The Role of Interoperability in eHealth

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ABSTRACT

In the light of challenges the lack of interoperability in systems and services has long been recognized as one of the major challenge to the wider implementation of the eHealth applications. The opportunities and positive benefits of achieving interoperability are eventually considerable, whereas various barriers and challenges act as impediments.

The purpose of this study was to investigate the interoperability among different health care organizations. The knowledge of this study would be supportive to health care organizations to understand the interoperability problems in health care organizations. In the first phase of literature review interoperability challenges in Sweden and other EU countries were identified.

On the basis of findings interviews were conducted to know the strategies and planning about interoperability in health care organizations. After analysis of interviews, questionnaires were conducted to know the opinions of different medical IT administrator and health professionals.

The authors find after the analysis of interviews and questionnaire that adopting eHealth standard, same system, insuring the security of patient’s health record information and same medical language could be implemented in Sweden and other EU countries health organizations.

Keywords: Interoperability, eHealth, Interoperability challenges
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Dedicated To
Our Loving
And
Caring Families
TABLE OF CONTENTS

ABSTRACT.................................................................................................................................III

ACKNOWLEDGMENTS ................................................................................................................IV

TABLE OF CONTENTS ...............................................................................................................VI

INTRODUCTION ........................................................................................................................1

CHAPTER 1: BACKGROUND .......................................................................................................5

1.1 CONCEPT ABOUT EHEALTH AND INFORMATION COMMUNICATION TECHNOLOGY .... 5

1.2 NATIONAL STRATEGY FOR EHEALTH-SWEDEN ................................................................ 6

1.3 BLEKINGE COUNTY COUNCIL .............................................................................................7

1.4 HEALTH LEVEL 7 ..................................................................................................................8

CHAPTER 2: PROBLEMS DEFINITIONS/GOALS ......................................................................9

2.1 RESEARCH QUESTIONS ......................................................................................................9

2.2 GOALS AND MEASURES FOR THE STUDY ......................................................................10

CHAPTER 3: RESEARCH METHODOLOGY ..............................................................................11

3.1 OVERVIEW .........................................................................................................................11

3.2 LITERATURE REVIEW .......................................................................................................13

3.3 INFORMAL DISCUSSION ....................................................................................................13

3.4 INTERVIEW .......................................................................................................................13

3.5 QUESTIONNAIRE ...............................................................................................................14

CHAPTER 4: INTEROPERABILITY AND EHEALTH .................................................................15

4.1 EHEALTH ..........................................................................................................................15

4.2 ICT .......................................................................................................................................15

4.2.1 ICT TREND IN SWEDEN ..............................................................................................16

4.2.2 ROLE OF ICT IN EHEALTH .......................................................................................18

4.3 SWEDISH HEALTH CARE SYSTEM ..................................................................................18
TABLE OF GRAPHS

FIGURE 1.1 INTEROPERABILITY BETWEEN SYSTEMS .................................................................3
FIGURE 3.1 OVERVIEW OF RESEARCH METHODOLOGY ......................................................12
FIGURE 4.3 ICT TREND IN SWEDEN ..................................................................................16
FIGURE 4.3.2 DIFFERENT AREAS OF INTEROPERABILITY ...............................................21
FIGURE 4.3.3 DEPLOYMENT OF ICT TREND IN SWEDEN ..................................................16
FIGURE 4.4 COMPARISONS OF GENERAL POPULATION ....................................................17
FIGURE 4.9.8.4 MESSAGE EXCHANGE BETWEEN HETEROGENEOUS APPLICATIONS ......30
FIGURE 7.1 RESPONSE AGAINST CLOSE ENDED QUESTIONS ............................................45
Introduction

eHealth means Information and Communication Technologies tools and services for health. Whether eHealth tools are used behind the scenes by healthcare professionals, or directly by patients [1]. The existence of test arise from elderly populations, rising occurrence of chronic diseases, high health care cost, quick revolutionize in technological equipment and medical knowledge, eHealth propose great capabilities to expand and deliver health care services to the end user that is both seamless and included according to the needs and requirements of individuals. The future of eHealth is acknowledged in academia as well as among policy-creators the health care schemer and health care practitioners, the execution of its applications has appeared to be difficult then prospects. The successful performance of eHealth, it is essential to suggest eHealth services regarding to the citizens and patients diagnosis [2]. Health care sectors are facing lot of problems worldwide. The average age of population continues increasing thus posing a real problem to health care. All citizens are not taking full facilities from health care including those people who are living in remote areas where it is often quite difficult to obtain care[3]. There is a rapid increase of demand in eHealth all over the world. Such as in U.S one of the strategic initiatives of government is the nationwide adoption of electronic medical records (EMR,s) by 2014. At present health information exchange is not sufficient to satisfy the demand of patients and public health services. Patients are not satisfied with the quality of patient care to overcome this reduce costs healthcare data needs to be available for exchange across different communities and states. From the IT perspective to achieve the health information sharing many IT groups have developed components either for internal consumption or for open source usage. This indicates that in a future the amount of technical assets will continue to grow. There is a need of common library where all the enabling components and assets are collected and managed and this can result in having to reinvent the technology. [4] Information and communication technologies (ICT) are providing potential benefits in terms of supporting health care professionals and decision makers as well as improvements in patient’s medical treatment. Around the world many countries are facing many problems in health care system and Sweden is one of them.

The challenges in Sweden health care system are identified below
- Deliver health and elderly care to an ageing population.
- Enable patients and their family to play an active role in decisions relating to health care provision and delivery.
- Patient information and medical record security
- Lack of interoperability in different health care’s.[5]

ICT provide opportunities for individuals, medical professionals and health care providers to obtain information, communicate with professionals, deliver first-line support specially where distance is a
critical factor[6]. After the Improvement in ICT-based it is now technically feasible to develop expert systems, decision support systems and other knowledge-based support systems at national level. These can give care professionals access to relevant, up-to-date information which can be used in health care work[6]. In eHealth ICT based systems; the citizens in “the County of Blekinge” need trouble-free, easy and reliable access to health care services, safe methods for monitoring, checking the progress of their own illnesses, routine tests, information and guidance on an individual basis, opportunity to become more actively involved in their care and treatment as well as take more decisions of their own. One of the priorities of Sweden’s National eHealth strategy is to develop common quality criteria and regulations governing common user interfaces with a view to creating easy-to-use, secure e-Health solutions[7]. Interoperability is one of the core challenges that eHealth is facing at the moment[8]. Interoperability in healthcare information systems which enables sharing of clinical and administrative data among healthcare stakeholders is considered as important building block in leveraging computer technology to reduce healthcare costs and improve quality[9]. The well-defined e-Health solutions must support relevant health care operations, be easy to use and be capable of exchanging information and interacting with other ICT systems in order to guarantee patient safety. They must also be designed and constructed in accordance with established national and international ICT standards [10].

In information communication technology (ICT) health is a different community consists of any organization that can deliver care through different channels to manage information. Interoperability of any software system is the capability to share information surrounded by different computing mechanism, operating systems, functions and networks [6]. We can say that the eHealth is the process to cover the interaction between healthcare service providers and the patients. eHealth depends on the ways of communication that it can be between institution to institution or it can be directly among the patients and health care professionals. This all information could be about health, electronic health records, telemedicine services and other different systems that can be provide and monitor and support the patients.

In this research we will focus on the case of eHealth interoperability among the primary health care centers and hospitals, this also can be possible through electronic health records (EHRs), patient summaries about their health and other important data that needs for interoperability among different centers. Swap of information and interoperability assure to bring huge payback to our healthcare system. In healthcare information systems the Interoperability facilitating sharing of clinical and administrative data between healthcare stakeholders it is measured significant building block in computer technology to decrease healthcare costs and improve quality [6].

In the aspect of interoperability we can say that the capability of two or more than two components or systems to share and exchange the information to each other. In interoperability aspects multiple systems
or components have the ability to work together. It makes things possible to bring information between two or more systems. There are different systems having different software and different data but in interoperability it make possible to exchange information with each system. Interoperability some time integrate the multiple systems to build a combine big structure. The main feature of interoperability is that the system should be compatible with each other or we can say that a common channel where all or multiple systems can communication to each other.

![Diagram of Interoperability between systems]

**Figure 1.1 Interoperability between systems**

In eHealth interoperability create chances to transfer medical data among the hospitals, among the telemedicine and primary health care centers. In health care centers the interoperability can be implemented on the electronic health records (EHRs). For healthcare interoperability the healthcare systems, services and other maybe technical staff should provide the facilities and they needs to work and collaborate with each other as team and they should develop an active, interactive and helpful relationship with each other.

