interoperable versions of PISs because it is an emerging concept of personalized medicine to provide patient centric, cross organizational health services to the patients [19]. The need for personalized PISs arises because of the fact that different patients have different needs and requirements, depending upon their age group and many other factors. For instance, children obviously have different needs and requirements than elderly people. Apart from this, personalized PISs are also needed because they seem to be the only vehicle by which we can get population-based genetic profiles for the patients in near future [19]. It means that both patients and health care professionals (physicians and nurses) need such systems. Patients need it because they can access their health records electronically in a more specific format which is meant for them (based on their needs and requirements). Health care professionals need them because they can analyze a patient’s medical history and current health conditions in a better way so they can make better prescriptions and monitor it in a sophisticated manner.

Interoperability becomes a main issue of concern when two or more enterprise systems or services need an effective and efficient transfer of information or knowledge as whenever required by one of those systems or services [14]. Different health organizations use different eHealth systems. It makes transfer of patient record from one organization to another a difficult task. According to Commission of European Communities [6], interoperability of eHealth systems and their tools will be a challenging task that has to be achieved by the European Governments and they should formulate strategies for doing so. Therefore, personalized Patient Information Systems’ interoperability is also an issue which should be given considerable attention.

Facts suggest that Sweden is one of the most successful nations in EU in implementing eHealth on mass level. Based on this success, Sweden along with 11 other countries has been given the responsibility of building robust and highly reliable eHealth systems. Sweden started storing patient records electronically in Seventies due to its high computer literacy, thus, it has structured these systems on national level in the areas of legislation, terminology, quality, and technical aspects of eHealth systems. [5]

In early 2006, Swedish govt. launched a citizen centered national eHealth strategy [37]. This strategy emphasizes on interoperability of eHealth tools and services up to an extent that four
out of six action areas defined in this strategy describe what kind of interoperability should be achieved. These four action areas are: [37]

1. Creating a common information structure.
2. Creating a common technical infrastructure.
3. Facilitating interoperable, supportive ICT systems.
4. Facilitating access to information across organizational boundaries.

According to [6], interoperability of health care systems and records would be a challenging task and it was suggested that open source software should be introduced in order to define standards to achieve this task. A piece of software which is open source is licensed to be freely available to its users to the extent that users may use, change or improve and redistribute the software by modifying the source code [1]. License should not be specific to a product or restrict other software. If the new or modified product has been extracted from an open source product, its license should give the same rights as of the producer to all the parties to whom that product has been distributed. It must also not insist that all the other programs or components must be open source as well. License should also be technology neutral which means that it should not be proclaimed by any individual or organization. [2]

The introduction of open source software in eHealth sector in Sweden would be advantageous in two aspects. First, cost reduction, because according to [7], based on a case study, the office of government commerce suggested that all the health organizations across UK should seriously consider adopting OSS for running their software because it can “improve the financial health of those health organizations”. According to [8], it can save more than £600m of the health organizations’ budget. Also, each of the eHealth systems, for example, primary care or dental care, can become personalized according to the needs of the patients. As OSS allows free modification of the source code and transfer of license from the original product to the new one therefore, it will remove the need for buying a separate copy of that system.

Second, open source software will help achieve interoperability and flexibility among different health care units such as primary care and maternity. Different standards could be defined and followed in order to make those systems work with each other even if the requirements change from one health unit to another. This is so because OSS means free and transparent access to the product details [9] i.e. source code, hence nothing is hidden from the developers which means they can make those systems interoperable with each other more conveniently.

Main focus of this study is to identify the benefits and challenges that health organizations have to face after adopting OSS for PIPIS in the county of Blekinge. These challenges would be gathered after interviewing several health care service organizers so that it can help current researchers to propose solutions for these challenges and frameworks to implement the benefits.
CHAPTER 1: BACKGROUND

1.1 What is eHealth?

The term eHealth is widely in use since its introduction back in 2000. But no single definition has been agreed upon so far as there are 36 different definitions that have been used in several publications and on the Internet. The reason behind this is that the scopes and contexts in which eHealth is used are significantly variable. [15]. Following definition by Eysenbach [17] is selected because it best suits the context of this study.

“e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.” [17].

In [16] Elizabeth Sillence et al. say that eHealth covers almost everything involving computers and medicine. She also suggests that the success of eHealth is widely dependent upon the issues such as quality of medical information, effective user interaction and personalization of patient data according to needs and requirements. eHealth can improve the quality and effectiveness of services offered [38]. This can be done by developing robust eHealth tools and systems. eHealth tools include systems and services that are both internet based or stand alone in nature [38]. It also promises to deliver better citizen-centered health services in less money [38].

In my understanding, eHealth can signify the services to the citizens of Blekinge County in Sweden. Swedish government is working to provide Swedish citizens the best health care by every possible way in light of its national eHealth strategy defined comprehensively in [37].

1.2 National Strategy for eHealth - Sweden

In 2006, Swedish government launched a national strategy for eHealth. The main objective of this strategy in documented format was to draw guidelines to achieve the goals of eHealth services and tools in light of recommendations from [38]. According to [37], citizens will have an increased contact with health care professionals that include general physicians, specialists, surgeons, and nurses about their health conditions and treatment methods.

In a visionary outline by [37], people who want to make a contact with their doctor can book an appointment or change an already made appointment through an easy to use web portal. This will remove any hurdles of getting in contact with health care professionals whether they are located at their permanent residences or summer houses, whether they are in Sweden or outside Sweden. Citizens will also have access to their electronic health records so that they can see information about the prescriptions or medicine or any previously made contact. [37] Displaying the information to a patient which is specifically meant for a patient will increase ease of use and ease of understanding for that particular patient because the internet has increased a demand for improved eHealth tools complying with quality standards and being available in a personalized manner [32].

