Achieving Interoperability among Healthcare Organizations

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ABSTRACT

The area of eHealth has been increased in the recent age but also facing a lot of challenges. In relation to these, there exists a lack of interoperability among different healthcare organizations in the way of providing care services to the healthcare professionals and the patients. Interoperability among the healthcare organizations is appreciated not only by the academia but also by the policy-makers and other related personnel. Today, implementation of interoperability has become an intricate job than expectations. Interoperability is resisted by different barriers but potentially can give several benefits to all stakeholders and ultimately should be focused. The study is conducted for investigation of challenges and benefits of interoperability among healthcare organizations in the Blekinge County. In the first phase, after having a comprehensive review of literature, the challenges and benefits for the implementation of interoperability among Swedish healthcare organizations are identified. Depending on the findings, interviews were conducted with the eHealth professionals of the Blekinge County to clearly understand about the strategies and plans regarding the interoperability among the healthcare organizations in the Blekinge County. After performing a thorough analysis, questionnaire were conducted with the Medical IT administrators and with other related personnel to know about their opinions about the problem. The authors find after analyzing the results of the study that focus on resolving issues like standards adaptation, accessibility, integration, privacy and proper ICT infrastructure could provide interoperable environment among municipality healthcare centers and hospitals in the Blekinge County and other areas in the Sweden.

Keywords: eHealth, Interoperability, eHealth standards, ICT infrastructure
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We dedicate our thesis to our families.
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INTRODUCTION

Information and Communication Technology (ICT) have played an enormous role in almost every field. ICT is giving a boost to health sector and its use can be beneficial from different aspects in health sector. Information management and communication process is a challenging task regarding ICT in health sector. Different healthcare providers are using ICT tools to enhance the capabilities and quality of the existed eHealth system. E-health is a global paradox and is related with the medical, citizens health, business and providing services. ehealth provides different services to the different care providers, stakeholders and regions for better health care. In eHealth the terms like Electronic Health Record, uses of different standards and ICT tools are often discussed. Electronic health record system (EHR) is defined by Iakovidis [1] as “digitally stored health care information about an individual's lifetime with the purpose of supporting continuity of care, education and research, and ensuring confidentiality at all time [1]”. It is also a service of ehealth environment. It includes the information regarding patient demographic, problems, past medical history, laboratory data, and radiology reports etc. It is capable of producing a complete record of a clinical patient and also supporting other different care related domains through an interface [2]. It is the patient medical history and is very essential in future medical treatment of the patients. Clinical information contains very crucial data which may be stored from different applications from a single domain or heterogeneous applications. Due to the several health care providers this record is composed of different independent parts and there is a lack of unified standards which resist to interoperability [3]. Interoperability among ehealth services still not been achieved, not only between the organizations like hospitals or health centers but also from regional perspective [4]. This interoperability issue relates with several standards which are under development including Health Level 7 (HL7) Clinical Document Architecture (CDA) [HL7 CDA Release 2.0 2005]. These standards are used for exchanging the information [1]. But the problem arises according to the According to Per-Eric Thorell; the standards are not followed appropriately in the in ehealth in Sweden [5]. Sweden is among the successful country in implementing the EU strategy on eHealth. EU has nominated the Sweden on the basis of this successful strategy to build effective and reliable eHealth system along with 11 countries. Sweden start storing his patient record electronically in Seventies and now has created a structural infrastructure of eHealth [6]. Also the counties in the Sweden have their separate web portals to provide ehealth services like Blekinge web portal [7]. Both EHR Vendors Association (EHRVA) and the Healthcare Information and Management System Society (HIMSS) 2008 have stated that Interoperability standards must be widely used otherwise care providers, healthcare
organizations etc may not adopt EHR frequently [8]. In the county of Blekinge different healthcares are exchanging their information but there is a need for the integration of work between municipality level care and hospital care for elderly people with consideration on the continuity of care to gain the effective healthcare delivery. The objective of this integrated work is not only the continuity of care but also take care of different activities carried out for the betterment of disease.

In this research we will focus on the interoperability of the municipality health care centers and different hospitals in the county of Blekinge with the concept of standardization and information technology. Different medical and clinical information in different places can share and exchange the information. This information exchange brings a new vision in which medical health centers and the primary cares centers can cooperate in future. This can be measured as a building block for quality and effective decrease in the cost [9].

Interoperability of Electronic health record and clinical information exchange within the county of Blekinge is an interesting area of research. This research will help in deep understanding of the current scenario and the implementation of the future work in a regional level.

This research would illustrate the benefits and challenges in achieving the interoperability among municipality healthcare centers and hospitals. This integration and exchange of information between different healthcare providers brings a care treatment chain and fulfill the interoperability gap between healthcare organizations. The interviews with the healthcare service providers would highlight the challenges in this field and purposed solutions will provide the researchers the current situation and implementation framework.
1 BACKGROUND

1.1 What is eHealth and use of ICT

Information and Communication technology (ICT) is used to increase the health services in the society. With the use of ICT different people in health get benefit and it makes environment much easy for doctors, patients and other health care providers and provides a better quality of life. The role of ICT is helpful in reaching the remote locations, providing training for doctors and facilitate in building a national health network. [10] According to Mitchell “A new term needed to describe the combined use of electronic communication and information technology in the health sector. The use in the health sector of digital data – transmitted, stored and retrieved electronically – for clinical, educational and administrative purposes, both at the local site and at a distance ”[11].

In [12] Elizabeth Sillence et al. say that eHealth relates to everything from computers to medicine and the health services and information are delivered using the related technologies. The success of eHealth depends upon the quality of medical information, effective user interaction and the patient data according to the needs and requirements. With the implementation of ICT tools in eHealth this area is spreading and creating new challenges in interaction between patients and healthcare providers, among different healthcare providers, exchanging of information and peer to peer clinical information between different healthcare providers. There are lots of ICT based tools which are used for the prevention, diagnosis, treatment, and monitoring of patients like electronic health record, information networks, web health portals, eprescription, telemedicine services etc.[13]

World Health Organization in Global Observatory for eHealth has identified different tools for providing different eHealth services. One of the tools is Patient Information Systems (PIS) [14]. EHR is one of the two provided services of PIS which is a repository of treatment information within an institution.

1.2 Electronic Health Record

Electronic Health Record (EHR) is a key area of research in eHealth. According to lakovidis [1] clinical information contains medical record of patient which is stored in digital format. This clinical information objective is to provide chain of care and learning for research purposes. Moreover this information is stored in structured and unstructured documents in a variety of formats. EHR can store different types of information for a patient like different lab reports, images, treatments, and patient identification number [15]. Many countries are
trying to provide solution to their health care services. In this regard some standardized organizational and technological infrastructure is used to provide basic factors for introducing EHR [16]. According to Jian Chaeng et.al [17] “The electronic health record is an electronic history record produced directly in personal health related activity and worth keeping for future reference to health care management and clinical decision making”. There have been many efforts in building and designing the content and structure of the electronic health record. Moreover this emergence of EHR brings new challenges in the field of medical informatics. The ultimate goal in this technological era is the interconnection of different medical applications.

1.3 Interoperability between Healthcare Providers

The interoperability of different medical domains make it easy for the patients, doctors and other stakeholders to get the access of clinical information at different locations without taking the burden of the keeping track of all previous history of treatment in a printed form. The interoperability of EHR makes treatment efficient, effective and low cost. According to Brown and Raynolds [18] Interoperability of two applications for a specific task is done if one application can accept data by the other application and can perform satisfactory task on that request. Different healthcare providers are providing the different procedures, and assessments about the patients. Some time the care process get delayed due to the administrator tasks creating a need of some information exchange and automation of system activities in order to carry a quality care of patients. The interoperability of patient clinical information make treatment more effective and providing the information at right time and at right place. Heterogeneous eHealth application specifically required [19].

Information sharing between different healthcare providers

- To have access to distributed clinical information at any place with any time.
- Different ICT based services.
- Doctor and patient both can consult with each other.
- Patient can access his/her electronic health record.

There are many standards to address the interoperability of clinical information among healthcare centers. The main objective of these standards is the exchange of clinical record by defining some structures and markup. These standards are focusing the structure of the content, functionality of the requested retrieval of the record, complementarities of different standards and how they influence in the market relevance [15]. According to [17], in the absence of standardized and sharable clinical information we can have lots of problems in different aspects and many developed nations are trying and putting focus on the development and utilization of health care information for providing different services. So
without the presence of appropriate standards for exchanging data, issues may keep arise in managerial, constructional and differences in functionalities. The interoperability of clinical information like EHR is a main focus in the National Strategy for eHealth. This research area in the Blekinge County will be very beneficial for the citizens and healthcare centers.

1.4 National Strategy of eHealth in Sweden

National Strategy for eHealth was launched in March 2006. According to this most of the ICT system is just working as storage of data which is not communicating and exchanging across the applications and hospitals in a county or within the counties. It was decided that all stakeholder should cooperate with each other. The main objectives were as under [20]

- Enhance the patient safety, accessibility, quality and care.
- Mobility of patient nationally or internationally.
- Integrating the health care information.

According to [20] people can contact their doctors using web portal and can book an appointment to meet the doctor or can change the already booked appointment. This facility provides the easy access to doctors which may or may not in Sweden or moved elsewhere. Patient may have access to their electronic health record in order to see the suggested prescription and medicine. Patient can use this record for previous medical history. Similarly health care professional can access the record in order to make new prescriptions, treatment, and can monitor the status of the patient. Transfer of information from one medical unit to another in order to increase the treatment efforts. This mean interoperability of the EHR is a main key focus in the future development.

There are many challenges even the variation of ICT use may be different in one hospital. ICT tools have different functionalities and limitation due to the different suppliers and different in terms of technical and structure and design. Working on the basis of standards is very low. These problems create hindrance in communication and make operating cost high [20]. National strategy for eHealth gives much importance on the interoperable health systems. There are six action areas defined in this strategy out of which four are on the interoperability of health information. These four action plan are [20]

- Creating a common infrastructure.
- Creating a common technical infrastructure.
- Providing interoperable, supportive ICT systems.
- Access of information across organizational boundaries.
1.5 Blekinge County Council

Blekinge County is situated in south of Sweden. The county seat is positioned in Karlskrona [33]. The major task of the county council’s is to provide different services regarding health care and medical field. It almost covers up to 80 % of the entire organization. The county makes a contribution for providing good health and medical services to promote the region. Blekinge county or in other word Landstinget Blekinge reflects like an entity of municipality that perform independently but having a common boundary with the County Administrative Board. Inside the county of Blekinge, there exist five self-governing municipalities also providing the foundation for the structure of the county. Mostly the primary healthcare services are sited at various centers within the municipalities.

- Olofström Municipality
- Sölvesborg Municipality
- Karlshamn Municipality
- Ronneby Municipality
- Karlskrona Municipality

Health care planners have recognized that the municipalities are associated with providing the county’s health care services for example dental care, advice and support to the disabled,
offering citizens with proper education as well as training in the Blekinge folk high school. These municipalities also help out for promoting the health sector within the region and also by progressing in cultural and environmental development [34]. Currently Blekinge municipalities are providing nine eHealth services at certain clinics and all clinics do not have the same eHealth services. But municipalities are also going to provide an interoperable environment for exchanging clinical information among primary health care’s and hospitals. But due to heterogeneity there is still lack of interoperability.