The interoperability of the consequential eHealth systems and all other related services will facilitate this type of development more effectively. The eHealth interoperability is not only the technical definition of the word that tells to relating different systems and exchanging information. It provides the concept of connecting people to each health care centre regarding this research.

eHealth interoperability can be possible when the healthcare centers are interlink with each other through any technology, system or any channel of interaction.

There should be a facility among these centers (primary healthcare and hospitals) that these centers can share their information to each other. For example if a patient goes to a primary health care centre for
his/her checkup and primary health care center’s doctor refer him/her to the hospital for further or better treatment (already diagnosed). But when he/she goes to the hospital there is no data available for his/her primary health care diagnostic. This all can be possible through the interoperability among these primary health care centers and hospitals. If there will be any interoperability among these centers then, all data will be available for next treatment. The eHealth strategy in Sweden also known the National Strategy for eHealth and it was made by the National High-Level Group for eHealth. The National Strategy for eHealth 2006, Sweden distributes health care system in different 20 county council and 290 municipal councils as a health care provider. The liability of as major contains the conditions of standard care services and the development requirement, quality-assure and finance all care activities. [6]

In the National Strategy for eHealth 2006, says that in Sweden we have a Health and Medical Services Act, under this the county councils are required to provide health and good standard of medical care to all resident in the county. The definite groups also under attack in this act according to this act municipals council require offering health and high standard of medical care to specific groups. [6] The Strategy Maker of county of Blekinge told us that Swedish government is developing a web portal at national level that will be accessible in future. With the help of this web cite the Citizens can access eHealth information, there will be available the eHealth services and booking the appointment with the doctor. Here in Blekinge County the software in primary health care centers, dental health care centers and big hospital are available from last eight years but there is no interoperability in these systems. All information cannot be shared (collected) among these centers. So patients are facing many problems when they go from one primary health care centre to hospital. Then patients cannot avail the facilities of other health care centre.

In this research topic we will try to study that how can we contribute in our research to provide the suggestions that can fill the gap between different health care organizations.

In this research we will also find the interoperability gaps among different health care organizations, challenges in interoperability, patients benefit with interoperability.

This research will support the health system and health managers that how can the patient information will be interoperable.
Chapter 1: Background

1.1 Concept about eHealth and Information Communication Technology

According to G Eysenbach “e-health is a growing field in the junction of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and through related technologies. In other words the term eHealth characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology” [11].

Elizabeth Sillence et al. explains that the main issues in the success of eHealth are the increasing of quality of medical information, effective user interaction and the patient data according to the need and requirement[12][13].

eHealth is increasingly becoming an important factor of national health care system in Sweden [14]. eHealth consists of many different technological applications and these kinds of technologies can be used in any health care system to exchange and process of information. From the beginning many highly developed eHealth services are used by the people related to health care systems around the world. Many public and private health care providers are involved to provide better health care delivery system to the patients. Sweden is one of the country which is involved in delivering the health care facilities[13]. Since 2002 all primary health care centers have been connected with the telecommunication network such as Sjunet(administrated by Carelink)[15]. Now a day some projects are going such as Sjunet and InfoVU are running in different primary cares and hospitals to provide the better health care delivery system. Mostly all counties in Sweden are involved at regional level to complete the national strategic goals towards the encroachment of health care delivery system and the county of Blekinge is one of them.[13]. Now a day main issue in eHealth is addressing common challenges and creating the right agenda to support eHealth such as interoperability. In order to face the challenges of the ageing population Europe needs a health care delivery model that should be based on shielding and person centered health systems, which can only be achieved by through the proper use of Information and Communication Technology (ICT) [16].

The purpose is ICT systems with good interoperability that allocate the exchange and the sharing of information and ICT provides safe and secure treatment [17].

According to Claudia Pagliari,[18] the basic aim of making the strategies for eHealth developing health information infrastructures are emerging across North America, Australia, Europe and elsewhere. The purpose of these strategies is to improve the patient safety, efficiency and quality
of patient care and enable citizens to accessing the health records, clinical practice research and policy though availability of appropriate evidence and data. These strategies also highlight the importance of standards, patient and policies for ensuring interoperability and data security, patient self-care through prerequisite of electronic information [18].

The role of technology in health care is very important. Using technology people can access different health care sites. Some benefits of using technology in healthcare are as follow.

- Usage of Information technology helps us to reduce errors in medications.
- Usage of computerized physician order entry can reduce medication error by 80%.
- Improvements in diagnosis and treatments with technology help the quality and availability of care.
- Telemedicine: monitoring different chronic diseases [19].

From last 15 years the application of Information and Communication Technology (ICT) in healthcare has grown exponentially. The main aim of ICT is to improve the effectiveness and efficiency in health care [20].

1.2 National Strategy for eHealth-Sweden

The National Strategy for eHealth Sweden 2006 was made by the National High-Level Group for eHealth. The National Strategy for eHealth focuses on the need of ICT to achieve the improvements of patients, health professionals and decision makers. Making the future strategy for eHealth in the country the Government says that the appropriate use of ICT based tools helps to guarantee that all patients are receiving reasonable, safe and good quality of service using ICT [5, 13].

According to the National Strategy for eHealth 2006 that Sweden has a decentralized health care system, with 20 county councils and 290 municipal councils as principals and care providers. According to National Strategy for eHealth Sweden 2006 act all counties are required to provide health and medical care of a high standard to all residents who live in the counties. Both the county councils and municipals councils employ the services of private health care providers to greater or lesser extent [5, 13].

According to National Strategy for eHealth Sweden 2006 there are six main priorities.

- Building laws and regulations into line with extended use of ICT.
- Creating a common infrastructure among different health care organizations.
- Creating a common technical infrastructure among health care organizations.
- Facilitating interoperable, supportive ICT systems in health care organizations.
• Facilitating access to information across organizational boundaries.
• Making information and services easily available to all citizens[5]

In the National Strategy for eHealth 2006 it is said that the number of projects are in progress. The main issue in the Sweden eHealth care system is the interoperability. According to [13], there is no interoperability among different primary cares and hospitals. The regulations include rules technical interoperability i.e. system adaptation and semantic interoperability and to further develop the regulatory framework on electronic interoperability in the health care services. These rules are designed to guide officers to introduce new eHealth solutions. Some projects as “Sjunet” and “info VU”, Health Level 7(HL7) as well as many projects are preparing to launch in future [5].

**Sjunet-** The National IT infrastructure for Healthcare Sweden

From the last five years Sjunet is providing facilities among the health and medication services communication network-Now all county councils and some 40 municipalities and a number of private care providers are members of Sjunet [5].

**Info VU-project**

The Info VU-project is working with collaboration with SALAR and its basic purpose is the collaboration among health care organizations [5].

**1.3 Blekinge County Council**

Blekinge is situated in Sweden which location is north of Germany, half of Denmark and the Coastal areas of the Baltic States. According to Strategy maker that 70 % million people live in this beautiful area of Sweden[21].According to Strategy maker we have 21 county councils,7 county councils are using the same system, and the six county councils are trying to work with integration. Interoperability among health care organizations is a main challenge for us. In the next year we are trying interoperability among different health care organizations in Blekinge. According to Strategy maker most county councils are trying to have the same Electronic Patient Record (EPR). [21] According to Strategy maker Sweden is working with EU about implementation of interoperability among the EU countries. [21]

According to Medical IT administrator at this time there is no interoperability in Sweden among different health care organization (public and private) and we cannot share information. [22].
According to Strategy Health Service Planner interoperability should be implemented in the health care organizations and it will be beneficial for both patients and health care professionals. [23]

The main aim of this research is to provide some helpful solutions which will be better for health care organizations. How interoperability can be beneficial for patients and how we can implement interoperability among health care organizations. Our research can support health care authorities and the different health organizations that how they can bridge a gap among different health care organizations.
Chapter 2: Problems Definitions/Goals

According to Octavian Purcarea concluded “the vital goal of eHealth interoperability is to facilitate access to a patient’s release summary and emergency data from any place in Europe, respecting data privacy and security” [25]. Information and Communication Technology (ICT) has become one of the main building blocks in this modern century [26]. Applying information and communication technology (ICT) in different primary health care centers and hospitals citizens can get fast and quick response in health care centers. [3].