Health care professionals will have access to patient information systems in order to see a patient’s medical history, ongoing treatment and monitoring status. This should all be done with the consent of the latter to avoid any legal complications. An easy transfer of data and information from other treatment units should also be assured in order to increase the efforts
of treating a patient. This means that all treatment units should use interoperable tools and systems. [37]

National strategy for eHealth gives quite a lot importance to interoperable health systems. We can judge this by the fact that 4 out of six action areas defined in national strategy for eHealth talk about interoperability in one way or the other. These four action areas are [37]

1. Achieving common information structure.
2. Achieving common technical infrastructure.
3. Building supportive and interoperable ICT systems.
4. Providing access to information across organizational boundaries.

Following picture has been taken from the published document for this strategy.

Fig. 1.1 Action Areas for cooperation and coordination at national level [37]
1.3 Personalization and Interoperability of Patient Information Systems

Personalization of eHealth tools and services means tailoring of these tools and services according to the needs and preferences of each individual [23]. This is especially true because users of these tools can be very diverse as they might belong to different groups for example very young and old people having disabilities. Situations where the citizens need eHealth services can be equally diverse which means wherever a client can be, at home, at work in his/her home country or abroad etc. [33]. In support of this, Germanakos et al. in [27] say that “Such applications should be characterized by flexibility, accessibility, context-awareness, quality and security in a ubiquitous interoperable manner in order to provide the citizens with quality on demand information (services).” Personalization discussed here is also useful in helping further widespread use of eHealth and to provide its efficient access to the citizens. Nick Hine et al. [23] say that currently, work is under progress to establish standards and guidelines for personalization of eHealth tools like Patient Information Systems to take care of the requirements of both care providers and patients.

Getting the right information at right time and place is not so easy. Improved interaction of citizens with eHealth services and tools is a need and for seeking solutions for this, serious analysis of citizen requirements in the area of eHealth is required. Furthermore, documentation of this analysis is also compulsory as it will help build effective and personalized Patient Information Systems to provide better services to the citizens. [27]

Finding ways for eHealth tools to interact with each other will broaden the spectrum of achieving personalized benefits. According to [12],

“The full benefits of eHealth services and tools will not reach patients unless a high level of interoperability is integrated at the heart of their design and deployment. Healthcare providers need to co-operate extensively with each other, and with their suppliers, to ensure that their services are well connected.”

For extensive cooperation of eHealth tools and well connectivity of eHealth services, standardization in information representation and dissemination will eliminate the communication gap between participating health organizations [24]. This standardization can lead to interoperability of eHealth tools such as Patient Information Systems. According to EU Action Plan for eHealth [38], “Member states within European Union have expressed their concerns about taking steps to achieve interoperability of heterogeneous Information Systems. They have also laid stress on exploration of possibility of developing open source applications to achieve this goal”.

This means that interoperability should be achieved in such a way that all stakeholders could benefit from it by shifting towards open source standards and models. This would allow citizens to have a free and open access to health resources electronically with greater ease of use.
CHAPTER 2: PROBLEM DEFINITION/GOALS

Elizabeth Sillence et al. explain, that eHealth refers to information and health services delivered via communicating over the internet or related technologies. Whereas the eHealth usage figures propose that the main issues in the success of eHealth are increasing the quality of medical information, effective user interaction, and personalization of patient data according to need and requirement. [16][34]

Simon Rogerson explained that [20] Medical informatics or Healthcare computing is one of the fastest growing fields of information and communication technology (ICT) applications. It is a versatile application concerned with electronic patient records, paramedical support, computer aided diagnosis, performance indicators, clinical governance, emergency service, hospital management and research support.

The EU Action Plan proposed different extensive standards and processes for eHealth tools or solutions to make the implementation and development more and more quality oriented. [34] In the current scenario due to the world wide implementation of eHealth the need of eHealth services and tools according to different patient requirements has been increased that would help to prevail over the health care accessing barriers. [34]

In eHealth tools the Patient Information Systems (PIS) is used to support both the administrative and clinical activities in E-Health areas. At the moment research is going on to achieve the personalized versions of PISs. This need rises because of the fact that different patients have different needs and requirements, depending upon their age group and many vital factors.

According to [18] the research is needed to explore the interoperability issues among the different health care organizations. The research’s is more concern with the personalized interoperable patient information systems (PIPIS) available in health care organizations to fulfill the need of different patients according to their requirements.

It is suggested by Commission of European Communities in [38] to adopt the Open Source Software (OSS) to achieve the interoperability and flexibility in personalized patient information systems among different health care organizations. The OSS allows free modification of the source code and transfer of license from the original product to the new one therefore; it will remove the need for buying a separate copy for different PIPIS [1].

I feel that it is necessary to study how personalized interoperable patient information systems (PIPIS) would be beneficial among health care organization in accessing the eHealth services and the challenges that it will face in the implementation. For their projection we have focused on the following research questions in our study.

2.1 Research Questions

1) What are the standards for Personalized Interoperable Patient Information Systems?

2) What are the challenges and benefits of achieving PIPIS through OSS?

The aim of eHealth in PIPIS is to progress the quality and safety of healthcare with the help of updated information and communication technologies. eHealth has a great impact on every citizen especially in Europe and it apprehends the application of information and communication technologies (ICT) across a intact choice of functions. Nowadays ICT is the
third largest industry in health sector with a global turnover of €50-60 billion and in 2010 its growth will be increased up to 11%. But in the other way, there are still problems in these systems; like that lack of interoperability between systems. [9]

According to the 1st research question, literature review presents the detailed description about the Personalized Interoperable Patient Information Systems and their standards. Standards are probably one of the key success factors in the research of PIPIS. The problem is that, standards for small and medium enterprises (SMEs) are not well known. To overcome these problems, different Standards Development Organizations - CEN standards, ISO standards, Other abbreviations (XML, EHR, DICOM, NEMA, HL7, CEN, AENOR, ECG, ASTM, ISO, IEC, JTC, LOINC, CCOW, CMA, ITU) assign different codes to the formal deliverables of Standard Documents and to the stages of standards development [10]. In a broader sense, they are trying to present the standards to support eHealth. There are four areas in which they are working [11]:

1. Technical Standards
2. Communication Standards
3. Terminology Standards
4. Information Governance

According to the 2nd research question, literature review and interviews with health care professionals will be conducted to identify the challenges and benefits of achieving PIPIS through OSS. Researchers and software experts on open source software have recognized several challenges and benefits to achieve interoperability in patient information systems. The main benefit is personalized information system and good way for business to achieve greater penetration of the market. Different companies are offering open source software according to eHealth standards to gain competitive advantages. [21] In other way, there are also many challenges to achieve PIPIS, while some researchers and software experts are not very convinced by open source’s ability to produce personalized interoperable systems for patients. The lack of empirical evidence and late defect discovery are the most important problems in these systems [22].