M Azam and Izhar Hussain in [5] with reference to their interviews have mentioned that there are 21 county councils in Sweden. Seven county councils using the same system and 6 are trying to integrate with them. Also interoperability is a big challenge among different health care organization in Blekinge but Sweden is working with EU for the implementation of interoperability among EU countries. They also mention that currently there is no interoperability in Sweden among different health care organization in public and private sector and sharing of information is still a challenging task. Moreover they reference suggesting that interoperability will be very beneficial for the patient as well as for the health care professionals.

1.5.1 Ronneby Municipality

According to the interview with Ulf Danielsson, elderly people who need care in everyday life make different ways including illness, rehabilitation after surgery to come to the municipality health centers. Ronneby municipality provides care in two ways. One is at ordinary home and other is caring at health centers. Care at home is only with the consent of a person if he/she feels more safety at their homes otherwise treated at healthcare centers. Municipality makes decisions under the safe planning with discussions of nurse, social educated person and with the family of the person who needs care.

Municipality has seven healthcare centers as under:

Table 1: Statics of people under care in Ronneby Municipality healthcare centers

<table>
<thead>
<tr>
<th>Municipality Healthcare centre</th>
<th>Number of people under care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vidablick</td>
<td>128</td>
</tr>
<tr>
<td>Agårdsbo</td>
<td>38</td>
</tr>
<tr>
<td>Olsgården</td>
<td>73</td>
</tr>
<tr>
<td>Ålycke</td>
<td>36</td>
</tr>
<tr>
<td>Backen</td>
<td>28</td>
</tr>
<tr>
<td>Lindebo</td>
<td>38</td>
</tr>
<tr>
<td>Björkliden</td>
<td>16</td>
</tr>
</tbody>
</table>
There are almost 800 people who are treated under municipality healthcare centers and at ordinary homes. Out of which 357 are treated at healthcare centers and remaining at ordinary homes. Personnel who are involved with the care of people in municipality healthcares are nurses, social educated persons and two more persons one from high school and other is college educated. A person who is college educated directly interact with municipality system while nurse interact with both systems of municipality healthcare and hospital. Nurses can see the medical information with the consent of a particular patient. According to Ulf Danielsson, municipality healthcare system named as “MAGNA CURA” is not connected with the Carelink. The medical information of a patient from the hospital healthcare system (SYSteam Cross) is not accessible to the municipality healthcare system.

There is need for exchanging medical information among these healthcare systems.

The main focus of this research is analyzing the interoperability of clinical information between municipality and hospitals in the Blekinge County, which results a better eHealth environment fulfilling the needs of patients, healthcare professionals and other stake holders.

Our research will support health care organization and authorities to eliminate the gap of interoperability between them exploring the technological and communication framework. This is a challenging task since organization like hospitals in the county of Blekinge can exchange the information about patients but when discussing the county level still many healthcare centers are unable to get connects with others, so information required at particular place for the continuity of care is limited and delayed the activities of care. This raises a need of collaboration of hospitals and municipality healthcare centers.
2 Problem Definition and Goals

In this modern era, Information and Communication Technology (ICT) has become a revolutionary and emerging field [21]. According to Simon Rogerson, healthcare computation regarding medical information relates with the applications of information and communication technology (ICT) [22].

According to the Claudia Pagliari, internet technology has given a boost to eHealth by delivering information about healthcare and health services frequently [23]. In this era, ICT based applications in healthcare have increased enormously and functioning in an effective manner. Applications of eHealth which have implemented in Sweden are purely ICT based. These applications are emphasized on giving different health services to the citizens of Sweden through primary health cares [23].

ICT based systems supporting the County council of Blekinge and providing free services regarding health care to the citizens. The Blekinge Citizens desire to have an easier approach by ICT to check their own medical information against the different diseases at different locations. Although a number of ICT based tools are used in different primary cares and hospitals but they are still facing a lack of interoperability because of no proper ICT platform to bring interoperability in healthcare [7]. For a long time, interoperability has become a major dispute in the Information technology sector. In this regard, various techniques have been introduced at the syntactic level including ODBC (Open Database Connectivity) data gateways. It is Microsoft’s strategic interface for accessing data in a heterogeneous environment [77]. Web services are also used for making interoperable environment among heterogeneous applications. Although these developments have importance, but there is still a problem in getting interoperability. It becomes more complicated while exchanging the clinical information in the healthcare domains because medical information itself contains complexity [15].

Electronic Health record (EHR) or Electronic Medical record (EMR) is the core eHealth service providing to the citizens, health care providers and the hospitals. EHR is the patient medical history and is very essential in future medical treatment of the patients. EHR contains very crucial data which may be stored from different applications from a single domain or heterogeneous applications. Due to the several health care providers this record is composed of different independent parts and there is a lack of unified standards which resist to interoperability [3]. Interoperability of medical information of patients especially elderly patients creates lots of advantages and facilitating the patients to retrieve their records from different locations like hospitals and municipality healthcare centers. But this is a challenging task in the advancement of information technology. To counter interoperability
issue lots of challenges have to be resolved. There is a need to identify the critical challenges to interoperability among healthcare centers and also give benefits to citizens regarding access to medical information through interoperability.

One main motivation for the interoperability of medical information of the elderly patients is that the municipality healthcare providers and hospitals would exchange information of the patients. Through this interoperability there would be a support for elderly citizens to receive assistance and medical attention remotely at different healthcare centers and also while sitting at their own homes. In the county of Blekinge as well as on the other places citizens want easy access to their medical information and to their reports by interacting with the municipality health care and hospitals separately. Below is the figure 2.1 showing elderly patient care process without interoperability and also if interoperability is attained.
2.1 Research Question

- What are the challenges and benefits for interoperability among health care centers?
- How an appropriate interoperability between municipality health care and hospital can be supported by ICT platform?

In our research, these research questions are contributing well to project the problem domain in a right dimension. According to our 1st research question, literature review and the interview proposes the detailed description regarding identification of challenges and the benefits of having interoperability among the various health care centers or stake holders. These are inevitable to explore for knowing about existing challenges and benefits for interoperability among different ehealth stakeholders. Different level of problems is concerned with the interoperability of EHR/EMR or other medical information among health care centers. The attempt is to focus regarding physical, structural, syntactic and semantic interoperability for exchanging information among different healthcare providers or stakeholders [24]. Different companies and researcher are working to overcome interoperability issues, but more challenges raise as domain expands. The core benefit to have the interoperability among health care stakeholders that they can provide better health care services and can avoid redundancy of patient examination [25].

According to the 2nd research question, Authors will conduct literature review and interviews with health care professionals. Regarding this question the interoperability between the municipality health care and hospitals is an immense dispute in healthcare organizations. There is a lack of information between municipality healthcare and hospitals. When a patient is discharging through a hospital and he/she still needs a medical care for healing process then municipality healthcare provide medical services at their homes or at other health care centers especially for elderly people. To do this, there requires a way by which a staff of municipality healthcare can see information like patients summary or medical information or prescription about that patient who just treated by the hospital. Similarly, if a patient again visiting hospital, there also needs information about how the patient is cured by healthcare center after getting serious medical treatment like surgery. But there is a lack of an information exchange between the municipality health care and hospitals. It emerges a concept of no interoperability between municipality health care and hospitals. We shall consider the literature about interoperability, different kinds of interoperability, several eHealth standards and most importantly the interoperability within the Swedish health care organizations. We shall also depict about how the interoperability gap can be reduced among health care centers through the use of ICT platform.
2.2 Goals and Measures for the Study

In order to get better services of health care, eHealth has provided a platform in collaboration with the information and communication technology (ICT). ICT based tools has provided the patient safety, support management functions and resource distribution. Authors predicting that in future there would be an interoperable information exchange in the form of electronic health record (EHR) e-Health service. Using it a patient as well as municipality health care will get safer, secure, adequate and good quality of services and treatment according to their requirements [7].

Our research will focus on the current challenges and the benefits of the interoperability among health care centers. It will also deal with analyzing different applications in Blekinge County to check either interoperability exists or not between health care organizations and in what way different stake holders or strategy makers can achieve interoperability. The goals of the study are listed below:

- The study would help to identify the existing challenges and benefits of Interoperability among health care centers.
- This study would also help to investigate the way of providing interoperability among the municipality health care and hospital.
- The study would also help to support patients and other stakeholders for the accessibility of clinical information through interoperability among health care centers.

It would make a satisfaction level high for the stake holders or healthcare centers to exchange information.
3 Research Methodology

This chapter depicts about the research methodology that will be used in our research work. An overview of the research methodology is mentioned in the section 3.1. The phase of literature review is covered in section 3.2 and informal discussion is defined in section 3.3. Survey design is concerned with the Interview that will be conducted from technical staff members of the municipality health care and the hospital where systems are used and requiring a proper way to exchange patient medical information between them. It is discussed in section 3.4. Questionnaire discussion is also defined in section 3.5.

3.1 Overview

Research methodology is used to conduct the research in a more sophisticated manner. It helps in organizing and analyzing the data collection to be used in the research. Our study is carried out using mixed research methodology which includes both qualitative and quantitative research methods. In the beginning, authors performed literature review in order to have an understanding about eHealth, eHealth service i.e. medical information about a patient electronic health record (EHR), interoperability and the standards used and the challenges and benefits for the interoperability among different health care organizations. It depicted the importance of having the interoperability of the patient’s medical information among health care centers. The literature review helped to adopt the method of conducting interviews, analyzing findings or collected data and distribution of questionnaire for having data to validity the study. In this research, interviews and questionnaires methods will be used to collect data. Interviews are conducted to ask both detailed and follow-up questions with eHealth strategy maker, health service planner and health care service providers. The interview is a qualitative research method which involves a series of questions asking from the respondents in order to collect data. It can be held remotely through mail or telephone and also by going personally to the respondents. After conducting the interviews, authors performed the analysis on the collected data. Then Questionnaire was designed and distributed on the basis of findings through the interviews and validates the study. Questionnaire is quantitative research method designed to collect quantitative data. It includes open ended or closed ended questions. Figure 3.1 presenting the overview of a particular research methodology for our study.
Figure 3.1 Overview of Research Methodology
3.2 Literature Review

Literature review is used in the beginning of the research. The aim of the literature review is to build a basis for the research and sharing the results of multiple studies. It helps in forming the research questions, filling the existing gaps and tends to extend the studies for future. In this research the authors are using different keywords that relate with the research area. They are also searching for the articles, published journals and various documents of the well known researchers that are related to eHealth, eHealth service i.e. the medical information about the patient, interoperability, and standards for interoperability and how the network protocols can play a significant role. These materials are assessed through Blekinge Institute of Technology (BTH) library, IEEE, ACM and different journals. Literature review helped the authors to have information about the eHealth services concerning the medical information about the patient that is helpful by having interoperability. In this study, authors focus on the existing challenges and benefits to the interoperability among health care center, standards for interoperability among different health care organizations and also the way to have interoperability between municipality health care and hospital.

3.3 Informal Discussion

In this research the authors has started face to face informal discussion with Doctorate students and many individuals who have working experience in eHealth projects. Authors got positive feedback from the students as well as people having expertise which help to emerge the core problem in e-health interoperability and also helped us to design Interviews.