ICT based systems support the County of Blekinge Citizens and providing free services regarding health care. The County of Blekinge Citizens wants safe method using ICT to check their own self illnesses and other diseases. But there are several reasons like there is no interoperability in different primary cares and hospitals. Many of the ICT based tools are arranged in different primary cares and hospitals. But there is a lack of interoperability among different primary cares and hospitals. [6]

Interoperability in health care information is the capability of health information systems to work together within an organization and across organizational boundaries. It is necessary for interoperability that systems agree what standard to use and what kind of information they can share. The possible way of communicating is through HL7 (Health Level 7) standards through which the system can be easily interoperable with applications in related domain. [27]

Our main objective of this research is to discuss about interoperability in health care organizations. How we can share information among different health care organizations and after empirical study we will give some suggestions that how we can implement interoperability in different health care organizations.

2.1 Research Questions

- How to bridge a gap among primary cares and hospitals (in Blekinge) regarding interoperability?
- How interoperability can be beneficial for patients regarding health cares?
- How technology can support the primary cares administration to build interoperability among them?

These research questions are helpful in our research area. According to our 1st research question the interoperability among different primary cares and hospitals is a big challenge in health care
organizations. There is a lack of information among different primary cares and hospitals. When any patient goes to a primary health care or to a hospital then that hospital has no information about that patient because there is no exchange of information among the primary health care and hospitals. This creates lot of problems due to lack of interoperability among primary health care and hospitals. We will discuss in literature about interoperability, types of interoperability, eHealth standard, and the interoperability in the Swedish health care organizations. In literature review we will also discuss about how interoperability can be implemented among different health care organizations. According to the empirical report these days the disintegration and lack of general standards are playing a role in Electronic Health Records (EHRs) Systems a lot in implementation but they are separated. This report also shows that there are lacks of eHealth standards there is no interoperability. [28]

According to 2nd research question in the literature review, the interoperability is beneficial for patients as well as health professionals. We will discuss about advantages of interoperability and patients benefits with using interoperability, and disadvantages without interoperability that many health organizations are facing these days.

According to 3rd research question, the role of technology in health care organizations is very important. Without technology we cannot implement interoperability in health care organizations. We will discuss in literature review the role of Information and Communication and Technology (ICT) and the role of technology in health care organizations.

2.2 Goals and Measures for the Study

Information and Communication Technology (ICT) playing a very important role in health care organizations. Many of the ICT based tools are arranged in different cities of Sweden like in primary cares, hospitals and municipals, but interoperability is limited among different primary health care centers and hospitals. We assume that in future County of Blekinge citizens will get more benefit, more secure eHealth services through the use of interoperability among different primary health care centers and hospitals [6]

The goals of the study are listed below:

- Interoperability principles, discovering issues in different areas of eHealth.
- Acknowledgment of health care institutes and organizations interoperability needs.
- The study will create interoperability among different health care organizations.
- Suggestions about how to bridge a gap among different primary cares and hospitals.
- How primary cares and hospitals can share information through the use of technology.
- How patients can get benefit with interoperability in health care organizations.
Chapter 3: Research Methodology

This chapter describes the research methodology that we will mention in our thesis. Overview of the research will be described in section 3.1. The phase of the literature review is mentioned in section 3.2 and informal discussion is in section 3.3, and section 3.4 will describe about Interview and section 3.5 about the questions that we will conduct from different primary cares and hospitals.

3.1 Overview

The basic purpose of the research is to think about how data can be collected and analyzed. In our thesis, we adopted a combinational approach using qualitative and quantitative research methodology. [29] The research will be carried out in different phases. First of all, we will study the literature review and will understand “what is eHealth” Role of interoperability in eHealth and how we can reduce to bridge a gap among different primary health care centers and hospitals. In this research, we will discuss with our senior fellows who already have presented thesis on eHealth will be very helpful for us to find the conclusion. From literature review, informal discussion and interviews, we will make questionnaire and will draw some conclusion.
Figure 3.1 Overview of Research Methodology

- **Literature Review**: Knowledge about interoperability and interoperability design
- **Interview and analysis**: Findings
- **Questionnaire and analysis**: Results
- **Conclusion**: Discussion & Validation Assessment

**Nodes**: ICT, eHealth, Interoperability, Types of Interoperability, Challenges in Interoperability, Health Level 7 Standard
Overview of Research Methodology

3.2 Literature Review
Literature review is the starting phase in our research area. The basic purpose of the literature review is to share the results of other studies, filling gaps and extending previous studies. Authors used several keywords that are relevant with the topic and search the material published, journals and all documents that are related to eHealth and interoperability through Blekinge Institute of Technology (BTH) library, IEEE, ACM and different journals [29]. Literature review also identified the some important factors in interoperability. In this study area of research, authors identify the role of interoperability in eHealth, interoperability gap among different health care organizations and how patients can get benefit through interoperability.

3.3 Informal Discussion
Authors started informal discussion with PhD students and many personnel who have worked in eHealth projects. Authors got positive response from fellow students who helped us to design the questionnaires and Interviews.

3.4 Interview
After literature review and informal discussion we conducted the interviews with Strategy maker, Strategy Health Service Planner and Medical IT administrator. From these persons we got lot of information about interoperability and asked them many questions related to our topic. The first interview we conducted with Medical IT Administrator in Ronneby Primary Health Care (Capio CityKliniken). Second interview we conducted with Health Care Planner in Wämö center, Karlskarona. The third interview we conducted with Strategy Maker.

3.5 Questionnaire
The authors described the questionnaire and distributed to the different county of Blekinge medical IT administrator groups. The questionnaire that we got answers from the different medical IT administrator of Blekinge was well aware of interoperability. The main objective of the questionnaires was to get the qualitative and quantitative study to support the findings of our data. The questions were arranged in such a way that the medical IT administrators of county of Blekinge can express their views about interoperability, how to fill gaps among different health
care organizations and how they can get benefit through the use of interoperability in different county of Blekinge’s primary health care centers and hospitals.
Chapter 4: Interoperability and eHealth

4.1 eHealth
In eHealth 2005 Conference, Petra Wilson explained that the term eHealth is not only about computers on doctor’s desk but the term eHealth contains a huge variety of tools, applications and procedures [30]. In the eHealth journal G Eysenbach explained that eHealth is an rising field in the connection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In other words the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology [31].

According to [32] that eHealth user is increasing in the world wide and the patients are more conscious about their health as before. According to [32] that

- About 600 million people are online in the whole world and from them 37 % ratio is those people whose native language is English.
- The usage of internet in Europe is very high.
- Almost half of physicians used Electronic Health Record (EHR) and 90-95% are from Nordic countries and other 20-35 % in the Southern Europe [32].

4.2 ICT
Information and communication technologies (ICT) offer many benefits in terms of improvement for patients, health and elderly care professionals and decision makers. Through the use of ICT citizens, patients will get trouble-free access to quality assured information on health care provisions and health concerns as well as personal data on their own treatment and health status.

The main benefit of ICT is that the patients will be able to contact care services through the internet and will get advice or help with self treatment. With the use of ICT health care professionals will be able to access the ICT systems with a single sign on to the usual system environment.[5] Today, ICT is engaged everywhere in the health care system, for different purposes and in different ways[5]. According to L. A. Ogunsola information and communication technology is basically an electronic based system that is build on information transmission which has dramatically changed the way we think [11].

It is not that ICT is the only cause of changes in health care but in every field of life, the rapid developments in ICT have boost up the current wave of globalization [13]. Two-thirds of the countries reviewed their health policy and
the deployment of ICT-based systems is directly linked to health policy objectives. In 10 countries eHealth is a essential part of the national on the whole health system strategy, and in 14 countries there is a more focused objective, which is usually cost control efficiency, and/or quality of health care services. In 13 countries, eHealth is one of several topics under the umbrella of ICT development or information society goals, or is the part of the Government strategy [13].

Deployment of ICT in Primary Health Cares

![Figure 4.2: ICT trends in Primary cares in Sweden & Europe [62]](image-url)

4.2.1 ICT Trend in Sweden

ICT is one of the growing areas in Sweden [13]. The usage of mobile is rapidly increasing after 90's till present. The usage of landline telephone is remains steadily after the slight fluctuation between the years 2000 to 2001[33]. In future many benefits would be achieved in Sweden through the utilization of ICT in eHealth delivery systems.
Figure 4.3 ICT Trends [13]

Figure 4.3: Comparison of General Population and Health Professional Use of the Internet per European Country, June 2002 [32]
### 4.2.2 Role of ICT in Health

In National strategy for eHealth it is stated that ICT based tools offers various benefits in health care in terms of improvements of patients, health care professionals and strategy makers. By using ICT citizens, patients will receive good quality of service and they will be able to actively involve in their health care and treatment according to their abilities and circumstances. [13]

The major benefits of ICT in eHealth that citizens can get access through internet and the patients will be able to contact health care services [11]. Furthermore by the use of ICT elderly and health care professionals will be capable to access interoperable, well-organized eHealth solutions that can be helpful to perform their routine work while guaranteeing about the patient safety and patient security in health care [13].