2.2 Goal/Result

The ICT plays a vital role in delivering eHealth services among different health care organizations. Information and communication technology based tools provide the patient safety, support management functions and resource distribution. We assume that in future the patients will get safer, secure, adequate and good quality eHealth services according to their needs and requirements. The goals of the study are listed below:

• Literature study of challenges and benefits of interoperable PIPIS and their available standards.
• Identifications of key benefits after the implementation of PIPIS in health care organizations.
• Through interview, identification of interoperable of PIPIS needs, benefits and challenges among health care organizations.
CHAPTER 3: RESEARCH METHODOLOGY

3.1 Overview

Cresswell writes in [36] that one of the major elements of a study is how an author collects data and analyzes it. In this study, author has used qualitative aspects of collecting data. This qualitative approach has been further divided in two sub categories. First category involves literature review through different sources while second one consists of interviews conducted at different places from different people.

A bird’s eye view of research methodology adopted for this study is given in below.

![Diagram of research methodology]

Figure 3.1 Bird’s eye view of Research Methodology for this study.
3.2 Literature Review

In the starting phase, I performed literature review in order to get in-depth knowledge of what work has already been done for achieving personalization and interoperability of Patient Information Systems. We also did this so that we can support theoretical part of this study, to provide reader with the concepts and better understanding of problem domain.

Author used different sources for searching the relevant material. Blekinge Tekniska Högskola’s Electronic Library Information Navigator (ELIN) was used as the primary search tool for finding articles and journals related to the study. Several keywords and search terms were used to utilize the ELIN up to the mark. As a result, a good number of journals and articles were found that are written by different renowned authors and published by famous organizations and databases like IEEE, ACM, Wiley. Apart from the articles and journals, author used different books and online (internet) resources such as Wikipedia, JMIR, Open source initiative etc.

3.3 Interview

After gathering sufficient amount of data to provide theoretical support to the study, author conducted interviews. The main purpose of conducting interviews was twofold. First, it will provide further evidence and support to already gathered qualitative material of the study. Second, it will provide an opportunity to do an in-depth investigation to identify the benefits and challenges involved in implementing PIPIS through OSS.

To better serve the purpose, author prepared some open ended questions so that an interviewee could get a greater opportunity to speak and share his/her ideas about the scope of the study. Audience for the interview was carefully selected. It was considered that the interviewee should have the knowledge of general trends of interoperability and personalization in eHealth tools.

Five individuals were interviewed in the form of videos recorded about 60 minutes each at different times. Four people were interviewed in Karlskrona while one was interviewed in Karlshamn. These individuals work as health strategy maker, health service planner, IT-manager in the county of Blekinge and eHealth project coordinator in Blekinge Tekniska Högskola.
CHAPTER 4: PATIENT INFORMATION SYSTEMS – STUDY AREAS

4.1 Overview

As this study revolves around Patient Information Systems therefore, in this chapter, author discusses relationship between eHealth tools and services first then, what other eHealth tools are available in health care domain. After that, an introduction of Patient Information Systems is presented together with the components they are comprised of.

4.2 Relationship between eHealth tools and services

There are three stakeholders in eHealth, namely citizens, health care professionals or givers, county councils and municipalities. According to [27], in Sweden, municipalities are going to play major role in providing eHealth services to the citizens in future. A number of eHealth tools are used by health care professionals to serve the citizens. These tools are mainly provided by the county councils in Sweden. World Health Organization in Global Observatory for eHealth has identified following nine tools for providing different ehealth services [26]:

1. Patient Information Systems (PISs)
2. Hospital Information Systems (HISs)
3. General Practitioner Information Systems (GPISs)
4. National Electronic Registries (NERs)
5. National Drug Registries (NDRs)
6. Directories of Healthcare Professionals and Institutions (DHPIs)
7. Decision Support Systems (DSSs)
8. Geographical Information Systems (GISs)
9. Picture Archiving and Communication Systems (PACS)

All these nine tools are used for the betterment of eHealth services. As discussed earlier, this study focuses on one of these tools i.e. Patient Information Systems (PIS), thus below is a discussion about PISs.

4.3 Patient Information Systems (PISs)

Traditionally, PISs contain information about an admitted patient in a hospital. A PIS can support an entire health care organization by catering the needs of only one department or several departments simultaneously. [26] A patient Information System is the superset of two eHealth services called Electronic Patient Record (EPR) and Electronic Health Record (EHR). This means that it is used to provide these two services.

An EPR contains patient record electronically and it provides new ways of storing and manipulating data of different kinds e.g. text, images, videos, sounds etc. EHR is a repository of treatment information within an institution like hospital or physician’s office. It cares for the requirements of patients, care givers, care services or scientific institutions. [34]

In this study, author will discuss two main issues of concern to patient information systems today. These issues are a) personalization of patient information systems, b) interoperability of patient information systems.
4.3.1 Personalization of Patient Information Systems

The traditional design of eHealth tools had a focus on clinical perspective of patient’s treatment. But within last few years, there is a growing demand for self health care in Sweden. [23] This means that patients should be empowered to the extent that they can handle their daily health routines with assistance from computers especially taking advantage of the internet revolution. This will increase the chances of helping a patient in sustaining the daily life activities like professional and family life etc. eHealth tools should become more user centric. [23] Also, according to [27], a considerable concentration should be diverted to user requirements that could be divided into two categories, a) General user requirements b) Effective user interaction requirements. This is useful for helping elderly people in carrying out their daily life activities. Frameworks for personalized eHealth aim for improving the quality of life of elderly people. [24]