3.4 Interview

In order to give a theoretical support to the study, authors aggregating sufficient data and then will conduct interviews to the related personnel. The main reason of conducting interviews is twofold. First, it will provide further facts and a support to already gathered qualitative material in this research. Second, it will also provide a prospect to do an in-depth enquiry for identifying the benefits and challenges involved in implementation of interoperability. Also about the use of appropriate approach of information and technology which can be useful for having an interoperability among health care centers. To better serve the purpose, authors will prepare some open ended questions which can help interviewees to speak and share his/her ideas comfortably about the scope of the research. Audience for the interview will be carefully selected. It is considered that the interviewee should know about the general trends of interoperability, information needed to exchange among health care centers and the current challenges for implementing the interoperability.
3.5 Questionnaire

Authors designed the questionnaire and make distribution to the different medical & IT administrators of the county of Blekinge. All Personnel were experienced regarding the interoperability and especially the strategy makers and health planners had a concern with implementation of Interoperability. They answered the questions according to their knowledge and experience regarding interoperability. The purpose of the questionnaires was to obtain both the qualitative and quantitative study in order to support the findings of our work. The questions were in such a way that the medical IT administrators of Blekinge can provide their opinions about interoperability, a way achieving interoperability among health care organizations and how they can get advantage through employing of interoperability in Blekinge municipality health care centers and hospitals.
4 THEORETICAL WORK

4.1 E-health overview

Petra Wilson said in the conference held in 2005 that term eHealth is concerned not only with the doctor’s desk having PC but eHealth is associated with the diverse domain containing various tools, applications dealing with several events and functionalities [26]. G Eysenbach [27] has also depicted about eHealth that it is a field which intensifying in conjunction with medical informatics, public health and commerce. It is also referred to different health care services and delivering the medical information through the use of information technology. In contrast, an improvement is inevitable for the health care not only locally and regionally but also globally through the use of information and communication technology (ICT). Regarding this, the term characterizes reflecting not only a technical aspect, but also focusing a mindset, a way of assessment, an approach and a pledge towards network [27]. In European commission First Level eHealth conference on 2003 [28], Denise Silber discussed that users of eHealth are growing globally and today patients are much cognizant regarding their health as in past.

According to this conference, following are the figures:

• Almost 600 million persons are facilitating by internet worldwide and 37 % out of them are those who use English language as their native.
• In Europe, internet surfing level is far above the ground.
• About half of the physicians from the whole using Electronic Health Record (EHR) and 90 to 95% are those who belong to Nordic countries and rest of them about 20 to 35 % are belonged to the South Europe [28].

4.2 Role of Information Communication and Technology (ICT)

Information and communication technologies (ICT) has provided a platform for improving the health care systems for patients and also helping different healthcare stakeholders and decision makers to provide better services to the citizens. It is because of the usage of ICT, citizens and patients can get access to unproblematic, guaranteed and quality information on healthcares. And also they can find the separation between clinical information and their personal data with respect to their treatment and health significance. The major advantage of ICT platform is that patients would acquire health care services using internet and would take assistance for their self treatment easily. ICT will also provide health care professionals for accessing the ICT systems by logging through single interface of health care systems.
In this era, ICT is growing and is affianced with the health care infrastructure for several purposes using various ways [29]. L. A. Ogunsola also presented that information and communication technology (ICT) has significantly given a revolutionary change to state of mind. It mainly comprises of system which is constructed for the transformation of information [30]. ICT has put tremendous efforts not only for the changes in healthcare systems but also in almost all sectors of informative life. Now, a gesture of globalization is been evolved rapidly through the significant grow of ICT and improving day by day [7]. ICT based systems are directly concerned with the objectives of health care policy, therefore considering it, different countries reviewed their policy plan regarding health systems. Keeping in view the importance of eHealth, 10 countries have acquired it as a national strategy for the overall health system, and other 14 countries are also setting their objectives with respect to the cost and quality of health care services and going on for reforming. And in 13 countries, ICT not only influenced the health sector for the development of society and set goals but has essentially integrated with the policy of government of healthcare [7]. Figure 4.1 show that Sweden has implemented ICT ranges from 90-95 percent in the health systems.

![Using computers](image)

**Fig 4.1:** Trends of Healthcare centers in Sweden and other European countries [77]

### 4.2.1 Role of ICT in Swedish health system

The National strategy of Sweden for eHealth has depicted that ICT based tools have offered several advantages for healthcare domain such as improving the patients, healthcare
stakeholders and different strategy makers. Depending on appropriate usage of ICT in health domain, citizens and patients would get services in a better way and according to various situations and their capabilities they would interact with healthcare for treatments very easily [7].

This strategy also stated the main benefits of ICT regarding ehealth that citizens can have an access through internet and patients will be easily engaged in taking healthcare services from the different healthcare organizations [30]. In addition to this, using the ICT in healthcare sectors, elderly citizens, patients and also healthcare professionals will have accessibility to the interoperable and well disciplined healthcare solutions for helping them to perform their work easily. This also gives assurance about the safety and security of the patients regarding health care purposes [7].

The role of patient is very clear in the use of ICT strategies while England is concerned with the implementation of IT infrastructure which aims to enable patients informed health choices. Several countries are going to put into action ICT based tools among healthcare organizations. Example is an attempt of Portugal by planning to endorse citizens more centric towards the health system. As for as ICT is concerned, the countries like Sweden, Norway, Denmark from the Scandinavia have already used in their healthcare organizations to facilitate citizens [31].

Sweden has established their own health care system in 20 county councils and 290 municipals councils. The main responsibilities of these health care centers are to provide better quality of health services to patients. In Sweden the different primary healthcare centers and hospitals many ICT based tools are implemented. ICT has not fully implemented in Swedish health care system because there are several reasons like difficulty to agreeing on the specific requirements for interoperable ehealth solutions. Many of the ICT based tools are working in primary cares and hospitals but their usage is only for small fraction of the tasks they are capable of sustaining and interoperability is limited [7].There are also some economic reasons that’s why all county councils should cooperate on ICT related issues at national level [9].

4.3 ehealth services regarding patient information

ehealth provides many services for the patients or citizens for their healthcare. Some services are described as under:

4.3.1 ePrescription Service

According to [7], in a situation when different patients coming towards different municipality healthcare centers want to have their eprescriptions but unfortunately due to lack of interoperable environment this is impossible to get this from Blekinge hospital units
Therefore, in accordance with the [7] if the interoperability among the systems of different healthcare organizations is achieved then all the Blekinge Citizens would be facilitate through eprescription [7].

4.3.2 Electronic Health Records (EHR)

The Electronic Health Records (EHR) is based on the electronic structure of medical information. An EHR basically go for following the requirements and significance of diversity such as healthcare services, services for providing rescue, patients and healthcare community and other scientific organizations [31]. There are about six nations that already designed their own electronic cards to store the medical information for hospitals and municipality healthcare organizations. But these healthcare organizations use it locally and not in a fully interoperable environment. In this regard, Luxemburg facilitates its citizens through maintaining and using radiology records and in the same way Sweden uses a medication record to serve citizens. Countries like Germany, Sweden and Turkey are putting some efforts for structuring a patient summary [31]. The municipality healthcares and hospitals are using EHR system in all of the Sweden. Swedish Association of Local Authorities and Regions (SALAR) provide a collaborative platform for the National Board of Health and Welfare to work together and working on a project InfoVU to enhance the facilities to different stakeholders of healthcares. The main goal of it is to give a platform to collaborate the healthcares and also providing the improved communication among different health care providers [9].

4.3.3 Electronic Patient Records (EPR)

According to [7] in comparison with the other countries there is about Percentage b/w 88 to 90 is using documentation related to information of healthcare in a digital format in the Blekinge County. This is identified by the Strategy makers within Blekinge County [7]. Accordance with the [7], there is a requirement for the implementation of same EPR standards in all the municipalities’ healthcare organizations within the Blekinge. According to [7], if EPR standards are used in a same format at both sides of the systems then it is easy to exchange medical or clinical information of patients with one another. Also accordance with [7], using the same EPR standard in different healthcare centers, would be a better choice for Sweden to follow for better interoperability of Medical records [7].

The Electronic patient record EPR is knowledge base in its nature [76]. Below is the representation of EPR for Blekinge citizens using figure 4.2. It shows that in EPR, patients have disease patterns and clinical conditions and according to the role specification of patients their digital clinical document is formed and is administering at different locations of the Blekinge. Notation 1 means one entity and * means many [76].
Figure 4.2 of Electronic Patient Record for Blekinge
4.4 The European Union Plan for Interoperability

European Union Action Plan for eHealth is specifically concerned with interoperability. According to the facts, not all countries of Europe have yet implemented interoperability inside the hospitals and other healthcares but there is almost 1/3 of European countries have shown their overt interoperability through fact sheets [31]. This EU Action plan encompasses objectives in several aspects, which are given as under:

- Developing a proper infrastructure of information technology within and among different healthcare organizations.
- Providing an Internet access to every health organization.
- Developing a trend to give access to the essential healthcare information.
- Increasing the health related education and promotion in different health care organizations.
- Giving protection to healthcare data in order to provide privacy as well as security.
- Providing interoperability among different healthcare organizations regionally, at country level and across the border [31].

EU is making constructive plans about how to collaborate among different health care organizations. The key ambition of this action plan is to give framework for providing the safety, privacy and also a security to the information of patients during their medical treatment inside the health care and in another country. There are 12 EU countries that have made the agreement for cooperating with each other in order to do work jointly on a project named as “epSOS”. Their aim is to give more concrete eHealth services outside the country [36].

4.5 Interoperability

“Interoperability in health care information is the capability of health information systems to work together within and across organizational boundaries”. It is important that systems must comply with agreement on type of information sharing and also with the type of using standards [37]. The systems and technologies are inevitably collaborate each others for sharing complete information by having diverse formats as well as structures, only if an integration of various enterprises take place. Sharing of such kind for the information in transparent manner is not easy obligation that emerge a complex issues regarding both the compatibility as well as interoperability [24]. Interoperability is considered as a broad concept and already many definitions been proposed for the interoperability that are relevant with both the fields academic and industry.

Following are the important definitions for interoperability and as given as under:
According to IEEE [38],” interoperability is the ability of two or more systems that is used to exchange information and to use this information that has been exchanged. In the field of eHealth applications “Interoperability means that the ability to communicate and exchange data accurately, effectively, securely and consistently with different information technology systems, software applications, and networks in various settings and exchange data such that clinical or operational purpose and meaning of the data are preserved and unaltered”[39].

4.5.1 Levels of Interoperability

There are three interoperability levels used for solving interoperability problem. These include physical level interoperability, content level interoperability, and specification level interoperability [40]. And also there exist two layers of interoperability i.e. syntactic interoperability and semantic interoperability. These levels are concerned according to the particular interoperability problem and might relate each others. Syntactic and semantic interoperability should be involved in almost all levels because in any interoperability problem there requires an acknowledgement of same information delivery on the destination.