The role of patient is very clear in the use of ICT strategies while England is focusing on implementing an integrated IT infrastructure which aims to enable patients informed health choices. Many countries are implementing ICT based tools in their health organizations like Portugal plans to place citizens at the centre of the health system. The three Scandinavian countries Sweden, Norway, Denmark already have implemented ICT infrastructure in their health organizations [36].

### 4.3 Swedish Health care system

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 health care 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[13]. There are also some economic reasons that’s why all county councils should cooperate on ICT related issues at national level[6].
4.3.1 The 10 standard in eHealth

According to G Eysenbach[11], the term "e" in eHealth does not only stand for "electronic" but it involves a number of other "e's," which together can best explain what is eHealth and is all about. The following 10 keys can give us the supporting ideas to understand the advantages of eHealth and how eHealth can be beneficial in different field of health care.

1. Efficiency: One of the main purposes of eHealth is to increase efficiency in health care, in that way decreasing cost, through enhanced communication possibilities among health care establishments and through patient involvement.

2. Enhancing Quality of Care: Due to increasing enhancing quality of care not only reducing costs but at the same time improving quality. Health improve the quality of care such as making the comparison among different providers involving consumers as additional power for quality assurance and directing patient flow to the best suitable quality providers.

3. Evidence based: eHealth interventions should be evidence-based by nature in a sense that their efficiency and effectiveness should not be implicit but it can be proven by rigorous scientific evaluation.

4. Empowerment: Empowerment of consumers and patients by making the knowledge bases of medicine and the personal electronic records and knowledge bases of medicine accessible to consumers through internet.

5. Encouragement: is a new relationship among the patient and health professional towards a suitable partnership where decisions are made in a shared manner and in a proper way.

6. Education: The new method of education for physicians through online sources (continuing medical education) and consumers (health education, tailored protective information for consumers).

7. Enabling: eHealth enables communication and information exchange in a standardized way among health care establishments and related to different organizations.

8. Extending: Health enables clients to obtain easily health services from global supplier. These services can be in a proper way such as an advice to more composite involvement or products such as pharmaceuticals.
9. **Ethics**: The eHealth started new forms of patient-physician communication and carry new challenges and threats to ethical issues such as online informed approval, professional practice, equity and privacy issues.

10. **Equity**: The main problem in eHealth is the equal accessibility of eHealth services to all citizens. People who don’t have the money, skills cannot use computer effectively [11].

4.3.2 **National Strategy for eHealth-Sweden**
The national strategy of eHealth in Sweden is grouped into six action areas these areas will provide significant opportunities and benefits for eHealth solutions of all types. [5]

- Bringing laws and regulations with extended use of ICT in different areas of health care.
- Creating common information structure among the health care systems, hospitals and primary health care centers.
- Facilitating interoperable and supportive ICT systems in health care.
- Facilitating access to information across organizational boundaries
- Making information and services easily accessible to citizens

In the Swedish national strategy 2006 there is a need to exchange of information between one primary health care to hospitals so through interoperable patients can get benefit [5].

According to [13] the Blekinge health care strategy maker described those at present county councils are not following the EU eHealth strategy because all counties have their own IT systems. According to [13], in future there will be considerable benefit if all counties follow the EU eHealth strategy [13]. About 40 municipalities and numbers of county councils are linked with Sjunet. Due to the patient’s record and information security the network is not implemented in large number of small health care providers. A Carelink an organization is examining that all primary health care centers and hospitals can join Sjunet [6]. According to [23], in the next year all of our primary health care centers and hospitals in county of Blekinge will be interoperable.
Different areas of Interoperability

Access-internet portal
Health services Portal
Information
Facilities etc

Information systems and Process support
Technical system support like EHR, ASS, DSS, Patient summery

Infrastructural support services
Network
Security rules
Logging
Handling process

Health Standards

For patients and citizens

Information sharing among the organizations

ICT systems for Interoperability

Technical requirement and infrastructure

Information sharing structure

Laws and Regulations

These four areas are belong Interoperability

Figure 4.3.2.Different areas of Interoperability [6]
4.4 HCI Study Area

According to Laurence Alpay et al. that one of the main challenges for HCI is in the development of computer based healthcare system that is the design of the effective user interfaces. The main aim of these interfaces that how patient and health care professional can communicate with each other. In HCI specialists insist that to develop such type of interfaces according to the behavior of the user because user behavior during interaction is very important [18].

According to Brad Myers et al. HCI is the area that how people design, implement and make use of interactive computer systems. It provides such type of interfaces and creates more powerful and feasible forms of communication. In addition it also covers that how the different computer’s actions are controlled and monitored in different situations. [34]

Another researcher Daniel Fallman explained that through HCI how people and computers can interactively perform tasks and how interactive systems can be designed according to user requirements. [35]

According to Daniel Fallman that in the present scenario the main challenge is in this information world is that not only to make information available to people but specifically to say the right thing at the right time [13].

4.5 The EU action plan is.

Interoperability is one of the core discussions in EU eHealth Action Plan. All countries did not implement interoperability in their hospitals and primary cares but only one-third of the country fact sheets mention interoperability explicitly [36]. There are many other objectives of EU action plan is like

- Develop the information technology infrastructure in health care institutions and primary cares.
- Provide Internet in every health organization.
- Develop access to healthcare information.
- Increase health related education and promotion in different health care organizations.
- Insure safety and security of medical data.
- Interoperability among different health care centers and primary cares in the country and across the country [36].

EU is planning to cooperate with each other in health care organizations. The main aim of EU action plan is the patient safety, patient information security during health care and treatment in
another country. Twelve EU countries are agreed to cooperate with each other and they are working in a joint project epSOS, to introduce concrete eHealth services across the border [37].

4.6 eHealth Services

eHealth covers a wide range of services for the citizens. Following are the detail view of the eHealth services.

4.6.1 e-Prescriptions

According to [13] that there are many patients that comes from other primary care centers who want to get e-Prescription but it is not possible in Blekinge hospital units(Karlsham and Karlskarona). So according to [13] that if health care organizations adopt interoperability in systems with each other then e-Prescription would be more beneficial to Blekinge Citizens[13].

4.6.2 Electronic Health Records (EHR)

The Electronic Health Records (EHR) is basically the electronic form of treatment’s information. The basic purpose of EHR is to follow the requirements and interest of different for example: care services, patients and medical personnel, rescue service and pharmacies or scientific institutions [33]. Almost six nations have developed local electronic cards in hospitals and other health provider organizations which are not fully interconnected yet. Luxemburg maintains radiology records for its citizens and in Sweden citizens have a medication record. Germany, Sweden and Turkey are working on developing the structures of a patient summary or minimal data set [36]. EHR system is mostly using in all primary cares and hospitals in Sweden. National Board of Health and Welfare has been working with collaboration SALAR and InfoVU. Its main aim is the collaboration of health care professionals, improving communication among primary care providers [6].

4.6.3 Electronic Patient Records (EPR)

According to [13] Blekinge County of Strategy maker identified in the county of Blekinge 88%-90% documentations are in digital format as compared to the other countries [13]. According to [13] that there is a need to implement same EPR standards in all county of Blekinge health care organizations. According to [13] same EPR standards helps all systems to share their medical data of patients with each other. According to [13] it will be a good idea if Sweden will follow the common EHR standard in their health organizations. [13]
4.7 Sweden Statistics

According to [38] health expenditure statistics there is a need to get health delivery systems in Sweden. Through it will increase the satisfaction level of citizens on health care policies.

- WHO region: Europe
- Total population: 9,078,000
- Gross national income per capita (PPP international $): 34,310
- Life expectancy at birth m/f (years): 79/83
- Healthy life expectancy at birth m/f (years, 2003): 72/75
- Probability of dying under five (per 1000 live births): 4
- Probability of dying between 15 and 60 years m/f (per 1000 population): 78/49
- Total expenditure on health per capita (Intl $, 2006): 3,119
- Total expenditure on health as % of GDP (2006): 8.9.[38]

4.8 Role of Technology in Health care

Software technology plays a very important factor in health care industry. Information Technology (IT) provides organizations solutions to make decisions at time. Health care organizations currently less invest in IT. Using of IT in health care improve both efficiency and quality. Through the use of IT in different health organizations all patient history can be saved. Using technology patient can get more information and interact with the health care system outside of visits much more than is usual today[39]

4.9 Interoperability

“Interoperability in health care information is the capability of health information systems to work together within and across organizational boundaries”. It is necessary that systems agree on what information they want to share and what standards to use [27].