In recent years, good amount of work has been carried out for achieving eHealth systems personalized according to each individual’s needs and requirements. The main objective is to make sure that these systems that comprise of several tools adapt to the patient’s needs in a uniform way and could be more trustworthy. The need for standardization of personalized eHealth tools rises because there is no consistency of preferences from one tool to another. By preferences, I deduce two meanings, first, hardware level settings of the user like volume level of any sound device, display settings of screen. This hardware will be providing an interface between the patient and patient information system. Second, information level settings for example what data can be seen by which health care personnel. With respect to this standardization, it will be better if there is one personalized tool and a user has particular preferences set on it. If there is another tool which needs the same preferences of same patient then there should be a way of importing or transferring those preferences. This makes it clear that even for doing so interoperability of eHealth tools is needed. It will probably be of great help if standards of expressing these preferences can be achieved. [23]

There are some issues involved in getting personalized versions of eHealth tools. These issues include [23]

a) Privacy of eHealth Information

Information stored in all types of electronic records is the most sensitive information that a person provides and saves. Hence, the importance of this information is highest in precedence. Citizens’ trust in eHealth systems can only be achieved if they feel confident that their eHealth information is being handled with care and only appropriate people are accessing it.

b) Roles of health care professionals

To solve the issue of privacy, roles of health care professionals should be clearly defined. It will allow a clear differentiation among different medical personnel and so patients will know exactly who will be accessing their information. It is also useful to help an eHealth tool determine authenticate rights for each personnel.

c) eHealth environment

Sensors collect useful data about patients. These sensors are either placed in the environment or worn by the patients. This data should be carefully combined to follow the rules and guidelines to make this data personalized. It should also follow the rules and preferences set by the patient.
Standardization of personalization issue in patient information systems may contribute to a better set of eHealth services to the citizens of county of Blekinge especially the elderly people who need care at home.

4.3.2 Interoperability of Patient Information Systems

To gain the full advantage of personalization of eHealth tools by sharing user preferences, we saw that interoperability is mandatory. Interoperability of eHealth environment is also required for the effective communication between different Medical Information Systems [27].

Umar Farooq and Usman Azmat in [35] with reference to IEEE gave a good definition of interoperability. According to them, “interoperability is the ability of two or more systems, applications or components to exchange information and to use the information that has been exchanged”.

This encompasses no effort from the end user. There are several types of interoperability. According to [35], there are three main types of interoperability namely:

1. **Channel Level Interoperability**

   This is the basic mechanism provider type of interoperability. It deals with interoperability of signals to transfer data after establishing connection between two or more systems. It is also called technical level interoperability. [35] It is achieved by using the latest telecommunication networks and technologies [27].

2. **Information Interoperability**

   Information interoperability is the capacity of different systems or applications to communicate and exchange data and information and to integrate with other systems and applications to provide services. [35]

   Information interoperability can be divided into three types: [35]

   i) **Structured Interoperability**

   It is the ability of two or more systems or applications to exchange data and information based on common data formats

   ii) **Syntactic Interoperability**

   It is the ability of communicating systems or applications to interpret the data in same fashion at both sides.

   iii) **Semantic Interoperability**

   It is the capacity of several systems to accept information and data based on agreed set of rules and guidelines.

3. **Process Interoperability**

   This type of interoperability works at top-level. Its main concern is with exchange of data and information among business processes of an enterprise. [35]

   This study’s concern is with syntactic and semantic sub-types of information interoperability therefore, author is going to discuss only these types of interoperability.
4.3.2.1 Syntactic Interoperability

It is an application level interoperability of systems and/or applications to share data and information with each other without any consideration of their interfaces, implementation languages and technologies. Theoretically, many solutions have been proposed for syntactic interoperability of ehealth tools including patient information systems. [30]

According to Kolovou et al. in [27], several solutions have resulted in platforms to make different medical information systems speak to each other. They have proposed a reference implementation model (RimM) which is actually based on OSI model. It suggests common message format and common communication interfaces to share data and information among different Medical Information systems.

Till now, absence of syntactic interoperability is due to three reasons:  
i) No common format for information exchange  
ii) No compatible messaging standards  
iii) Implementation of these standards with overlapping aspects

The RimM proposed by Kolovou et al. in [27] specifies types of users of this RimM, the architecture and message structure. The users identified are of two types one is called Application Entities (AE) and Data Storing Entities (DSE). Two AEs belonging to same MIS can exchange data directly without any interfacing between them. However, if one of the AEs belongs to another MIS then it has exchange data through its DSE. It means that in this case, DSE would act as an interface between them. Each user will have five profile attributes which are user type, administrative domain it belongs to, messaging standard employed for it, types of messages it can handle, users it is allowed to contact with.

The AE-layer acts as an interface between an AE and the internal middleware. The DSE-layer works as an interface between DSE and middleware and between two AEs that belong to different MISs. [27] In our case, when two medical personnel want to communicate or share data from one patient information system, they will be able to do it directly. But if they want to share data from hospital information system to a patient information system or from two different patient information systems, they need to do it through DSE which will provide them with an interface to talk to each other. The DSE domain will also remove the envelope of message [27].

The exact message structure proposed by Kolovou et al. is depicted in following figure on next page which has been taken from [27].
Every message will consist of two main parts a) Envelope and b) content. The envelope part will contain information that will be useful for determining the nature of the message like who is the originator and who is the receiver of the message, what kind of encoding technique has been used, what is the priority of the message etc. The content part will contain actual contents of the message. This is exactly in accordance with OSI model.

4.3.2.2 Semantic Interoperability

Semantics are the meanings associated with words and terms. Semantic interoperability is the ability of information systems to exchange data and information based on pre-decided meanings of terms and expressions. It plays a vital role in enabling other types of interoperability like syntactic, structural etc. A general example is of science. Science is all about regularities and rules without exceptions which apply universally in same fashion. If there is something which is variant to universal phenomena then it is not science. [31]

To achieve semantic interoperability among patient information systems, clinical terms used in county of Blekinge should be mapped to a unique terminology system. A step towards this could be like that of taken by The Long Term Ecological Research Network. A data dictionary can be helpful in achieving interoperability because it is a repository of information about data for example, meaning of a specific block of data, relationship to other data blocks (if there is any), origin and format of data [28]. When we have meaning, origin and format of data, it can help greatly in getting a common information structure. In this way all the patient information systems can fetch data from data dictionaries and interpret it accordingly. But it implies that all PISs should have an ability to recognize and interpret the information and utilize or process it.