4.5.1.1 Physical level interoperability

According to this level, electronic media like floppy disks, chip cards and magnetic tapes are used for achieving interoperability by transferring the information physically. Regarding this scenario, the transmission of information takes place manually among the different applications. First the information is stored from first application into physical media and then is reentered as an output data into another application [40]. Application of tele-electrocardiography uses this kind of interoperability and normally with known format of data. It uses magnetic tape, chip cards and floppy disk as transmission medium among stations. It is a generic level of interoperability and difficulty at this level is resolved mostly by the electrical engineers, and also computer scientists put some efforts to overcome problem by using several storage standards [40].

4.5.1.2 Content Level interoperability

This level is concerned with the content and structure of the data that is to be transmitted among different systems. At this level of interoperability, designers focusing the schemas and models for designing databases to resolve the issues. The formatting as well as presenting of the data like ECG reading requires an appropriate manner in which data using by one application on a particular machine can also be used by different application on another machine. More specifically interoperability with a standard Like Health Level Seven (HL7) is associated with this level. Usually, requirement of this kind of interoperability is the usage homogenous databases and same formats for data storage. Most of the solutions at this level are made for database designing [40].
4.5.1.3 Specification level interoperability

According to this approach, an interoperable platform can be achieved at software application level having heterogeneous database. In order to provide solutions at this level, there involves standards like HL7 and methods for object oriented software for distributed environment [40].

4.5.2 Layers of interoperability

There involves two layers of interoperability.
- Syntactic Interoperability
- Semantic Interoperability

4.5.2.1 Syntactic Interoperability

Syntactic interoperability is referred to as if two or more systems communicate and exchange data, they demonstrate syntactic interoperability. More importantly both specified data formats and communication protocols are fundamental in this regard. In general, syntactic interoperability is achieved by XML and SQL standard. For lower-level data formats like guarantying characters store in ASCI format in the systems that communication. Syntactical interoperability is need for other efforts towards interoperability [42].

4.5.2.2 Semantic Interoperability

Semantic is referred to as meaning and expression. Thus, Semantic interoperability is concerned with the “the ability of information systems to exchange information on the basis of shared, pre-established and negotiated meanings of terms and expressions”. Semantic interoperability is required for the syntactic interoperability [43].

This type of interoperability gives surety about message delivery at the receivers end. It means the acknowledgement of message delivery at the destination. Regarding semantic interoperability, the aspect of semantic mediation plays an important role in the healthcare domain for clustering the data through heterogeneous sources. The core purpose of semantic mediation is to have an alteration of medical messages already characterized in one standard format into another format as can observe through considering the scale of the Artemis project [41].

4.5.3 Challenges to interoperability among healthcares

The main purpose of having interoperability among healthcares is to exchange information among them. This requires an interfacing and integration among healthcares. Thus, the interfacing and integration are important to consider for having interoperability [44].
4.5.3.1 Interfacing

A boundary at which interaction occurs between two systems or processes is called interfacing [45]. In computer science terminology, there are three types of interfaces: user, hardware, and software interfaces. For instance, a software interface according to Webopedia, defines “the languages and codes that the applications use to communicate with each other” [46].

4.5.3.2 Integration

It is the combining the diverse applications into a relationship for functioning as a joint collaboration of several system components to form a single entity [44]. Integration must involve a specification of appropriate standards and communication platform that possibly give interoperability among healthcares, otherwise integration would not takes place [44].

4.5.3.3 Accessibility

It’s very important to focus on the accessibility when different healthcare organizations communicate each other. The question raised who can access the shared information and at which level particular user can access medical information through the system? So, it’s better to provide a way for accessing clinical shared information through the systems [76].

4.5.3.4 Privacy

Accessibility is followed by privacy. Once information is accessible then there is problem arise known as privacy. In order to handle privacy there should be an access to the information only by the authorized users who have permission to use the system [76].

4.5.3.5 Security

In order to distribute the patient medical information to the patient itself and to other healthcare organizations, according to Health insurance portability and Accountability Act (HIPAA) there is a need for the proper authorization and consent to interact with the medical information. Most specifically who is going to access patient data and at which level can access and when can access. This is implicitly endorsing the procedure for distributing the patient medical information. But for this, healthcare organizations to should provide appropriate level of security and also ensure their systems give security [81].

4.5.4 Benefits of Interoperability

It is because of the data exchange by implementing the interoperability that the healthcare professionals can get absolute medical information about any particular patient. By espousing the interoperability, a patient can easily know about his health situation by having
appropriate information. Also only the interoperable world can provide access to the individual medical records and similar kinds of accessing approaches. It is only because of interoperability, a patient can easily travel among different healthcare centers without considering that his information might be lost [47]. Several benefits can be achieved through the interoperability. These are as follows:

- Citizens would able to share their information regarding health even if they travel outside the country or broad.
- Through the regulation concerning interoperability among different hospitals, primary healthcares and also Dental Services, citizens would get extensive benefits.
- Persons would have a choice among different alternatives in order to have their medical treatments.
- There would be Accessibility for the people to eHealth services anywhere at any time if they require.
- Through it, an EHR can be accessible not inside the country but also among EU countries.
- There would also be a reduction of cost for the health care if interoperability among healthcare systems is achieved.
- It will be possible to have a proper Verification of Electronic Identification Card (EIC) among different EU countries [7].

A recent study estimated that if data exchange standards were utilized across the health sector then it is estimated that the saving of approximately $78 billion could be achieved in US health care [48]. According to [49] patients will get fast and quick response, reduce telephone calls and it enable healthcare professionals to better diagnose.

### 4.5.5 Interoperability among Swedish Healthcare

Sweden occupied 21 county councils which are self governing and liable for providing services through hospitals and other primary Healthcares. There are 290 municipalities that are giving health care amenities to elderly people. Thus, there requires an integrated environment or collaboration in order to facilitate the same patients locally. In Swedish context, the usage of Patients medical information is in a manner that at Municipalities Healthcares is 97% and at Hospitals is 81%. But among these hospitals there involve 6 products covering only 5% of the market that wrap up 90% of the digitalized information. However, it happens that no communication occurs if local systems interacting each other [53]. And the Swedish 290 municipalities or local authorities give services to the citizens at their homes and also offering special accommodation for their residences. Not only hospitals and other healthcare centers but also home care units are completely computerized.
A ratio of people interacting with computers is high almost in all Sweden [54]. Moreover, there were different projects were commenced and carried out not at regional level but also at country level. These projects were concerned with different facets regarding the applications or services of eHealth.

Some of these include [31].

- In order to have a Document for a care administration, an InfoVU-project is very useful.
- The government is very much concerned for supporting evaluation and deployment of SNOMED.
- There is also a National Patient Summary has already instigated.
- Sjunet is a secure communication network using in almost all county councils, municipalities, healthcare suppliers and are connected through it. Communication cost is reduced using Sjunet and providing accessibility of healthcare services [73].
- A project of CarelinkPLUS has designed a reference architecture which is mainly used for providing a communication platform to collaborate systems for different organizations.
- For health care specialized personnel, harmless solutions of IT verification have been designed by the influence project named SITHS.
- In order to facilitate citizens, a health portal is designed by the project for National Patient Advice.
- According to the report submitted by Guohua Bai, OVK is a project started in 1997 in the Blekinge region of Sweden. It’s an abbreviation of Seamless healthcare chain supported by ICT (Obruten vårdkedja med IT–stöd) project. The objectives of the OVK project was to have a documentation and secure communication of all medical information about patient transferring among different healthcare organizations. It also focused on developing a digital platform in order to support information necessary information of healthcare [74].

According to regulation (SOSFS 1996:32), provide a proper structure to collaborate different care providers for transmitting healthcare related information [74].

4.5.6 Implementation of Interoperability among different Healthcares

It’s very difficult to manage information of patients in large hospitals and municipality healthcares because it is stored in a complex way and more specifically the systems are different and working separately. It’s a well known existing issue that there is a lack of interoperability among these systems by which medical information cannot be shared among different healthcare centers including municipality healthcares and hospitals. It’s not easy to handle the Clinical information as it aggregates in a complex way. Usually applications store
or represent data in a different way. Data presentation using free text is not difficult for a human to easily manipulate but automatic processing makes more complexity for its handling [5]. These requirements can be fulfilled with the use of Health standards.

The Health Level 7 (HL7) can be more beneficial in order to make interoperability among the applications related to the different systems [55]. One of the main problems in health care domain, that there is no interoperability among different health care organizations. Interoperability among municipality healthcare centers and the hospitals is important by which clinical information can be exchanged between these health care applications. By having interoperability reduction of cost would takes place for health care. The Municipality can facilitate patients coming to their healthcare centers after hospital treatments by accessing the patient’s information.

4.6 Health Level Seven (HL7)

Patients need to have their medical history along with them. A hospital may have issued an access code for the patient of his/her medical history but on the other hand if this information is managed and used differently in other health care center then this leads to a usefulness of this access code. This leads to a challenging task for the health care centers in the absence of information at right time and right place consequently affecting the cost, safety and effectiveness of the healthcare. Healthcare centers have to cater with the dissimilar information. These problems arise due to the data exchange between and within healthcare centers [56]. Use of standards in health information system reduces interoperability problems. Interoperability is discussed in three different aspects which is technical, semantic and process interoperability. The HL7 standard is used for the management, integration and exchange of data. It also facilitates the healthcare providers with many services. HL7 provides interoperability standards. These standards enhance the workflow, exchange of data and clinical record and reduce the ambiguity of healthcare providers. It is not for profit organization. HL7 specify the way in which healthcare organizations and healthcare providers have the guidelines and methodology and different standards to communicate with each other. These standards permits the different applications to exchange clinical information between them and helping to enhance the interoperability. HL7 contains many standards which includes [66].

- Version 2.x Messaging Standard
- Version 3 Messaging Standard
- Version 3 Rules/GELLO
- Arden Syntax
Moreover a patient may visit to several hospitals and medical care centers forming a distributed medical record. If some patient like elderly person may have visited the hospital and due to the continuous care treatment he/she needs to move the municipality healthcare centers then his/her medical information should be retrieved correctly and efficiently at the municipality healthcare. The communication of medical information among hospital and municipality is an important issue. Many architectures and framework has been proposed for the exchange of clinical information. HL7 has also proposed a comprehensive framework for the record sharing and exchange of clinical information like electronic health record, message sharing and discharge report etc. HL7 rely on reference information model (RIM). HL7 V3 provides a standard which helps the vendors to conform their products and can be testable. HL7 v3 messages originate from RIM and use object oriented methodology. RIM provide explicitly the semantic and lexical of the messages exchanged in HL7 and it is part of HL7 v3 [56].