When different enterprises are integrated it is necessary that all the systems and technologies share whole information with different structures and formats. Such type of sharing and of information transparently is very difficult requirement which raises the very complex issues of compatibility and interoperability [40].

Interoperability is a wide concept and there are lot of definitions about interoperability that is exist both in academia and industries. Few definitions of interoperability are as follows:-

According to IEEE [41]." interoperability is the ability of two or more systems that is used to exchange information and to use these 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”[42].

According to [43], an ABC reports that “one of the major killers of patients in the medical system’s own chronic inability to share vital information”.

4.9.1 Types of Interoperability
One of the popular models [44] describes the three types of interoperability. These types of interoperability are channels interoperability, information interoperability and process interoperability.

4.9.1.1 Channels level Interoperability
Channels level interoperability also know as connection interoperability and it is defined as that the ability of system to exchange data and information in terms of signals[44]. That type of interoperability is the basic type and it provides such type of methods to establish connections both physical and logical between two or more systems. There are different types of standard that are used to ensure interoperability to transfer information on multiple networks. The OSI reference model (TCP/IP) is an example of this. Channel level type of interoperability is also known as technical level interoperability [40, 44].

4.9.1.2 Information Interoperability
Information interoperability is the ability of different information systems that share and interchange data, share information and knowledge and as well as to integrated with other systems, applications and services in order to deliver new products and services [45]. Information interoperability has many types like Morphological interoperability, Syntactical interoperability and Semantic interoperability.

4.9.1.3 Morphological interoperability
Morphological interoperability also called structural interoperability ensures that the same data is in same structures and in the same format [44, 40]
4.9.2 Interoperability Layers

There are two types of interoperability layers.
1) Semantic Interoperability.
2) Syntactic Interoperability

4.9.2.1 Semantic Interoperability

Semantic interoperability is also called knowledge level interoperability, is the capability of different type of information systems, components, applications and services to exchange information on the basis of joint, pre-established and negotiated meanings of terms and expressions [46].

Semantic interoperability guarantees that the message is received at the user end. Another important use of semantic interoperability in the healthcare domain is the combination of data from heterogeneous sources through semantic mediation. The main function of semantic mediation is to convert health care messages that are defined in one standard format into another as realized with the scope of the Artemis project [47].

4.9.2.2 Syntactic Interoperability

If two or more systems agree on communicating and exchanging of data then they are said to syntactic interoperability [48]. Syntactic interoperability guarantees that the message is delivered but does not guarantee that receiver receive the message. To guarantee message content interoperability that is received at the user end then semantic interoperability will be used [47].

4.9.3 Advantages of Interoperability

Through health care information exchange and interoperability doctors can have a longitudinal medical record with full information about each patient. By adopting interoperability patients will get better information about their health status since personal health records and similar access strategies can be possible in an interoperable world. Patients can move more easily between and among clinicians without fear of their information being lost [49]. There is many benefits by adopting interoperability such as

- People will share health related data even when they will be out of the country.
- The rules of interoperability among hospitals, GP’s, Primary cares and Dental Services would provide substantial benefits to citizens.
- People will have many alternatives for their medical treatments.
• People will access eHealth services whenever and wherever they need.

• EHR accessibility among EU countries.

• Making health care information systems interoperable will reduce cost of health care.

• Verification of Electronic Identification Card (EIC) in EU countries [13].

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. [50].

According to [23] patients will get fast and quick response, reduce telephone calls and it enable healthcare professionals to better diagnose.

4.9.4 Disadvantages without Interoperability

According to [21] that without interoperability there are many disadvantages like

• Patient cannot get fast and quick response.

• Health care professionals cannot better diagnose patients.

• Without interoperability patients cannot access his/her record in another country [21].

Every year 3000 deaths in Australia are occurred due to the lack of interoperability among different health organizations [51].

4.9.5 Interoperability in Swedish Health care

In Sweden there are 21 self-governed county councils/regions responsible for emergency hospitals and primary care. 290 municipals councils are responsible for providing health care facilities to elder. So locally there is a need for collaboration around the same patients.

Electronic Health Records in Sweden
Primary care 97%
Hospitals 81%

But in these hospitals 6 products with at least 5% of the market covers 90% of the digitalized records. But mostly local system doesn’t communicate with each other. [52]

In Sweden 290 mostly local authorities provide at home services and special accommodation for their citizens. Approximately all hospitals, primary care centers and home care units fully digital and computerized. User computer literacy is very high in most areas of Sweden. [53] Furthermore
many other major projects or activities were initiated and undertaken on a regional and/or national level during the last five years covering different aspects of eHealth applications and/or services. A few of service are as follow. [36]

- A continuing study of legislation by the patient data inquiry on the handling of information.
- The InfoVU-project which will use in care administration documentation. Appropriateness evaluation of SNOMED is being supported by the government.
- A National Patient Summary has been launched.
- The CarelinkPLUS project developed reference architecture and its main purpose is the communication of the systems among the different organizations.
- The SITHS-project has developed safe IT verification solutions for health care professionals.
- For citizens The National Patient Advice project has developed a Health Portal.

4.9.6 Implementation of Interoperability perspective in Sweden and other European Countries.

In Sweden since 2002 all hospitals and primary health care centers have been connected via Sjunet that is administered by Carelink and dedicated to health care. It is stated in eHealth ERA report 2007 this network also links together county councils, regions, pharmacies and many other healthcare projects. At present it is connected in 80 public hospitals, 800 primary care centers, 950 pharmacies and a number of private health care institutions. A large number of eServices are also implemented by Sjunet such as ePrescription and telemedicine. Denmark and Norway also doing cooperating with each other in health care and are using operational national eHealth infrastructures that provide messaging and other services. Finland regional networks are being interconnected to many hospitals and primary cares to allow for exchange of various types of patient summaries. Almost twenty countries are implementing national eHealth infrastructure connecting all actors of the health sector [36].Some countries are also working of implementing interoperability among systems. Like Slovakia is currently undertaking feasibility studies and adopting different eHealth standards for insuring technical (HL7) and semantic interoperability and they are also planning to implement health and insurance card. Bulgaria health care is also working on the government policy to implement eCards, electronic health records management information systems and web services are the Government policy of agenda [36].In Denmark for example they have developed a platform for technical standards and interoperability for eMesages [36].
4.9.7 Implementation of Interoperability in Health Care

To handle patients in large hospitals and primary cares is very complex because all information is stored in a complex system. The interoperability of these systems and the sharing of data among different primary cares and hospitals is a well known problem now days. Clinical data comes from many different sources and the hardware or software solutions are insufficient for handling them. The format in which many applications record data, using free text that is easy for human manipulation but it is very complex when it process through automatic processing. Using health standards is a solution that accommodates both requirements. The possible way of communication is through the Health Level 7(HL7) that makes the whole system easily interoperable with applications in related domain [54].

One of the key problems in health care informatics, that there is no interoperability among different health care organizations. Interoperability can be judged in different ways such as the interoperability of message exchanged between health care applications, interoperability of Electronic Health Records and the interoperability of patient identifiers. Making health care information systems interoperable will reduce cost of health care.

4.9.8.3 ARTEMIS

Currently there are no such methods from which we can check the patient identification. ARTMEIS develops a protocol that allows the identification of patients that is called Patient Identification Process (PIP). The major benefit of ARTEMIS that it enables clinicians to capture the complete history of patient.

The problem in healthcare interoperability can be investigated in the two categories [60].

4.9.8.4 Interoperability Categories

4.9.8.4.1 Interoperability of Healthcare Message Exchanged

To exchange information among different healthcare organizations messaging interfaces are used. The main function of messaging interfaces that it receives data from the back end of application systems and encodes that data into messages and then it transmits over a network such as Value Added Network (VAN). At the receiver side the received messages are decoded, processed and the data which receives at the receiver back-end systems are stored and processed as shown in the figure 4.9.8.4. [47]
4.9.8.4.2 Interoperability of Electronic Health Records (EHR)

The Electronic Health Record (EHR) can be defined as that the patient’s information record in digital format. Patient medical healthcare information can be placed over a number of institutes which do not interoperable with each other. To provide the continuity of care clinicians should be able to capture the patient history and check their all previous records. A number of efforts are going on progress to provide the interoperability of electronic health records such as HL7 open clinical document architecture (CDA), open EHR. But implementation of interoperability among electronic health records is not achieved yet. There is also different health care domain in which there is a need of interoperability among them such as patient identifiers, coding terms health care business processes [47].