From a developer’s point of view, a data dictionary can be useful because it catalogs the contents and conventions of one or more databases. Once these conventions are understood and accepted by all the patient information systems, the task of achieving interoperability can be simplified. One good approach could be to mould EML best practices for achieving semantic interoperability of patient information systems. In [29], there are recommendations for best practices of metadata registries. Different levels of EML contents are mentioned in [29]. Author will try to figure out how these levels can
become compliant with the common message structure mentioned in section 4.3.2.1. The levels mentioned in [29] are:

1. **Identification**

   This level can help in identifying the originator and recipient of the message as it contains the title of dataset from which the data has been fetched, who is the creator of the message and dataset, date, any keywords related to the data or dataset, receiver, contact information of both creator and receiver etc.

2. **Discovery**

   This level of information can be helpful in identifying, for example, the geographic location of both the sender and receiver of the message, time when the data was recorded, type of disease about which the data is related etc.

3. **Evaluation**

   Ideally, this kind of metadata should contain all the information like rights of authorized persons on patient data

4. **Access**

   This level of metadata should contain all the access attributes of the message or actual data. For example, what standard has been used, what encoding scheme has been used, what type of message it is, what is the content type, session id etc.

5. **Content**

   This is the actual data sent in the message.

   The reason we have studied the above attributes is because it will help in getting semantics simpler to understand on communicating information systems’ end.

   Figure on next page describes the integration of our syntactic and semantic study that is actually a blend of Reference Implementation Model from [27] and EML best practices from [29].
Figure 4.2 Fusion of Syntactic and Semantic Interoperability
CHAPTER 5: INTERVIEW

Interview is one of the methods of primary data collection. In primary data collection, researcher collects data him/herself. The unique thing about primary data collection methods is that data is not accessible to anyone except the researcher until he/she publishes it. [13] In this study, interviewees were asked specific open ended questions to know about their knowledge about the challenges and/or benefits of getting PIPIS through OSS. Interviewees were selected very carefully and it was ensured that they have technical and theoretical knowledge about the concepts of interoperability, personalization and open source technologies.

5.1 Purpose of interview

During the study, three interviews were made in order to know what benefits and challenges different health care professionals think might be faced by health organizations if they go for adopting PIPIS through OSS. Another purpose of conducting interviews was to have an idea about what IT managers think could be the solutions to problems or challenges in introducing open source applications within eHealth domain in the county of Blekinge.

5.2 Interviewee Selection and Interview Execution

I selected five interviewees for this study. One of them is the strategy maker in the county of Blekinge. His office is located in Wämö Center Karlskrona. Second person is the project manager in county of Blekinge. Her office is also located in Wämö Center Karlskrona. Third is the IT Manager/ Strategist in Karlshamn Kommun. His office is located in Karlshamn. Fourth and fifth individuals who were interviewed are Project Coordinator and Project Assistant respectively. Both of them are working on a R&D project in Blekinge Tekniska Högskola Karlskrona. Their offices are located in BTH Karlskrona.

As discussed above five people were interviewed at three different occasions, two in Karlskrona and one in Karlshamn. All interviewees were orientated with the background of problem domain and the purpose of the interview was explained to them before formal beginning of each session. The duration of first interview occasion was 54 minutes, second occasion consisted of 38 minutes interview while third and last one was 58 minutes long.

5.3 Conducting the interview and data collection

I put open ended questions in the interviews. Main reason for this was to keep the interviews more like discussions or dialogue where the interviewee was given maximum opportunity to express his/her thoughts.

After the interviews were conducted, the author gathered common challenges and benefits identified by health care professionals that might be faced by health care organizations. These challenges and benefits were gathered after careful observation of ideas and opinions reflected by the interviewees. Since, all the interviews were video recorded, thus author documented all the data with interviewees’ permission.
5.4 Data Analysis

Data collected in all the interviews were converted down to simple text as it made analysis process simpler. As the interviews revolved around three main themes of this study namely, Personalization, Interoperability and open source systems therefore, author divided the analysis process according to each theme. Questions and answers were extracted and separated according to these three themes. This analysis procedure helped the author in scaling down issues like up to what extent health care organizations are ready to adopt PIPIS through OSS in county of Blekinge. On the basis of this analysis work, author suggested some measures and recommendations to persuade health care organizations for adopting OSS in eHealth tools like Patient Information Systems(PIS) along with Personalization and Interoperability. Prepared to the interview questions can be found in Appendix 1.

5.4.1 Personalized Patient Information Systems

In question 8, project manager said that, it is good to have personalized eHealth tools, so that health care professionals and citizens only get the relevant information. According to strategy maker it is a lot more helpful to the citizens than professionals, which is a good sign. At present, when the citizens access their medical records, they get a generalized overview instead of a specific one which is not meant for each of them. It would help reduce the unnecessary information to be displayed.

According to IT strategist, there is need for personalized eHealth tools because it would be helpful for patients and as well as health care professionals to get right type of medical information at right time.

Project assistant and project coordinator said that, it will increase accessibility for patients. It will avoid the overnight stay of patients in hospitals and it will help in providing health care at home in the same way as in hospital.

In question 9, project manager and strategy maker said that it would be as equally advantageous to have closed source personalized PISs as open source PISs.

IT Strategist, project coordinator and project assistant gave almost same response to question 9.

In question 11, Project manager said that there is no such system right now which is personalized. But it would be great if patients could get personalized PISs because according to a survey held in 2004, patients agreed to have personalized versions of eHealth tools.

IT Strategist said that there should be a personalized version of any of the eHealth tools by now but he hasn’t heard or aware of one to his knowledge.

Project coordinator and project assistant were not aware of any personalized PISs.