4.6.1 HL7 Clinical Document Architecture (CDA)

Clinical Document Architecture (CDA) is an ANSI HL7 standard, release 1 is approved in 2000 and release 2 in 2005 [57]. HL7 standards use comprehensive style of clinical information. CDA Release 2 uses the XML format [58]. HL7 is next step to version 2 and enhance the capabilities in process and outcomes. HL7 V3 uses Object Oriented methodology and UML principals. It is easy to represent in graphical representation. HL7 version 3 Reference Information Model is the core structure of the Clinical Document Architecture. It is used in the information content. CDA document have XML schema which contain the content of information in tags. It contains body and header. Medical record, its supervision, authentication, and others clinical data related record is stored in tags. The body of the document may have structured and unstructured contents. The unstructured part of the document contains the non XML contents. CDA documents also have external reference which may be used for the hyperlink, sounds, multimedia and image completing the clinical information in a more comprehensive way [59]. Figure 4.2 shows the structure in which content of clinical information is arranged using the CDA Header, structure Body, section, text, and entry and observation tags.
CDA focuses on the six objectives in a clinical document. This is as under:

- Tenacity of the document
- Clinical document should manage other properties
- It should have some authentication mechanism
- Should be context related
- Completeness of the document
- The document should be readable

CDA document can have medical content of every type like discharge summary, inpatient and outpatient record summary, reports from different departments. It is an XML but can also use non-XML content like jpg, word and pdf for implementation [74]. Mayo Clinic are producing large amount of CDAs daily and they reach up to 50,000 notes/week. They consider this document as strategic information for reusability in different applications. Today many applications have been developed for these documents managing, generating and viewing the clinical information. CDA is developed in XML so it is compatible with any application which is compatible with XML like internet browsers (Mozilla, Opera, and internet explorer). This information is parsed into a HTML document using XSL style sheet for displaying and any XML repository can store this information [56].
Different vendors have different ways for producing CDA document and give an output in CDA format. Also electronic health record vendors convert the original format into CDA document. Many desktop technologies are using eForm applications which results in creating a CDA document. CDA have a challenging problem using available technology is that information is not sufficient for the conversion of the document at source, but this has been tackled with the application having input functionalities. The step by step semantics in a CDA document is a key concept to address interoperability, since it provides the user to find out their level of interoperability for completion of tasks and set accordingly their complexities in the specification. According to fig shown above a CDA document contain XML metadata and can have few fields like document provider, name and identification etc and body may contain few MIME type data like word, pdf and scanned files of images [56].

Some applications like decision support cannot translate the body part of the document so some metadata standard and display characteristics are set in a document so that they can be produced and categorized using some richly encoded documents. This CDA document is translated using HL7 RIM model and LONINC, ICD, CPT, SNOMED are used for the translation of the vocabulary. Semantic interoperability is addressed with the levels of CDA document. CDA document support application like decision support than it may be called as full semantic interoperability because these documents are not designed for that applications and document can be used in a multipurpose ways. So levels basically give the concept of how receiver of the document can use the automated process of the document. Level one of CDA document is used for a simple standard based header which has simple body with no extra functionality. Level two of CDA document gives a relatively extra number of functionality than level one with XML body and coded sub sections. Level three of CDA document provide both level one and level two functionality and some extra coded information in the section part of the body [74]. CDA release two is using the RIM and include the functionality in the CDA body. The RIM structures and the use of vocabulary in the medical statement model is the important addition to the CDA document which improves
and enhance the semantic interoperability whereas in release 1 the body contain only coded entries which have not a good expression [56]. The standard DICOM is used in applications to view the multimedia and graphics files of the CDA document [59].

4.7 Distributed Computing

A distributed database system (DDBS) is concerned with combining both database technology and the network technology for computing [60], [61]. A distributed database system relates with nodes or systems at different locations linked together and communicate through a network. These nodes may belong to the same location like building or situated at distant. Data is arranged logically and is related with the databases in a distributed environment through a network. In this kind of computing, a user can have an accessibility of data not only with their local databases but also with databases of different nodes in a network [62]. In a modern age, a distributed environment is more useful especially when organizations working separately.

4.8 Peer to Peer paradigm

Peer-to-peer computing is new field in this era and it is distributed in nature. Peer-to-Peer involves a mechanism in which different participants share their resources and use services of each others. In P2P computing there is a concerned with combining several resources to make a distributed system having much reliability. In this environment, every participant or a node is known as peer. Each peer performs various roles. Some times in order to access information they behave like clients and to serve information they behave as server and for forwarding information they act as routers [63]. According to figure 4.4, the conceptual framework of peer to peer network shows that when peer provides services on requests to other peers it refers to as Master peer or Server peer. The peers at different locations requesting information are called Client peers.
Fig 4.5: Conceptual framework of Peer to Peer network [73].
5  **EMPIRICAL WORK**

5.1  **Interview**

According to Kvale in 1996 [80], interviews are used to search and describe the basic theme of investigating subjects. The major task for conducting interview is to have better understanding regarding the interviewee’s perspective and as a resulting getting useful information. The interview process is mostly used for the qualitative research work. In this study, authors conducted interviews with the personnel working in eHealth sector. All of them have a well understanding about the interoperability.

5.1.1  **Purpose of the interview**

In this study authors have conducted three interviews with the experts having a purpose of understand existing working systems among municipality healthcare centers and the Blekinge hospital. Also, to know about what are the barriers in the way of having interoperability among the municipality healthcare centers and hospitals in Blekinge Sweden? Due to which there is still lack of interoperability among these healthcare organizations. The interview conduction was mainly focused on investigating the interoperability among different healthcare organization.

5.1.2  **Planning of Interview**

All the interviews were conducted in a descent way without any hurdle. These held at different locations of Blekinge. One held in Ronneby Municipality and two were form the Wämö center Karlskrona. For the first interview time schedule was 50 minutes which we conducted in Ronneby Municipality from the Ulf Danielsson and then author conducted second interview with Anders Christenssson and the duration of this interview was 55 minutes. The third interview was conducted form the Thomas Pehrsson from the Wämö center Karlskrona and its duration was 60 minutes.

5.1.3  **Designing the Interview**

The authors asked questions in formal and informal mode from the interviewees about the interoperability among municipality healthcare centers and hospitals. The question sessions with the interviewee were very much concerned with the interoperability, challenges for the interoperability, and the complications that result the lack of interoperability among health care centers and also about benefits if the professionals or patients get the interoperability among municipality healthcare centers and hospital. The authors formally designed different
questions related to investigated area i.e. interoperability among healthcare centers. These questions really helped the authors to oversee the actual vision of the professionals having an experience and their jobs closely related to the investigating domain. Informally, the authors had a discussion having different questions related with different systems using in municipality healthcare centers and hospitals. Depending on the findings of interviews authors came to know about what lacks for interoperability and also how can have interoperability among municipality healthcares and hospital for facilitating the patients and healthcare professionals.

5.1.4 Selection of interviewees

According to the research questions, authors conducted interviews with three persons namely as, Ulf Danielsson, Thomas Pehrsson and Anders Christensson one in Ronneby and two in Karlskrona. Ulf Danielsson is the Medical IT administrator of the municipality healthcare centers like Vidablick. He is working in the Ronneby Municipality. He has worked for several activities in Health sector. Now he is responsible for providing IT Health care services to the patients coming to the municipality healthcare centers from the hospitals and providing home care services. Thomas Pehrsson is Health Strategy Maker working in the Blekinge County. He is responsible of making the health strategies for different health care centers and hospitals. Now, he is doing his work as Strategy Maker and sitting in the Wämö center Karlskrona. Anders Christensson is a nurse (doctor) in Blekinge hospital in Karlskrona. He served for many years and also has a responsibility to work as nurse for emergency in the hospital. He has worked in different medical companies and has been a medical instructor. He is dealing with emergency department for treating the patients.

5.1.5 Collection of Data

The data collection was documented and recorded during the interview sessions with all interviewees. Afterwards, authors arranged the data in an appropriate way. Anders Christensson helped the authors in collecting this data. He has shared his views about interoperability among different healthcare centers. He has also told about the system of a hospital and how patients can get benefits if there is interoperability. Ulf Danielsson helped us to know about system of municipality healthcare centers. He talked about the national strategy for the interoperability and also the vision for future plans for having interoperability among the municipality healthcare centers and hospital. Thomas Pehrsson also did help regarding data collection and told us about importance of standards for interoperability. He also explained about the issues of interoperability, services and the National strategy about the interoperability regarding eHealth.
5.2 Questionnaire

Questionnaire conduction for gathering the data is an appropriate way and also cost efficient. In order to get comprehensive information from multiple locations, a well structured questionnaire would be a better choice. However, in this regard, for having information about specific domain questionnaire can be more effective.

5.2.1 Questionnaire Planning

In order to give strength to this study, the authors make a plan for conducting the questionnaire. The authors decide to do questionnaire in the county of Blekinge about the ehealth services in one part and in other part of questionnaire are related to the people who are working with primary healthcares and hospital about the interoperability. That if there is any interoperability among these hospitals and these healthcare centers then what will be the benefits to the citizen and other stakeholders.

5.2.2 Designing a Questionnaire

The authors conduct few interviews orally and also discuss the matter with the personnel belong to municipality, hospital and the teachers having the knowledge about problem domain. After that the authors design the questionnaire with the IT administrators and strategy maker of healthcares. Some questions are included in the questionnaire for knowing their opinions about interoperability among the municipality healthcare centers and hospitals. The authors also included some questions for asking about the possibility to have interoperability among the municipality health care centers and hospitals. The basic motivation to concentrate on the healthcare experts is that as they are currently using the systems, it’s important to know about their satisfaction level for using the systems that lacking interoperability among municipality health care centers and hospitals. As going through the design phase of this questionnaire, the authors were also considering that how can possibly cover the problem area regarding the interoperability among different organizations. They were also focusing in which way they can suggest an appropriate solution or can propose an idea to have interoperability among the municipality healthcare centers and the hospitals.

5.2.3 Questionnaire Selection

There is different technique for data collection but questionnaire is economical regarding design time and interpretation. The administration is very easy and if there is resources and money deficiency then this method is a good alternative. It can be useful in a limited time frame because target users can be accesses through emails and results can be obtained in a single day. For self administrators questionnaire data confidentiality can also be maintained.
5.2.4 Conducting a Questionnaire

This chapter will depict about how the authors are involved in conducting the questionnaire within the county of Blekinge. They will go through different phases like the questionnaire planning, the designing and more importantly the analysis of the questionnaire. The chapter also exhibits the related subject in order to conduct the questionnaire. Through this chapter, authors will tell about the questionnaire circulation to different people. There will be a discussion about those questions that authors would ask through the use of questionnaire. Most important thing to consider during this questionnaire process is the selection of people for having answers of the questionnaire. In this regard, due to some technical questions, the questionnaire distribution would be focused on three kinds of people that can answer in an appropriate way. So, the readers must understand while go through the study of questionnaire. According to this questionnaire, there involves people including health professional, IT administrators and the strategy maker for the health sector.

5.2.5 Questionnaire Distribution

The next phase is to circulate the questionnaire when we complete the planning and designing phase of the questionnaire. The circulation is carried out with printed copies of the questionnaire. Brief introduction of our research is added that how we have designed the questionnaire, why there is a need of interoperability between hospital and municipality healthcare center and how we can contribute and suggest some methodology to achieve interoperability. We have emphasized on the valued contribution in the questionnaire so that we can contribute and find some good mechanism of interoperability. We would distribute questionnaire to the four professionals in medical IT administration of municipality and the hospitals and their feedback from the questionnaire will help us to analyze and for suggestion on interoperability between municipality and hospital.
6 RESULT & ANALYSIS

6.1 Analysis of Interviews

The authors translated the recorded form of data of the interviews into the text layout. The authors conducted interviews following which they collected data in order to analyze extracted information that perhaps don’t reflect through different literature or missing in some context. By having interviews with Health service coordinator, healthcare professional and eHealth strategy maker, lot of information relevant to the interoperability among the municipality healthcare centers and hospitals. The authors also acquired information regarding different challenges for the interoperability and also benefits for the patients and healthcare professional if it is attained. Next to the interviews conduction authors perform analysis on the current issues that municipality healthcare centers and hospitals that are in the way of having interoperability. These interviews helped for analyzing the problem domain and more specifically about the how to have an interoperability among the municipality health care centers and hospitals.