![Message exchange between heterogeneous applications](image)

**Figure 4.9.8.4 Message exchange between heterogeneous applications.** [47]

Recently the Health Level 7 version 2 is mostly used in healthcare domain. But the problem in HL7 version 2 that it does not imply direct interoperability among healthcare systems. To overcome this problem HL7 version 3 is developed which is based on Reference Information Model (RIM) [47].
Chapter 5: Health level 7 (HL7)

5.1 Health Level Seven (HL7)

HL7 is an organization consisting of experts in healthcare that work together to create standards for the exchange, management and the integration of electronic health information [24]. Hospitals and other primary health care centers have different software systems where they save patient’s data. All of these systems should communicate from one primary care to another but not all do so because there is no interoperability between systems. HL7 provides a number of standards, guidelines and methodologies by which various primary cares and hospitals can communicate with each other. These standards allows the primary cares and hospitals to communicate with each other [24].

Health Level 7 (HL7) is an ANSI accredited Standards Development Organization. HL7 was founded in 1987 to overcome the problems in health care. HL7 is an organization consists of experts in health care work together and creates standards for exchange of information. The rapid increase of HL7 is beneficial for both users and the vendors. The main function of HL7 is how to increase the efficiency in healthcare organizations. According to [55] HL7 basic purpose how different heterogeneous system communication with each other, HL7 is an application layer through which data is exchanged in healthcare environments.

In Sweden HL7 started work in late 2005 and today there are about 30 members from different counties, organizations from Sweden [55, 48].

Health Level Seven (HL7) is an organization that creates health care messaging standard. HL7 also developed such standards for the representation of clinical documents [56]. HL7 provides several functions for the exchange and the combination of data regarding both patients and health care services. HL7 is strictly related with XML because HL7-based documents can be easily coded in this language. Furthermore it is widely accepted standard in the marketplace [57].

5.2 HL7 Versions

5.2.1 HL7 Version 2.X

The basic aim of HL7 version 2.X is to support hospital workflows. It was made and established in 1987. HL7 version 2.x uses textual and non-XML encoding. HL7 version 2.x allowed for interoperability between Electronic Practice Management (EPM) systems as well as Electronic Health Record (EHR). [58]
5.3 Benefits of HL7

- HL7 allows information exchange among different computer applications.
- HL7 is a platform and technology independent standard protocol [59].

5.4 Health Level 7 in Sweden

HL7 is an international organization consisting of experts in health care that work together to create standards for the exchange, management and integration of electronic health information. HL7 is working primarily with the clinical and administrative information. HL7 is working to spread the use of standards to increase good organization in health care. HL7 is an Accredited Standards Development Organization.

HL7 Sweden is the Swedish subsidiary organization representing HL7 in Sweden. HL7 Sweden started in late 2005, and today consists of about thirty members from counties, organizations and businesses. HL7 Canada is a non-profit organization open to all persons, companies and organizations active in Sweden.

HL7 Sweden aims to facilitate their members to understand and where appropriate use of standards from HL7 Inc. and to contribute to the Swedish comments on the overall HL7 development can be brought up to the international organization.

HL7’s vision is to create the best and most widely used standards in healthcare. Their mission is to (oöversatt) "HL7 provides standards for interoperability that improve care delivery, optimize workflow, reduce ambiguity, and enhance knowledge transfer among all of our stakeholders, including healthcare providers, government agencies, the vendor community, fellow SDOs and patients. In all of our processes we exhibit timeliness, scientific rigor and technical expertise without compromising transparency, accountability, practicality, or our willingness Thursday put the needs of our stakeholders first."

A not entirely unusual misconception is that HL7 develops software. In reality, HL7 develops specifications and standards.

Members of HL7 are called HL7’s Working Group, which in itself is organized into technical committees (TC - Technical Committees), and special groups (SIG - Special Interest Groups). There are technical committees responsible for the content of the standards. The specific groups (SIG) may be seen as test beds for exploring new areas for which HL7’s standards. HL7 has in recent years become a more global organization. HL7 is now organized in 30 countries. HL7 also cooperates with other standardization organizations such as CEN in Europe and the ISO (International Standards Organization).
Basically HL7 standard works in application layer through data exchanging in health care environments. The HL7 combines the work among healthcare providers, consultants and vendors and it was established in 1987. The basic purpose of HL7 standard is that it defines the message, segment field. The quick expansion of the HL7 standard in health care organizations is benefit both the vendors and the users. [62]
Chapter 6: Interview

An interview is a discussion among two or more people where questions are asked by the interviewer to gain information from the interviewee.

In our study we conducted the interviews those persons who were expert in their domain and who knows very well about Interoperability.

6.1 Purpose of the interview

In this study we conducted three interviews with the purpose to identify how interoperability can be implemented among the primary health care centers and hospitals in Sweden. What are the difficulties that the primary health care and all health care centers are facing due to the lack of interoperability? Our main purpose of conducting interviews was to investigate the interoperability issues in health care organizations.

6.2 Selection of Interviewees

According to the research questions no one and two we select 3 peoples to interviews with them naming Per-Eric-Thorell, Thomas Pehrsson and Kathrine Alriksson.

Per-Eric-Thorell is a nurse (doctor) in Ronneby primary care (Capio CityKliniken). As a nurse he is working from the last 30 years and he is working as a medical administrator as well. He has worked in different medical companies. He has been teacher in medical field. He also worked in Norway in medical fields. He also worked as emergency for sickness of people. Now he is working as a nurse administrator in Ronneby primary care (Capio CityKliniken). Thomas Pehrsson is working as eHealth Strategy Maker in the county of Blekinge. He makes the health strategies for primary health care centers and hospitals. Now he is working as eHealth Strategy Maker in Wämö center Karlskarona. Kathrine Alriksson is working as a Health Service Planner Project Manager in the county of Blekinge. She is working as an operational planning and evaluation department at Wämö center in Karlskarona.

6.3 Interview implementation Planning

The three different interviews were conducted at different location in Karlskarona. One is in Ronneby and two is in Wämö center Karlskarona. Time duration of the first interview was 55 minutes which we conducted in Ronneby primary health care and second interview was with Kathrine Alriksson in Wämö centre and the duration of this interview was 40 minutes. The third
interview we conducted with Thomas Pehrsson in Karlskrona Wämö center and the duration of this interview was 60 minutes.

6.4 Designing the Interview
In the interviews we put formal and informal questions related to our topic “Role of Interoperability in eHealth”. The questions we asked to the interviewee were very important about interoperability, benefits of interoperability, and the difficulties that the health care professionals are facing without interoperability among health care centers. In the formal approach we designed some questions related to interoperability. With the help of these questions we try to bring out the original thinking and views of the professionals according to their experience and job nature. In the informal approach we discussed some questions about the different systems that are used in health care centers and hospitals. With the help of interviews we observed and noted that how we can implement interoperability among different health cares and what are the shortcomings regarding the interoperability.

6.5 Collection of Data
All the data during the interviews was documented and recorded. After interviews all the data was arranged in a proper way. While calculation the data Per-Eric Thorell helped us in getting the data. He also explained about the next future plans about interoperability among health care centers.
Kathrine Alriksson helped us to know the Government policies about interoperability, Government strategies and the next future planning of the implementation of interoperability among the health care centers.
Thomas Pehrsson also helped us getting the data and told us that how patients and health care professionals can get benefit through interoperability. Thomas person also told us the Government strategies and planning about the eHealth.

6.6 Analysis of the Interview
After conducting the interviews all the recorded videos were converted into the text format. Conducting all interviews and after collecting data we analyze different information which we may be missing from different literature. The interview with strategy maker, health professional and health service planner we gather much information regarding interoperability among the health care centers and also get the information about the problems and hurdles in the way of interoperability. After the interviews we also analyze the problems that health care organizations
are facing now a day. These interviews help us to analyze the issues regarding the implementation of the interoperability among the health care centers.

6.6.1 Interoperability in Primary Health care centers and Hospital
According to Per-Eric Thorell in question 1 that our primary care is linked with Stockholm, Gotheborg, Hamlstad and Karlskrona branches. He told us that these branches are interoperable with each other because they are using the same system in Capio CityKliniken. Thomas Pehrsson told us that the two hospitals which are in the Blekinge County are also interoperable with each other because they are also using the same system and they can share the information.

6.6.2 Expected interoperability in Future
According to Per-Eric Thorell in question 3 that in the next year we are planning that in the county of Blekinge all the health care centers will be interoperable by using the same system. According to Thomas Pehrsson they are also going to implementing the interoperability among some primary health care centers in next year.