In question 13, project manager and strategy maker said that private sector has been working with public sector for last 10 years and it has to work under the framework of national ehealth strategy therefore, it will get benefits similar to those gained by public sector health organizations.
IT Strategist, project coordinator and project assistant gave almost same answer to question 13 as above. However, IT strategist said that it might be difficult for small scaled companies to gain benefits as large companies.

5.4.2 Interoperable Patient Information Systems

In question 4, strategy maker said that it is necessary to get the full picture of patient’s previous medical history but we don’t have this thing at the moment. Strategy Maker said that at least, it should be readable by other health care professionals for future medical treatment.

IT strategist said that it is good for patient to see his medical history like what medicine he has purchased from aptoteket in the past. Secondly data sharing is not only beneficial for patient but also it will help patient’s guardian who can be his/her relative or a nurse.

Project coordinator said that every IT project in health sector is unique at the moment and they need to interact with each other to provide better services to the patients. They don’t interact right now because they are so new and they are not so mature yet.

Project assistant said that interoperability would allow citizens to access their personalized data anywhere in Sweden.

In question 6, strategy maker said that, the biggest problem we face today is that we can’t share medical information of patients which leads to wrong drug prescriptions. Project manager added that a considerable number of emergency cases are reported every year due to wrong drug prescriptions.

IT Strategist said that the situation will not change. Patients will not be able to see their data in an organized way and there will be lack of communication between patients, health care professionals and municipalities.

In question 7, strategy maker said that there is a small community of county councils that collects recommendations from county councils and decides what should be done in order to provide better eHealth services. Hence, researchers approach that community to share ideas.

Similar answer to this question was given by IT strategist, project coordinator and project assistant.

In question 13, Strategy maker said that there are some systems working in some of the organizations that are interoperable but we need to implement them on national level in Sweden.

IT Strategist replied in same fashion as strategy maker did.

Project coordinator referred to a complete eHealth system which is interoperable. It is built by the county of Norrbotten and running successfully in three or four other counties also. User satisfaction levels of this system are quite high.
5.4.3 Open Source Patient Information Systems

In questions 1, 2 and 3 Strategy maker and Project manager identified a challenge that open source PIPIS can be illegal in Sweden if there is no proper or clear supplier and/or open source vendor of an eHealth product. They referred to legislation in Sweden which describes that for every health care system, there should be a clear supplier who can be held responsible if the system fails to deliver and a human being’s life gets in danger due to that failure.

But if this is made sure according to the legislation, then the benefits of introducing open source systems in health care domain would be numerous but the level of benefits gained in different health care units in that case is a debatable concept.

IT strategist said that at the moment health organizations are not ready to do in house development of open source eHealth tools. He also said that the quality of open source software has improved considerably in last few years and that is a positive sign. Although it is important for health care professionals to benefit from open source eHealth tools but it is more important for citizens and patients to get maximum benefits from open source platform.

Project coordinator and Project assistant agreed that there would be great benefits for citizens and health care organizations if open source platform is adopted for building PIPIS. Project coordinator referred to an already built open source platform called “care on the web”, it is an open source platform where they have put all the technology but services have not yet been developed. So the next step is to build services by using that platform.

5.4.4 Personalization, Interoperability & Open Source Transition of PISs

In question 5, Strategy maker said that that as the whole society is IT driven so patients highly expect greater data sharing among different health care organizations. According to him up to 98 percent Swedish population wants information and data sharing about their medical history.

Project manager said that they conducted a survey in 2004 for their need and requirements about the eHealth services. A good majority of Citizens gave their feedback that they would appreciate personalization and interoperability of eHealth tools.

Project coordinator and project assistant said that all the county councils in Sweden have agreed to use National Patient Overview by 2012. This would definitely help in achieving interoperability to some extent.

In question 10, strategy maker said that different colleagues have different opinions about having personalized and interoperable patient information systems, but as far as a majority of them is concerned, they think in the same way.

IT strategist said that regarding interoperability his colleagues have positive attitude. But for open source software there are few proprietary vendors who are dominant in public sector so they don’t want to introduce open source software in public sector. Therefore, not many people are ready for this transition to open source platform.
In question 13, the project coordinator said that there is an interoperable open source health system running on in county of Norrbotten. This system is running very well for the users and county of Norrbotten shared this system with three or four other county councils as well.

In question 15, all interviewees said that private sector in Sweden has been working with public sector for 10 years and it works within the framework of National eHealth Strategy. This means that private sector can benefit as much as public sector. It has to face almost same challenges as public sector will be facing to adopt PIPIS through OSS.
CHAPTER 6: DISCUSSION

6.1 Overview

After analyzing the interviews, author believes there are several points raised by the interviewees that need to be discussed separately. In this chapter, discussion about those ideas and points is being made. Discussion will follow the same pattern of themes as in previous chapter i.e. chapter 5.

6.2 Discussion

Due to an influence of EU Action plan for eHealth and National Strategy for eHealth – Sweden, current direction of research is pointed towards achieving interoperability of eHealth tools and services. There is a debate on introducing open source applications in the scenario to make these tools and services talk to each other without any hurdle. [37][38]

According to [23], to achieve eIncusion and eAccessibility i.e. for empowering the citizens, each eHealth tool and service has to be tailored according to each patient’s individual requirements hence, making personalized tools and services. Author studies personalization, interoperability and open source software in light of EU’s action plan for eHealth [38] and Sweden’s national eHealth strategy [37] and data gathered during the interviews in chapter 5.

6.2.1 Personalized Patient Information Systems

Standardization work is in progress for personalized eHealth tools by keeping patient and health care giver’s point of view [23]. But one problem in Sweden is that county councils are not following EU Action plan’s recommendations because each county is using a system which is unique from the others [34]. This means that county councils will not be able to get advantages of current standardization efforts being made because they have to follow some standards for their own tools first. Only then they can be able to get their share out of the cake.

According to strategy maker and project manager it is highly desirable to have personalized versions of eHealth tools so that the patients only see the relevant information based on their needs and requirements. IT strategist agreed with the general notion that providing right information to patients at right time and place is the biggest challenge faced by eHealth domain.