6.1.1 Interoperability among Municipality Healthcare centers and Hospital

According to Ulf Danielsson, in question 2 that Municipality Healthcare centers using a system called MAGNA CURA. This is using in all of their healthcare centers like Vidablick, Ågårdsbo, Olsgården etc. He has informed us that all these healthcares are connected and interoperable with each other because they are using the same system “MAGNA CURA”.

According to Anders Christensson in question 2, there are two hospitals serving citizens. These are situated in the Blekinge County. These are situated in Karlskrona and Karshamn and are also interoperable with each other and can share information. According to Anders Christensson in question Blekinge hospital using the system “SYSTEAM CROSS” and Hospital is not interoperable with the municipality Healthcare centers. It creates a problem for patients and healthcare professionals for having information.

6.1.2 The challenges for Interoperability

According to Ulf Danielsson, there is problem facing by the patients and Healthcare professionals due to the lack of interoperability among these different Healthcare organizations. According to Ulf Danielsson in question 4 and Thomas Pehrsson in question 10, proper integration, interfacing, access control, privacy, security, operational and
administrative cost etc are the challenges and most importantly the implementation of standards.

6.1.3 Vision of Interoperability

According to Ulf Danielsson in question 6, there is need for the patient’s information not in a paper form when patients come to Municipality Healthcare centers for further care. Now, we are focusing on separate systems which should be interoperable in a recent future. In future, there is an expectation that all Healthcare systems would have a National Database for accessing information.

6.1.4 ICT role in interoperability

According to Thomas Pehrsson in question 4 that ICT has substantial role in implementing the interoperability among healthcare centers. The application should be ICT based and to use these applications there should be some ICT infrastructure.

6.1.5 The goals of interoperable system

According to Thomas Pehrsson, There should be continuity regarding the care. Clinical information should be in a document right information should be available at right place. Decision should be on the safety and security of patients. There should be cooperation between healthcare professionals.

6.1.6 Advantages of interoperable system

According to Anders Christensson and Thomas Pehrsson in question 4 and 12, no doubt interoperability is beneficial for the patients who would able to receive medical information through a document form not a paper form. They can take better care because of quickly response and safety of medical information. In the same way medical professional can also give quick response when the patients come to Municipality Healthcare center from the Hospitals.

6.1.7 About Swedish National Health strategy

According to Anders Christensson and Thomas Pehrsson in questions 5 and 13, the strategy is helpful for the implementation of interoperability and which is useful for citizens and healthcare professionals. Its aim is to connect different healthcare centers to exchange information through integration. It also focuses on enhancing the safety, accessibility and providing mobility to the patients. The Government also focusing it but the project is huge and cost factor creating resistance.
6.1.8 eHealth standards for Interoperability

According to Anders Christensson and Ulf Danielsson and in question 7 and 8, there is an importance of standards for the implementation of interoperability among different Healthcare centers. Also according to question 9, Ulf Danielsson told that these are not adopted by the municipality Healthcare centers.

6.1.9 HL7 standard for interoperability

According to Ulf Danielsson and Thomas Pehrsson in questions 10 and 8, the HL7 standard is important for the interoperability. Especially, Thomas has told that HL7 can be useful for the documentation of information of a patient.

6.1.10 Decentralized/Centralized approaches for interoperability

According to Thomas Pehrsson and Ulf Danielsson in question 10 and 15, they personally think that Decentralization can be useful approach because each system can deal with other systems or collaborate but not dependent on the Central Authority. When system expands and more systems will be engaged. Then definitely, then there will be load on Central authority when they request for data. Also distributed environment is very important for the interoperability.

6.1.11 Accessibility of information for interoperable system

According to Ulf Danielsson and Anders Christensson in question 12 and 10, there are different personnel belong to healthcare centers want to interact with the patients for their care. But using the system, for the medical record only authorized person should have an access to the patient medical information. This will provide appropriate accessibility for the medical information.

6.1.12 Use of portable medium

According to Anders Christensson in question, the idea of portable medium is not suitable for the elderly people. Because the data in a portable medium is very sensitive for their care and it should be protected from unauthorized persons. Also it is the possibility to loss and damage of this device due to the age factor.

6.2 Questionnaire Analysis

Questionnaire is conducted successfully among healthcare professionals more specifically with medical IT administrators. Questions are separated with close ended and scaling questions. Quantitative analysis method is used to get correct results, obtained from questionnaire. The results of the questionnaire are presented in graph 1, graph 2 and graph 3.
The analysis with the collected data through questionnaire results is very important and challenging task. We have analyzed the data collected from the questionnaire and relate these results with our research questions.

The data collected through the questionnaire and relate these results with our research question are very important because this gives us the direction of our research to a particular domain. This chapter presents the analysis of results of questionnaire and relates these results with our research questions.

6.2.1 Scaling Questions

This research question is related to our study of interoperability between municipality and hospital healthcare centers. We have presented the answer through literature study in Chapter 4 where we discuss the different challenges and benefit involved when discussing the interoperability between different healthcare organizations. After conducting interviews we categorize and find out the challenges and benefits involved related to our study and make questionnaire according to the satisfaction level (from 1 to 5 (1= disagree, 5= agree)) with critical consideration. We have selected seven different interoperability critical challenges with the help of literature study and interviews (Interfacing, Integration, Accessibility, Privacy, Authentication, Cost and Security) and seven different benefits to have interoperability between municipality and hospital healthcare systems. These are (Patients Treatment, Professional ease of work, Reduced work, Quality of patients care, Safety of patients, Reduced Cost, Shared clinical information) The results obtained from these questionnaire are shown in graph 1 and graph 2.

The graphs have Cartesian coordinates with x axis representing the key factors involved in challenges and benefits while y axis shows the level of satisfaction. The graph 1 for challenges of interoperability shows that privacy, accessibility and integration are major challenges when discussing the interoperability. The graph 2 shows that interoperable system has major advantages for the professional to carry out their tasks. The safety of patients will also increase with interoperable system and clinical information can be shared among healthcare centers are the big advantages of interoperability. It is also observed that for some IT medical experts administrators considered the integration, accessibility and authentication are the major challenges the interoperable system can have but some suggested that interfacing and security are also big concerns. Over all each results responded that privacy, accessibility and integration are major issues and cost is less in the list of challenges. The results of questionnaire are shown in the Graph 1. In Graph 2 it is indicated most advantageous for the interoperability system between municipality and hospital is the exchange of clinical information, the professional can easily manage working regarding patient’s medical history and safety of patients will be increased with the presence of the
interoperable system. It is also observed that some experts believe that quality of care will be increase and ultimate goal of patient care is also an advantage. The graph 2 is shown below indicating the major advantages of interoperability between municipality and hospital.

Graph 1: Interoperability Challenges between Municipality and Hospital Healthcare System

Graph 2: Interoperability Benefits between Municipality and Hospital Healthcare System
6.2.2 Close Ended Questions

In questionnaire’s question 1, 100% medical IT administrators were agree that there should be interoperability between municipality healthcare and hospital. This indicates that interoperability is undoubtedly beneficial for all stakeholders. Patients will get advantage of fast and quick care from the doctors. Unnecessary extra work will be finished.

In questionnaire’s question 2, 100% medical IT administrators were agree that interoperability between municipality healthcare and hospital is beneficial for patients, professional and other healthcare stakeholders. This indicates that there is a need of information exchange between hospital and municipality in order to bring better working environment for the professionals to interact with patients.

In questionnaire’s question 3, 85% medical IT administrators were agree that ICT platform can play a vital role in obtaining interoperability between municipality healthcare and hospital. This indicates that the use of ICT in eHealth is increasing day by day.

In questionnaire’s question 4, 90% medical IT administrators were agreeing that both systems should implement standards. It means that without implementing standards it is very difficult to get interoperability.

In questionnaire’s question 5, 80% medical IT administrators were agree that HL7 V3 and CDA standards should be implemented for the generation of digital document to facilitate the municipality healthcare professionals for the care of patients. This indicates that patient record needs to be organized with some standardized rules and should be documented form for the healthcare professionals.

In questionnaire’s question 6, 70% medical IT administrators were agree that in order to share patient’s information, there is a need of consistency. This indicates that document shared among healthcare centers needs to be consistent in their wording and meaning.

In questionnaire’s question 7, 90% medical IT administrators were agree that decentralized and Peer-to-Peer approaches can be useful for exchanging digital document. This indicates that both healthcare organizations can exchange medical information directly using peer to peer approach.

In questionnaire’s question 8, 30% medical IT administrators were agree that some portable medium can be used for exchanging clinical information. It means that the idea of portable medium is not so much successful due to reliability of portable medium.

In questionnaire’s question 9, 80% medical IT administrators were agreeing that Government has taken initiative for the interoperability among municipality healthcare centers and hospitals. This indicates that interoperability cannot be obtained successfully without the consideration and managing this issue.
In questionnaire’s question 10, 90% medical IT administrators were agree that some communication protocol can be useful for exchanging clinical information among healthcare centers. This indicates that a communication cannot be possible without considering set of rules.

Graph 3: Response for the Questionnaire to the IT medical administrators
7 DISCUSSION AND VALIDITY ASSESSMENT

This chapter gives a discussion and assessment of validity in the thesis. Section 7.1 the authors have discussed about different barriers and benefits for adopting the interoperability and also have discussed about the way of achieving the interoperability among municipality healthcare centers and hospitals. In section 7.2 authors have discussed about the validity assessment to support the study.

7.1 DISCUSSION

In the study the authors focused on the eHealth domain in which they studied the interoperability in this area. The author’s main focus was to know about which the barriers and benefits to adopt interoperability and how municipality healthcare centers and hospitals can achieve it in an appropriate way. In order to analyze the importance of interoperability among municipality healthcare centers and hospitals they used a well organized way.

According to the results interoperability is very important among the municipality healthcare centers and the hospital and at this moment there is no interoperability among them. Also the patients have to take a paper form of medical information from the hospitals towards the municipality healthcare centers for the continuity of care. There are a lot of challenges that cause problem in the way of having interoperability.

These healthcare organizations are facing almost all of the challenges with reference to the literature. There is a need to put efforts to focus on the challenges for having an appropriate interoperable environment. It is required to resolve these issues to make interoperability among municipality healthcare centers and the hospitals. According to the results, among these important critical challenges of interoperability there are some which has more significance level to resolve and to focus on. These include adaptation of appropriate standard, integration of systems and information accessibility and privacy. According to the author’s point of view if these healthcare organizations follow the proper standards and focus the integration, accessibility and privacy then they can have interoperable systems for exchanging their information. In the same way through the result if interoperability is attained then most importantly the clinical information can easily be exchanged and patients can get better treatment if this interoperability will help healthcare professionals.