6.6.3 Interoperability is beneficial for patients and health care professionals
According to Per-Eric Thorell interview questions 4 and 5 that definitely interoperability is beneficial for patients. Patients can get quick response, reduce of telephone calls etc. We can check patient history and can give proper treatment with a quick response. Per-Eric Thorell told us that we are facing much problem without interoperability when patients come from different health care centers then we cannot get their information from the system, so if system will be interoperable then it will be beneficial for both the patients and health care professionals.

6.6.4 eHealth Standard
According to Per-Eric Thorell in interview question 6 he told us that at this time all health care centers does not follow the eHealth standard but in the future it may be possible.

6.6.5 Interoperability in EU
According to Per-Eric Thorell interview question 7 he told us that there is no interoperability in EU at all. But we are planning to implement interoperability among EU by adopting Health Level 7 standard.
According to [21] strategy maker also told us we are working with EU in different projects to establish interoperability between different EU countries the major one project is epSOS. Sweden is leading this project.

6.6.6 Government strategy about Interoperability

According to Per-Eric Thorell interview question 8 he told us that Government is not interested in interoperability among health care centers because it is a big project and lot of cost is required for this project. The most important thing is the patient record and information security.

6.6.7 Smart Card or RFID technologies

According to Per-Eric Thorell interview question 10 he told us that Smart Card or RFID technologies can be better idea. If smart card implemented then patient record can save in smart card and patient can go anywhere and health care professional can check his/her medical record.

6.6.8 Systems should be same

According to Per-Eric Thorell in interview question 11 he told us that interoperability is possible if systems are same in all primary health care centers. He told us that we (Capio CityKliniken) are using the same system so we can exchange the information among our branches. All the data is interoperable among these primary cares centers. But we cannot access public sector primary health care centers or other companies’ patient’s health related data.
Chapter 7: Questionnaire

7.1 Questionnaire
Questionnaire is a good and less costly way to gather data from different places. The data getting from different palaces depends upon the design of questionnaire. If the questionnaire is designed well then you can gather information in better way.

7.2 Questionnaire Conduction
In this chapter of our thesis we will discuss that how we conduct the questionnaire for the county of Blekinge. We will also discuss in this chapter about the planning of the questionnaire, designing of the questionnaire, analysis of questionnaire and all other related issues to conducting a questionnaire. We will also discuss about the distribution of our questionnaire in this chapter. We will also discuss in this chapter about the questions which we ask in our questionnaire. To study this questionnaire reader should keep in mind that when we conduct this questionnaire there are three categories of people who answer these questions because there are some technical questions in this questionnaire. In this questionnaire the health professional, eHealth IT administrators and the health strategy maker professional take part.

7.3 Questionnaire Design
Before conducting the questionnaire we also complete some oral interviews and then we do much formal discussion with teacher and with some hospital experts, we design these questionnaires with some medical IT administrators. We also include some questions that how they think about interoperability among the health care centers and hospitals. We also include some questions that how it is possible to create interoperability among the primary health care centers and hospitals. The reason to include the health expert who already uses this system is this, that how much they are satisfied to using these systems without any interoperability among these health care centers and hospitals.
When we was designing this questionnaire we also in mind that how can we cover study about interoperability and how can we provide any solution or give any idea about the interoperability among the primary health care centers and hospitals.
7.4 Questionnaire Planning

We plan questionnaire to strengthen our study and research. We 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 health care and hospital about the interoperability, That if there is any interoperability among these hospitals and these health care centers then what will be the benefit to them and what will be the benefit to the citizen and users of eHealth.

7.5 Circulation of Questionnaire

When we complete all the planning and designing of our questionnaire then we circulate questionnaire to and health experts. We circulate all persons the printouts of our questionnaire. Before the circulation of our questionnaire we brief describe that why we design this questionnaire and what we are think about the interoperability and how can we suggest some good method for interoperability among these primary health care centers and hospitals. So we also tell them that if they fill this questionnaire proper and in well informed manner then they will help us to suggest some good method of interoperability.

After when they will give us back this answered questionnaire then we can better analyze and suggest some better way of interoperability.

7.6 Questionnaire Selection

The method of conducting questionnaire is very low cost and communicative to collect different data through different people. This is also an economical and easy way to collect data as comparison of other data collecting methods.

The method of collecting data through questionnaire is also little fast way to get data even some time if we have an online questionnaire then we can get and collect data within a single day.

In this ways of gathering information is also manageable the data confidentiality, privacy and security.

7.7 Analysis of Questionnaire

After the completion of successful conduction of questionnaire with health professional and health (system) expert, to get the actual result we do the analysis of questionnaire in the quantitative way. We analyze the questionnaire according to the feedback of the people...
Table 7.2-Questionnaire

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<tr>
<th>Sr.</th>
<th>Questions</th>
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<tbody>
<tr>
<td>1</td>
<td>Should all health care centers adopt the eHealth standard?</td>
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<tr>
<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<td></td>
<td>• Don’t Know</td>
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<td>2</td>
<td>Do you think there should be interoperability among health care centers?</td>
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<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<tr>
<td></td>
<td>• Don’t Know</td>
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<td>3</td>
<td>Do you think that interoperability among the health care centers is beneficial for patients?</td>
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<td></td>
<td>• Yes</td>
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<td>• Don’t Know</td>
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<td>4</td>
<td>Do you agree that all health care centers should use the same system (i.e. same software)?</td>
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<td>• Yes</td>
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<td>• No</td>
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<td>• Don’t Know</td>
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<tr>
<td>5</td>
<td>Is there any interoperability among the different health care centers is available these days?</td>
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<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<td>• Don’t Know</td>
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<tr>
<td>6</td>
<td>Do you think that the RFID or smart card technology should be implemented in health care centers?</td>
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<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<td>• Don’t Know</td>
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<td></td>
<td>Question</td>
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<td>--------------------------------------------------------------------------</td>
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</tbody>
</table>
| 7 | Do you think that health standard 7 could be helpful in the implementation of interoperability among the health care centers? | - Yes  
- No  
- Don’t Know |
| 8 | Should Government of Sweden take initiative of implementing interoperability among the health care centers? | - Yes  
- No  
- Don’t Know |
| 9 | Do you think that some political issues are the hurdles in the way of implementation of interoperability among health care centers? | - Yes  
- No  
- Don’t Know |
| 10| Do you think that some social and economic issues are the hurdles in the way of implementation of interoperability among health care centers? | - Yes  
- No  
- Don’t Know |
| 11| Do you think that there are some administrative issues of the different health companies that not want interoperability among the health care centers? | - Yes  
- No  
- Don’t Know |
<p>| 12| Do you think that patient security is the main issue that’s why the Government of Sweden is not interested in implementation of interoperability among health care centers? | - Yes |</p>
<table>
<thead>
<tr>
<th></th>
<th>Question</th>
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<tbody>
<tr>
<td>13</td>
<td>Do you think that cost on projects of the implementation of interoperability among health care centers is the problem?</td>
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<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<td></td>
<td>• Don’t Know</td>
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<tr>
<td>14</td>
<td>Is there any interoperability is expected in the county of Blekinge near future?</td>
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<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<td>• Don’t Know</td>
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<tr>
<td>15</td>
<td>Do you agree that Information and communication technology (ICT) playing an important role in health care organizations?</td>
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<td></td>
<td>• Yes</td>
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<td></td>
<td>• No</td>
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<td></td>
<td>• Don’t Know</td>
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7.8 Close Ended Questions
In questionnaire question 1, 100% medical IT administrators were agree that all health care centers should adopt the eHealth standard.
In questionnaire question 2, 100% medical IT administrators were agree that interoperability should be implemented in health care centers.
In questionnaire question 3, 100% medical IT administrators were agree that interoperability is beneficial for patients. Patients can get quick and fast response through interoperability.
In questionnaire question 4, 80% medical IT administrator was agree that all the health care centers should use the same system, but 20% were disagree that there should be some standard in health care centers.
In questionnaire question 6, 95% medical IT administrators were agree that Smart card or RFID technologies can be a better idea and it is beneficial for both patients and health care professionals while the 5% people think that this is an expensive and complex method.
In questionnaire question 7, 100% medical IT administrators were agree that there should be health standard, we should adopt the health standard to elaborate this they say that when the standard will be adopted then there will be better interoperability chances.
In questionnaire question 9, 50% medical IT administrators were agree that political issues are hurdles in the implementation of interoperability among health care centers, while 50% were think that we should adopt the eHealth standard and no political issues involved in the implementation of interoperability among the health care centers.
In questionnaire question 10, 70% people think that there is no economic and social issue involved in the implementation of interoperability while 30% people say that there are also some economic and social issues are the hurdles in the implementation of interoperability among the health care centers.
In questionnaire question 11, 80% professional say that the administration of different companies are not the problem for the interoperability while 20% people says that there are also some administrative issue are the hurdles in the implementation of interoperability among the health care centers.
In questionnaire question 12, 80% medical IT administrators were agree that patient information security is the main problem in the implementation of interoperability between health care centers while 20% think that patient information security is not issue in the implementation of interoperability.
In questionnaire question 13, 95% medical IT administrators were agree that the cost is the problem that’s why the Government of Sweden is not implementing interoperability among health care centers while 5% thinks that cost is not the issue. 
In questionnaire question 14, 98% health professionals expected the interoperability among the health care centers in future while 2% not expected.