In fact, personalization means empowerment of patients/citizens because it will put the balance in favor of them. Citizens will be in charge of deciding who can access their medical records, what type of information they want to see, what type of information they do not want others to see. It is all about giving the control in the hands of citizens and it is believed that today’s citizens are mature enough that they understand and know their rights very well.

Personalization of PISs not only conceptualizes the idea of tailoring some factors mainly according to patient requirements and needs but it also gives secondary importance to care givers (health care professionals and organizations). These factors are [25]:

- Process design
• Workflow management
• Concept Representation
• Concept aggregation
• Ontology/Terminology
• Compilation of results
• Methods for diagnosis
• Therapeutic means

The range of benefits of personalized versions of Patient Information Systems can be increased if personalized data can be shared among different health care organizations either in a single county or at national level. This calls for greater data sharing among different health care units or organizations. Below I will discuss Interoperability of Patient Information Systems in view of ideas of different health care professionals.

6.2.2 Interoperable Patient Information Systems

As discussed earlier in this study, interoperability is something which is emphasized much in National eHealth Strategy for eHealth, Sweden [37], thus interoperability is central to the idea of building smart, efficient and effective eHealth tools and services. According to project assistant, current problem in Sweden is that a patient can’t see his/her medical data from one organization to another even in same city. She added that for example it is not possible for her to see her own medical data in another hospital in Karlskrona except where she is registered. One of the challenges is to make patient data and record about his/her medical history accessible at national level in Sweden.

Strategy maker raised a challenge very correctly that not every patient will want to share his/her complete medical data. It means that there will be legislation involved to restrict unwanted data sharing. This must be made sure by interoperable PISs to allow customize the view of data of a particular patient so that unwanted data could be disallowed from being displayed to unauthorized persons. For legal issues like who should see my health record and who should not, people’s fear is similar to one when online banking services were introduced. Everyone was afraid of getting online banking services because they were afraid that anyone can see my account details. But today, almost everyone uses it and they are much more secure than in the past. So eHealth records would also be secure in the same way, let’s hope.

IT strategist thinks that there is not much resistance in health care organizations to introduce interoperable PISs. This is rather good because a vast majority of citizens also demand greater sharing of their medical record as mentioned by strategy maker, 98% Swedish population wants it. He also added that 10% of emergency cases occur due to this lack of sharing of patient’s medical history. Health care organizations and providers believe that interoperable PISs will reduce this rate.

If PISs continue to work without interoperability, then there will be no change and as IT strategist discussed, there will still be a gap among patients/citizens, health care
Interoperable Patient Information Systems will not only allow sharing of patient data and information but also care givers can share their expertise. This is very much helpful in a case where a citizen moves out of a county. For instance, a patient moves from Blekinge to Kronobergs and he gets sick, the general physician or even a nurse could share data from his general physician or nurse in Blekinge.

European Union’s action plan for eHealth [38], suggests that in order to achieve interoperability of electronic patient information systems, open source applications should be introduced. It will make the goal of interoperability easier to achieve. Below we discuss this paradigm in detail.

6.2.3 Open Source Patient Information Systems

During the interviews conducted at different locations, author observed that there is a mixed opinion about the adoptability of open source software within eHealth domain. According to strategy maker, there is legislation in Sweden which states that there must be a clear supplier of every product used in health care. If open source software get in the domain, then there is a possibility that such systems will be illegal as it might allow anyone to add or remove something from the source code. But one point here is that when we say open source eHealth tools, we are not suggesting something like Wikipedia where anyone can come and update the contents of the system. Of course, open source software allows the developers to do so but it is not mandatory or it is not bound that it shall happen. This dynamic updating can be disallowed as in many examples say, Sun Solaris operating system where all the developmental responsibilities are bound to Sun Microsystems Inc. only. To put it simply, open source PISs must focus on agile aspects of development rather than code level aspects.

Healthcare organizers are only afraid of adopting open source idea otherwise there are examples within European Union where open source eHealth tools are successfully run. Biggest examples are, in UK National health service ran open source eHealth systems in a few organizations for testing purposes and it has been noted that it helped NHS in saving 600 million £ per annum [7]. Second example is in Sweden, as mentioned by project coordinator and project assistant county of Norrbotten has developed an open source interoperable system on its own. This project was named VAS and it has been running very smoothly and user satisfaction levels are quite high. Unfortunately, no documentation was found in English that is why it has not been referred properly in this study.

IT strategist agreed that not all county councils or health care organizations are in a position to do in-house development of open source PISs but they are also not in a position to outsource development process as there is a great resistance for adopting open source paradigm. But during last couple of years, quality of open source systems has improved greatly and it is improving consistently, hence, the resistance has decreased also and it seems that health care organizations will see OSS as an important tool to increase their efficiency of work procedures and reducing the costs of providing eHealth services.

Another advantage of introducing OSS is that as we see in Mozilla, the frequency of updates is higher than in closed source counter parts. Also, there is an automatic updating of software
copy so there will be no need for healthcare professionals to check for updates, an open source PIS shall be updated automatically.

But one of the problems with Open Source is security and reliability. Most of the open source platforms do not seem reliable for running critical applications. Secondly, according to [39], there are lots of arguments about OSS’s performance in security critical application domain. IT Strategist raised a point that despite recent improvements in OSS quality, there are still concerns in the minds of people regarding data security. Like how can an OSS application cater the automatic log in of an individual to a service who has successfully been logged into some other service? For example, if a healthcare provider signs into a health care organization service, he/she must be able to enter county council service also without needing to give log in information again. This type of data security is of high concern to the open source ability. But, as mentioned in the previous chapter, according to project assistant, this fear is just similar to the one that people had when online banking services were introduced. The same security issues can be raised for proprietary software also.

6.3 Summary

In this chapter, author discussed that according to a survey conducted in 2004, a vast majority of citizens demanded an increased data sharing for their benefit and personalized or customized eHealth systems were also appreciated by them. For achieving personalized versions of eHealth tools for citizens it can be a good idea to sub-divide the users into groups on the basis of services they share[32]. This will help in the empowerment of citizens and will make sure their fruitful involvement in improving eHealth services through better eHealth tools. Sharing of this personalized data among different tools and systems is a challenging task and efforts are being made to achieve it.