Authors also think that it would be more beneficial thing that if clinical or medical information is shared among municipality healthcare centers and hospitals. Therefore, by using the standards and overcoming the critical issues and solving them, there would be benefits for all the stakeholders including patients, municipality healthcares and the hospitals. Also, according to the literature and findings there is a need to have a document
containing clinical information of the patient. The results depict that clinical document architecture can be useful in making a medical document in digital format. Most importantly an ICT platform can support for this document to be transmitted from the hospital to the municipality healthcare centers. According to the author’s point of view if the medical document is developed for the patient in a digital format then there requires an ICT platform to transmit form one place to another. So, ICT platform can be useful in order to exchange the medical information from the hospital to the municipality healthcare centers. Therefore in order to have integrated and collaborative environment among these healthcare organizations, decentralized and Peer to Peer approach can be useful for supporting exchange of the digital document of the patients information. According to authors, the clinical or medical information must be exchanged in a secure way so avoiding portable devices there should be a proper platform to have interoperability among municipality healthcare centers and hospitals.

7.2 Assessment of validity

It is very essential to make a validation of the research study and its results. The validity assessment is essentially used in qualitative as well as quantitative research approaches. In this research work the criteria to make a validation assessment for the qualitative research work is divided into four categories. These four include Creditability, Transferability, Dependability and Conformability.

7.2.1 Creditability

Trochim has told that creditability is considered as the results of research work are trustworthy or realistic in nature. As for as participants viewpoint is concerned, they also believe on it [72]. In order to attain the creditability of the research work of this thesis authors have used mix research strategies. During the first phase of this study authors have performed a literature review and then conducted an informal meeting for the discussion about interoperability among different healthcare organizations. It was held with academic senior teachers and PhD students. After having initial findings in this first phase the authors conducted three interviews with the healthcare professionals. Then after performing analysis on the interview findings they have designed the questionnaires and circulated them to several medical IT administrators from different healthcare organizations. Then they performed analysis on these questionnaire findings. Finally, a confidence regarding the creditability is achieved through analysis on both the interviews and questionnaire in an appropriate manner.
7.2.2 Transferability

Trochim has also told about the transferability that it is the extent to which there is a generalization of the results of research work occurring into other contexts [72]. In this research study, findings are very helpful in identifying the challenges to the interoperability among healthcare organizations. Also, the findings are depicting about the way to have interoperability among different healthcare organizations by using standards and a communication platform. There is a detailed description of the context in this study. By having a proper understanding, the findings of the study can be generalized and helpful for having a collaborative environment for the healthcare organizations. As experience in a particular domain may on the study results, so there can be a possible threat regarding expertise and experience of the IT professional of the healthcare organizations.

7.2.3 Dependability

Trochim depicted about the dependability that it accentuate to have changes that occur in the context setting and also how approach towards study can be affected by these changes [72]. The authors have conducted interviews with relevant personnel and the meeting time was different. First interview conducted at 10 am and other two were conducted in the afternoon. Authors conducted first interview easily but there was a problem for having second and third interview. But after two week of the first interview, the authors have got time and conducted interviews. Medical IT administrator in Ronneby municipality and Strategy Maker both were very busy. Expert persons were not fluent in speaking English, so there is a probability that their reply to questions may be affected during interview. After 10 days of conducting interviews, the authors distributed the questionnaire. Now, there could also be a validity threat when the questionnaire distributed to the Medical IT administrators of the healthcare. There could be not proper understanding or the misjudgement of basic theme and the logic of asked questions. We conducted questionnaire with the 4 professionals form the municipality healthcare centers and hospital. The authors tried their best to cover the entire crux regarding interoperability area but there could be a probability of missing essential things relevant to the study of interoperability.

7.2.4 Confirmability

Trochim has also told about the conformability that it is an extent to which the other researchers can make a confirmation of the results [72]. In order to ensure the Confirmability, first of all the interviews were properly documented into text layout and also have presented for analyzing in different sections. Then after having an analysis, authors have presented a questionnaire to the healthcare organizations for achieving the Confirmability.
8 EPILOGUE

The epilogue is related with the conclusion, suggestions and the future work.

8.1 Conclusion

The aim of this research work is to study the area of interoperability among municipality healthcare centers and the hospitals in the Blekinge County. This research study is based on the literature review, interviews and the questionnaire with the different IT medical Administrators and other experts related to the municipality healthcares and the hospital. With the help of findings and results of the questionnaires, we have presented some critical challenges in adopting interoperability. Some of these have high significance level and should focus on and these include eHealth standards, integration and accessibility. In the scenario where there is no interoperability among municipality healthcares and the hospital yet, these is need to focus on the implementation of appropriate standards and the proper use ICT platform. Result shows that 80 to 90 percent interoperability is based on the standards and the ICT tools. But due to the presence of a lot of standards there is a problem for implementing an appropriate standard.

At this moment there is interoperability among the municipality healthcare centers and they are sharing information among each other like Vidablick. In the same way the two units of Blekinge hospital one in Karlskrona and Karlshamn can exchange medical information with each other. But municipality and hospitals have no interoperability. Patients need clinical information like discharge summary and different medical records or reports from hospitals when they move to the municipality healthcare centers for the continuity of care. According to questionnaire results, the clinical information should be in a digital document form. We conclude that this digital document can develop through the eHealth standard. But in order to exchange this document from the hospital to the municipality healthcare centers, there is a need for a communication framework that enables hospitals to share it. Also the interview and the questionnaire depicts that if there is an interoperability then there should be an access of information with the consent of a patient and by the authorized person in order to have a privacy and security for the patients information. After analyzing all the research study there is need to concentrate on eHealth standards in order to have interoperability and also focus on the ICT infrastructure because of the decentralized nature of the municipality healthcares. These also should focus on information access in a secure way.
8.2 Suggestions

According to the research study, the authors have some suggestions for the experts in the area of eHealth who are responsible for having interoperability among municipality healthcare centers and the hospital. These personnel are also putting their efforts right now and so these suggestions would help to attain interoperability among these healthcare organizations because in the Blekinge County these organizations are not interoperable yet. The interviews findings and the results analysis of the questionnaire with eHealth professionals have supported the authors to present some useful suggestions for the interoperability in healthcare organizations.

- Municipality and hospitals healthcare centers should adopt eHealth standard like HL7. HL7 v3 and CDA standard can be used for developing a digital document for the patient’s medical information using hospital database system.
- The professional who use the medical information of the patient in the form of a digital document should be authenticated by the use of device like smart card.
- Both hospital and municipality should adopt same medical and clinical terms to maintain the consistency of the digital document. This digital document can contain medical images and multimedia files.
- As municipality and the hospital health care systems are decentralized in nature, so there is a need to have an ICT infrastructure for exchanging the document of patients information from hospital to the municipality healthcare centers. So, a distributed peer to peer environment could be useful.
- A peer to peer communication would provide an environment in which more municipality healthcare centers can join to share the medical information as the scope expands.
- Peer to peer approach would provide privacy as communication will be one to one.
- As there is a need for the communication protocol that can transmit patients document from hospital to the municipality healthcare system and provide a secure exchange, JXTA protocol can be used which also supports XML language for data transmission.
- When hospital will transmit a digital document of patient’s medical information to municipality healthcare system this document could be viewed by the application browser.
- Because there are many healthcare professionals involved in care chain of patients, so in order to access the information their roles must be defined in an appropriate way to control the accessibility issue.
Portable medium such as USB, Smart card are not useful for the transmission of medical information in our scenario because most of the citizen moving from hospital to municipality healthcare centers are over age. Putting some responsibility on them in the form of this medium may create problems.

8.3 Future Work

This research study was focused on the area of interoperability among municipality healthcare centers and the hospital in the County of Blekinge. The authors put their efforts to have an appropriate way by which these healthcare organizations can get interoperability and can exchange medical information. The authors feel that their suggestions would be useful for the professionals who are currently working for achieving the interoperability. Even authors have performed a thorough analysis on the interviews and the questionnaire findings but there is a probability of missing important aspects of the investigated area. They believe that there still requires a comprehensive research study to achieve the interoperability among these healthcare organizations to facilitate the patients especially when moving from hospitals to the municipality healthcare centers for continuity of care. In future, there is a need to emphasis on the architecture of distributed peer to peer system among these healthcare organizations for its implementation and gathering the requirements of the projecting the area of interoperability. A comparative study to this study can also be made to find out the benefits, challenges of interoperability among municipality and hospital by using ICT platform with those presented in this study.
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Appendix 1: Interviews

A-Interview with Nurse at Blekinge Hospital

Question 1: What do you think about interoperability?
Answer 1: Interoperability has an importance for all stakeholders like patients and healthcare professionals.

Question 2: Are the municipality healthcare system and hospital healthcare system same?
Answer 2: No, We have separate systems. But we have two hospital units in Blekinge that are using same system “SYSTEAM CROSS” for the patient’s medical information.

Question 3: Is there interoperability among municipality healthcare centers and hospital, if not what is the impact?
Answer 3: No, both have different systems having no interoperability. This causes a problem for the patients that they cannot access information fast even not outside the country. Due to this healthcare professional also cannot diagnose patients properly.

Question 4: What is your opinion about the interoperability that it can give benefits to the patients and other healthcare personnel?
Answer 4: No doubt, if there is interoperability among these healthcare organizations, then all stakeholders can get benefits. Especially a patient can get a document of medical information that municipality healthcare requires for further care.

Question 5: What do you think about Swedish strategy for interoperability and tell us what is role of government?
Answer 5: According to the strategy, there must be interoperability which is useful for citizens and healthcare professionals. It also tells about to make a connection among different healthcare centers to exchange information through integration. But government even more is interested but due to costly project facing problems.

Question 6: Are the Municipality Healthcare centers and hospitals using the same eHealth standards?
Answer 6: No, they are not using the same eHealth standards.

Question 7: Do you think that eHealth standard can be useful for the interoperability among health organizations?
Answer 7: Yes, they can be useful.