Data sharing ability or interoperability of eHealth tools and systems will be highly beneficial for the citizens and patients. They can access their medical data and information even if they move out of their county or out of Sweden. There are several issues related to achieving interoperability and during interviews it was discovered that standards are present which define the procedural steps to share data between health care organizations but there are no set methods and techniques to implement those standards. In chapter 4, author tried to present an abstract methodology to achieve interoperability. This methodology presents an approach in which two different types of interoperability i.e. syntactic and semantic interoperability are mingled by fusing methods of achieving each type of interoperability. A reference implementation model for syntactic interoperability has been mixed with different levels of EML best practices for LTER sites. After interoperability, author tried to give answers to some of the key factors identified by the interviewees about open source adoption for achieving personalized interoperable patient information systems (PIPIS) in chapter 5.

One of the major concerns is a resistance against the adoption of OSS in eHealth domain. Author explained what benefits could be achieved by adopting oss for building PIPIS. These benefits were identified after literature review, interviews and success story of open source adoption in UK.
CHAPTER 7: EPILOGUE

7.1 Conclusion

The main focus of this thesis is to identify the benefits and challenges that could be gained and faced respectively by health care organizations in county of Blekinge if they implement personalized interoperable patient information systems (PIPIS) by using open source software (OSS). A good amount of literature was reviewed in order to gain an insight about what is currently going on within European Union to achieve PIPIS through OSS. Five people were interviewed at three different occasions. Analysis of interviews was done to identify key points raised by the interviewees. There is also a section which discusses those key points in detail. Some points were arguable so necessary arguments were added to make the information complete. This analysis work was done with prior permission of interviewees.

There are two research questions in this study. According to first research question which is “What standards are the standards for PIPIS?”, author discussed that work is under progress for building and establishing standards of PIPIS. There are different standards that have been defined. First advantage of following standards is that it will simplify the task of achieving interoperability. Second, it will be easier for all health organizations in Sweden generally and in county of Blekinge specially to gain same amount of advantages.

According to second question “What are the challenges and benefits of achieving PIPIs through OSS?”, My conclusion is that it is extremely very difficult to adopt Open Source Software for implementing Personalized Interoperable Patient Information Systems in Sweden due to current challenges and problems that exist in health care organizations regarding this. These challenges and problems are:

1. Resistance from health care professionals for open source software.
2. Legislation for outsourcing.
4. Trust issues in PIPIS.
5. Laws for patient data privacy.
7. Common vocabulary.
8. Common mechanism for information transfer.
9. Writing services to implement interoperability standards.
10. How a system will get to know about a patient’s medical condition after a period of time?
In light of second research question mentioned above, author tried to figure out what benefits could be available to these health organizations once we get the answers of those challenges. The benefits could be:

1. To get a complete picture of patient’s past at a different location, for instance, a different county or even a different health organization.

2. To get the most relevant data and information about the patient. It will help care givers and patient itself.

3. Increased specific data sharing will meet citizen expectations.

4. Data sharing is good not only for the patient but also for the care givers who could be patient’s close relative or nurse.

5. Personalized data display will help a patient in seeing what actions he/she has taken in the past like what medicine he/she has purchased.

6. For open source PIPIS, medical personnel will not have to update it as automatic updating like Mozilla will be a good idea.

7. Communication air bags will be filled up by increased data and information sharing between patients, health care organizations and Municipalities.

8. Personalization and interoperability will be an enormous source of empowering the citizens/patients i.e. giving them more control and increasing their involvement in improving eHealth tools and services that are built for their betterment.

9. As eAccessibility will greatly enhance, so patients will not need to stay in hospitals overnight. This will save them from paying costs of staying in a hospital.

10. Citizens can access their data anywhere in the county of Blekinge and anywhere in Sweden if interoperability is achieved at national level.

7.2 Recommendations

There are few recommendations which will help a lot in providing better eHealth services through smart eHealth tools. These recommendations are based on the findings from interviews and extensive literature review.

Although, quality of open source software has improved considerably during the last few years but there is still a lot of resistance against adoption of open source systems in health organizations. Therefore, more and more orientation programs should be run in order to reduce this resistance. A public interest organization has already started awareness program in county of Blekinge. Universities and other research institutions can play an important role in supporting this awareness program. Open source PIPIS development should be focused on agile aspects like business processes rather than code level aspects. Closed source vendors should be pressurized in order to let the other systems speak with their system. At initial levels, patient records must be made readable at least. Trust issues in PIPIS should be handled properly for example, identification and signatures.
7.3 Future Work

Future work of this study should focus on other types of interoperability such as functional interoperability. As we have provided just a little glimpse of it, an investigative study of same nature can also be conducted for private sector health care organizations in county of Blekinge say what challenges and benefits they will exactly get if they opt for PIPIS through OSS. A comparative study to this one can also be made where the comparison of challenges, benefits and resistance against OSS in private sector could be made with those presented in this study for public sector organizations in the county of Blekinge. Another exciting perspective could be to study how to reduce the resistance against open source software in health care organizations.
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**Theses**


**Books**


**Reports**


APPENDIX 1

1. How beneficial can be an open source electronic health record for the citizens?

2. How beneficial can be an open source electronic health record for eHealth organizations in technical and financial aspects?

3. How beneficial can be an open source electronic health records for Health Care professionals?

4. In your opinion what benefits can be achieved by interoperable electronic health records?

5. Have you heard any comments or feedback about such systems from your colleagues or citizens or health care professionals?

6. If we don’t use interoperability then what will be the scenario?

7. Research is going on to achieve interoperability have the researchers contacted you to get your ideas?

8. Do you think there is need for customizable eHealth systems? (if no then argue about its need according to elder populations increase)

9. If you are given closed source software that is customizable how much successful it can be or what drawbacks you see in such systems?

10. What do your colleagues or patients or health care professionals say about this do they think in same way?

11. Do you know any system which is some how similar to our propose systems that might be interoperable, customizable or open source?

12. How do you see interoperability and open source software in public sector?

13. Do you think they will have same impact on private sector?