Question 8: What do you think Clinical information like Electronic Health Record (EHR) is useful for the interoperability?
Answer 8: Yes, of course it is useful for patients and Healthcare professionals as well.
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<th>Question</th>
<th>Answer</th>
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<td>Question 9: Are you agree that a patient should get document form of clinical information when discharge from the hospital?</td>
<td>Yes, definitely there should be a document of patient’s medical information when he discharges form hospital and go towards municipality healthcares for further care.</td>
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<td>Question 10: Do you think that accessibility is an issue regarding the interoperability?</td>
<td>Yes, this is also a problem. Because while using the system, when healthcare personnel interact with the system for having the medical record only authorized person should have an access to the patient medical information. In this way privacy and also access control can be achieved.</td>
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<td>Question 11: Are you agree that more healthcare centers would interoperable by connecting to the each other as time spends?</td>
<td>Definitely, with the passage of time adaptation will increase when more healthcare centers will connect to exchange information with each others.</td>
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<td>Question 12: Do you think idea of portable medium is good for transferring the patient medical information?</td>
<td>the idea of portable medium is not suitable for the elderly people. Because the data in a portable medium is very sensitive for their care and it should be protected from unauthorized persons. Also it is the possibility to loss and damage of this device due to the age factor.</td>
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<tr>
<td>Question 1:</td>
<td>What is the importance of interoperability?</td>
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<td>Answer 1:</td>
<td>Interoperability is very important for the patient, doctors and healthcare professional.</td>
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<th>Question 2:</th>
<th>Are the municipality healthcare system and hospital healthcare system same?</th>
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<td>Answer 2:</td>
<td>No, we are using MAGNACURA for the patient health care record.</td>
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<th>Question 3:</th>
<th>Are you agreeing that there should be interoperability among municipality healthcare and hospital healthcare?</th>
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<td>Answer 3:</td>
<td>Yes.</td>
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<th>Question 4:</th>
<th>What are the challenges in adopting interoperability among municipality healthcare and hospitals?</th>
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<td>Answer 4:</td>
<td>Integration, Accessibility, security and privacy are the big issues. Implementation of standards and cost is also an issue.</td>
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<th>Question 5:</th>
<th>What are the services the interoperable system should provide?</th>
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<td>Answer 5:</td>
<td>There should be quick and fast mechanism for viewing the medical history of patients, patient summary and different reports. It should be useful for having a document of patient's information that can exchange among healthcare organizations.</td>
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<th>Question 6:</th>
<th>What is your vision to have interoperability in recent future?</th>
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<td>Answer 6:</td>
<td>First we want to access patients information when comes to Municipality healthcare from hospital. Now systems are decentralized there should be interoperability among these systems. We are also planning to have interoperability among all healthcares in future through national database to access information.</td>
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<th>Question 7:</th>
<th>What is the Swedish national health strategy?</th>
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<td>Answer 7:</td>
<td>The Swedish National Health Strategy is very useful for implementing the interoperability among healthcare centers. It provides the guidelines for the interoperable system. The ultimate goal of this strategy is to provide mechanism that all healthcare organization interconnect with each other and share information. There is emphasis on implementing standards in all healthcare organizations.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Question 8:</th>
<th>Do you think that standards are important for the implementation of interoperability among municipality and hospital.</th>
</tr>
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<tbody>
<tr>
<td>Answer 8:</td>
<td>Yes</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Question 9:</th>
<th>Do you think different healthcare organization have adopted eHealth Standards?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer 9:</td>
<td>No.</td>
</tr>
</tbody>
</table>

Question 10: Do you think HL7 standard is important for interoperability?
Answer 10: Yes, definitely, it is useful for having interoperability for information exchange.

Question 11: Are you agreeing that EHR (Electronic Health Record) is beneficial for healthcare professional?
Answer 11: Yes.

Question 12: Regarding interoperability, what are the accessibility issues?
Answer 12: There are different healthcare persons who interact with the patients but for the medical record only authorized person should have access to the patient medical information.

Question 13: Do you think that privacy is an issue in clinical information?
Answer 13: The all information about patient should be used with the consent of the patient.

Question 14: Is there any centralized system among hospital and municipality healthcare system?
Answer 14: No, working in a decentralized mode.

Question 15: What do you think which approach can be useful centralized or decentralized for interoperability among the Municipality Healthcare centers and hospitals?
Answer 15: In my opinion, Decentralized can because every system can deal local and not dependent on the Central Authority. When more systems will be engaged by requesting data then there will be load on Central authority. Also distributed environment is very important for the interoperability.

Question 16: Do you think that distributed environment should be adopted to have interoperability?
Answer 16: Yes, Definitely distributed environment can be useful for take advantage in sharing data efficiently by reducing latency time.

Question 17: Is your system is connected with national database?
Answer 17: No.

Question 18: Do you think with the passage of time more healthcare professional should connect with each other?
Answer 18: Yes.
## C-Interview with Strategy Maker

| Question 1: | What are the advantages of Interoperability?  
Answer 1:   | information and knowledge is accessible with low cost and enhancing the patient safety.  
Question 2: | Do you think in Blekinge County healthcare organizations follow the eHealth standards?  
Answer 2: | No.  
Question 3: | Is there any common standard being implemented regarding Electronic Health Record or for the discharge summary etc.  
Answer 3: | No.  
Question 4: | Do you elaborate the role of ICT in eHealth?  
Answer 4: | ICT has substantial role in implementing the interoperability among healthcare centers. The application should be ICT based and to use these applications there should be some ICT infrastructure.  
Question 5: | Do you think that standards are just enough for the interoperability?  
Answer 5: | No, I don’t think so. Some time same standard by different vendors may not interoperable with each other.  
Question 6: | There are many advantages of interoperability what do you think would be the ultimate goal of interoperability?  
Answer 6: | There should not be any life risk involved in implementing interoperability, so safety should be the ultimate goal.  
Question 7: | Do you think that standards are important for the interoperability among municipality and hospital.  
Answer 7: | Yes.  
Question 8: | Do you think HL7 standard is important for interoperability?  
Answer 8: | Yes, More importantly the HL7 can be useful for the interoperability of medical information. It can also be useful for having a document of information.  
Question 9: | What are the major hurdles in implementing the interoperability among healthcare centers?  
Answer 9: | Security and privacy are the major issues but in future Blekinge will have an interconnected system of all healthcare organizations.  
Question 10: | As hospital and municipality systems are working separately, means decentralized in nature, so what do you think that they should be centralized or decentralized in nature for the interoperability?  

Question 10: It's an important question. I think a decentralized system can be useful because it cannot rely on central authority. Because may be any stakeholder does not want to put information central due to security. If there are more systems getting involvement for sharing information then there would be a load which can result a dead lock.

Question 11: Different persons have different responsibilities in an organization. So what do you think about the safety of patients in an interoperable system?

Answer 11: There should be some authentication mechanism so that the right person can interact with the information.

Question 12: How do you rate the privacy issue in clinical information?

Answer 12: All with the consent of the patients.

Question 13: Do you think interoperability is helpful for the medical professional?

Answer 13: Yes of course because they can get quick and fast response in continuing the care of patients.

Question 14: Will you comment on the National Strategy of eHealth in Sweden regarding interoperability?

Answer 14: The main focus in this strategy is to enhance the quality, safety and accessibility of patients care. The patients can use his/her medical information across the boundaries of the country. In this strategy it is focused to integrate the scattered information in different healthcare organizations.

Question 15: Considering the interoperable system in Blekinge County, what services do you find?

Answer 15: I think there should be continuity of care, clinical information should be in one document right information should be available at right place, decision should be on the safety and security of patients and there should be cooperation between healthcare professionals.
### Appendix 2: Questionnaire

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<thead>
<tr>
<th>No</th>
<th>Questions</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you think that there should be interoperability between municipality healthcare and hospital?</td>
<td>Yes, No, Don’t know</td>
</tr>
<tr>
<td>2</td>
<td>Do you think interoperability between municipality healthcare and hospital is beneficial for patients, professional and other healthcare stakeholders?</td>
<td>Yes, No, Don’t know</td>
</tr>
<tr>
<td>3</td>
<td>Are you agreeing that ICT platform can play a vital role in obtaining interoperability between municipality healthcare and hospital?</td>
<td>Yes, No, Don’t know</td>
</tr>
<tr>
<td>4</td>
<td>Do you think both systems should implement standards?</td>
<td>Yes, No, Don’t know</td>
</tr>
<tr>
<td>5</td>
<td>Do you think HL7 V3 and CDA standards should be implemented for generating the digital document to facilitate patients and professionals of municipality healthcare centers?</td>
<td>Yes, No, Don’t know</td>
</tr>
<tr>
<td>6</td>
<td>Do you think that in order to share patient’s information, there is a need of consistency?</td>
<td>Yes, No, Don’t know</td>
</tr>
<tr>
<td>7</td>
<td>Do you think decentralized and Peer-to-Peer approaches can be useful for transmitting medical document from hospital to municipality healthcare centers?</td>
<td>Yes, No</td>
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<tr>
<td></td>
<td>Question</td>
<td>Options</td>
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<tr>
<td>8</td>
<td>Do you think that some portable medium can be used for exchanging clinical</td>
<td>o Yes</td>
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<td></td>
<td>information?</td>
<td>o No</td>
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<td></td>
<td></td>
<td>o Don’t know</td>
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<td>9</td>
<td>Do you think Government has taken initiative for the interoperability among</td>
<td>o Yes</td>
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<td></td>
<td>municipality healthcare centers and hospitals?</td>
<td>o No</td>
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<td></td>
<td></td>
<td>o Don’t know</td>
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<tr>
<td>10</td>
<td>Do you think some communication protocol can be useful for exchanging</td>
<td>o Yes</td>
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<td></td>
<td>clinical information among healthcare centers?</td>
<td>o No</td>
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<td></td>
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<td>o Don’t know</td>
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# Questionnaire Evaluation of Interoperability Challenges and Benefits

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<tr>
<th>S. No</th>
<th>Questions</th>
<th>Level Of Satisfaction</th>
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<tr>
<td></td>
<td><strong>1. Challenges</strong> (Interoperability between municipality and hospital)</td>
<td></td>
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</tr>
<tr>
<td>1.</td>
<td>Do you think interfacing is a challenging task regarding interoperability?</td>
<td>Disagree 1 2 3 4 5</td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<td>2.</td>
<td>Integration of different application can solve the interoperability problem?</td>
<td>Disagree 1 2 3 4 5</td>
<td></td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<td>3.</td>
<td>Talking interoperability there is issue regarding accessibility?</td>
<td>Disagree 1 2 3 4 5</td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<td>4.</td>
<td>Privacy of information is a biggest challenge to interoperability?</td>
<td>Disagree 1 2 3 4 5</td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<td>5.</td>
<td>Do you think authentication is major issue regarding interoperability?</td>
<td>Disagree 1 2 3 4 5</td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<td>6.</td>
<td>Do you agree that implementation cost of interoperable system is an issue in obtaining interoperability?</td>
<td>Disagree 1 2 3 4 5</td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<td>7.</td>
<td>Interoperable system have a security challenge?</td>
<td>Disagree 1 2 3 4 5</td>
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<td></td>
<td></td>
<td>Agree</td>
<td>N/A</td>
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<tr>
<td>2. Benefits  (Interoperability between municipality and hospital)</td>
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<td><strong>8.</strong> Do you think interoperability will benefits the patients, stakeholders and healthcare professionals?</td>
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<td>Disagree 1  2  3  4  5 Agree</td>
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<td>N/A</td>
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<td><strong>9.</strong> Workload of caretaker will be minimized with the help of interoperability between municipality and hospital?</td>
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<td>Disagree 1  2  3  4  5 Agree</td>
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<td>N/A</td>
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<td><strong>10.</strong> Overall cost for the patient’s treatment will be reduced with the help of interoperability?</td>
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<td>Disagree 1  2  3  4  5 Agree</td>
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<td>N/A</td>
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<td><strong>11.</strong> Do you think interoperability will increase quality of patients care?</td>
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<tr>
<td>Disagree 1  2  3  4  5 Agree</td>
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<td>N/A</td>
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<td><strong>12.</strong> Do you think interoperability will increase safety of patients care?</td>
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<td>Disagree 1  2  3  4  5 Agree</td>
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<td>N/A</td>
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<td><strong>13.</strong> More healthcare centers can connect with each other with the passage of time?</td>
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<tr>
<td>Disagree 1  2  3  4  5 Agree</td>
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<td>N/A</td>
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Appendix 3: Screenshot of Municipality Healthcare System “MAGNA CURA”
Appendix 4: Screenshot of Blekinge Hospital System “SYSTEAM CROSS”