![Figure 7.1 Medical IT administrator response against close ended questions](image)

### 7.9 Analysis and Conclusion of the Questionnaire

From the above bar graph it is clear that in questionnaire question 1, we should adopt the eHealth standard otherwise it is very difficult to interoperability among health care centers. All the health care centers should follow the same rule.

In questionnaire question 2, 100% medical IT administrator wants that there should be interoperability between health care centers. With interoperability it will be easy for health care professionals to diagnose the patients in a better way.

In questionnaire question 3, 100 % medical IT administrator agree that interoperability is beneficial for patients. With interoperability patients can get fast and quick response from doctors or health professionals, reduce telephone calls etc.

In questionnaire question 4, 90 % medical IT administrators agree that we should use the same system. Using same system there will be low error and the transfer of medical data will be easy.
In questionnaire question 5, 30% medical IT administrators think that the interoperability among health care centers is not too much. The health care organization that is using the same system there is interoperability but the percentage is only 30%.

In questionnaire question 6, 95% medical IT administrators think that Smart card or RFID technologies are better idea. Patient can check their own record in their Smart card and they can check there record.

In questionnaire question 7, 100% medical IT administrators were agree that eHealth standard should be adopted and it is a better and secure way in the implementation of interoperability among the health care centers.

In questionnaire question 12, 13, 80% medical IT administrator were agree that cost and security of patient information is the main problem that’s why the Government of Sweden is not interested in the interoperability among health care centers.
CHAPTER 8: Discussion Validation and Assessment

This chapter discusses the validation and assessment in our thesis. In section 7.1 the authors discuss about different issues regarding interoperability and discuss about shortcomings of interoperability. In section 7.2 authors discusses about validity assessment.

8.1 Discussion:

The interoperability in eHealth are studied and analyzed to know about the importance of interoperability. The authors adopted a well structured approach to analyze the role of interoperability in eHealth. In this section the authors study the interoperability in different health care organizations.

8.1.1 eHealth Standard in Sweden and other EU countries

According to authors point of view it will be a good idea if all health care organizations adopt eHealth standard in their health organizations. By using eHealth standard all health care organizations will be able to interoperate with each other.

By adopting eHealth standard there will be substantial benefits in the future for example:

- Health care organizations will be able to interconnect with each other.
- It will allow the interoperability between EU countries.
- Patient’s record will be available to every health organization.
- Peoples can share their medical data even when they will be out of the country.
- Electronic Health Record (EHR) accessibility in EU countries.
- Doctors can better diagnose their patients.

8.1.2 Systems Connectivity

According to medical IT administrator, all health care organizations are not using the same system. The health care organizations that are using the same system are able to interconnect with each other. In authors point of view if all health care organizations use the same systems then there will be following benefits.

- Peoples can go any primary care and hospitals in Sweden.
- Doctors will be able to share their experiences.
- Reduce of telephone calls and save time of patients and doctors.
8.1.3 Smart Card or RFID Technologies

According to medical IT administrator, in Sweden we are not using the Smart Card or RFID technologies. In the authors point of view that Smart card or RFID technologies should be implemented in Sweden. There will be many benefits like.

- Patient medical history will be save in Smart Card.
- The health professionals can check patient’s medical record from their Smart cards when they will be out of the country.
- Usage of Smart Card technologies will save the time of health professionals to get the previous medical record information of patients.

8.2 Validity Assessment

Research result validity assessment is an important part in our thesis. In our thesis the assessment of validity is based on four categories. Creditability, Transferability, Dependability and Conformability.

8.2.1 Creditability

According to Trochim 2006, creditability means that the results are accurate by the participant’s point of view in the research [61]. To accomplish thesis creditability authors used a mix approach of research methodology. In the first phase of our thesis we studied the literature review and informal discussion with senior students. After findings in our first phase of thesis we conducted three interviews. After analysis of the interviews we conducted the questionnaires from different health care medical IT administrator. Authors deeply analyze the questionnaire findings. After adopting analysis techniques from questionnaire and interviews authors are confident about the creditability of the study.

8.2.2 Transferability

According to Trochim 2006, transferability refers to the degree to which the research results are generalized for other context of setting [61].

Our interoperability findings are based upon interoperability standards to provide interoperability among health care organization. These interoperability standards are worldwide recognized or worldwide acceptable so our findings regarding interoperability standards can be transferable to any other health care organization.
8.2.3 Dependability

According to Trochim 2006, dependability means that the research is responsible for describing the changes that occur in the setting and how these changes affected the way of research approached the study [61]. Three interviews were conducted in different timing. One interview was conducted at 3 pm and two interviews were conducted in the morning. Second and Third interview was conducted after one week of the first interview. Strategy Maker was very busy and his English was not so good. So it is possibility that strategy maker answer may get affected during interview because his English language was not good.

The questionnaire is distributed after one week of the interviews. It can be a validity thread because some medical IT administrator doesn’t understand the logical terms in questionnaire. We conducted questionnaire with five health care organizations within county of Blekinge. There is a possibility that we missed some important information about interoperability because there are still many health care organizations left.

8.2.4 Conformability

According to Trochim 2006, conformability refers to the degree in which the results could be confirmed by other authors [61]. To achieve thesis all interviews were converted into the text format and then separated into sections for analysis and comparisons purpose. After analysis the questions authors send these questionnaire different health care organizations for conformability.
CHAPTER 9: EPILOGUE

The epilogue contains conclusion, suggestion and future work.

9.1 Conclusion

The objective of our research is the study of interoperability among different primary health care centers and hospitals especially in Blekinge County. eHealth facing big challenges of interoperability in the 21st century not only in Blekinge County but whole in Sweden and as well as whole EU and even whole world. This research is based on the literature review study and also interviews and questionnaires with different medical IT and health experts. The literature review study, interviews with experts and analyzing the questionnaire and all the results describe that the big challenge in the implementation of interoperability is the lack of same system that is running in different health care centers. In Sweden every health care organization (public and private) is using their own system. After analyzing all study we conclude that there is also a big challenge for the interoperability is the patient’s record and information security.

After the interview in our findings we found that there is some interoperability among the health care centers but they are only in between their own system such as Capio CityKliniken is a private health care services provider and they have interoperability among their 5 branches but they are not interoperable with public health care centers. There are also two hospitals in Blekinge they can share their information with each other but they are not interoperable with other counties hospitals.

These challenges in the field of eHealth and interoperability need much hard work to resolve these issues of patient information security and same system as a technology aspect. For the interoperability the security of patient’s record and information and the use of same system are very important and to resolving these issues there can be a better implementation of interoperability among the health care centers and hospitals. The questionnaire and interviews main theme is also the security of patient’s records and some issues of different software system. After analyzing the interviews and questionnaire there also one other very important and big issue is the eHealth standards, if all health care centers and hospitals adopt the same eHealth standards then the interoperability can be implemented among the country as well as among the EU.
9.2 Suggestions

The authors have some suggestions for the responsible persons in this field might be these suggestions will helpful to improve the eHealth interoperability among the different health care centers and hospitals in the Blekinge county and also rest of the Sweden. These suggestions are supported by our findings and observations from the interviews with experts and analyzing the questionnaire results.

Today is the age of technology and information science so we suggest that if all healthcare centers use the same system then this can be helpful in the implementation of interoperability. We suggest that when all health care centers will use same system it will be not much cost.

The adopting the eHealth standards same in all hospitals and health care centers they can be easily interoperable to each other.

We suggest that if all health care centers follow or adopt the eHealth standard 7 then there will be very easy interoperability among these health care centers. Health standard 7 provides all the facility for sharing the information to each other. By using this standard 7 there is also overcome to the technology and the gap of technology will also filled by using this standard.

We also suggest that if the following options will adopt then it will helpful for health care organizations.

- All health care organizations primary care and hospitals should adopt the eHealth standard.
- From every health organizations there should be a representative using their own format and should agree on one format.
- In cooperation there is a need to identify synonyms.
- There is a need to select the most appropriate terminology and all health care organizations agree on these terminologies in a consistent and coherent manner.
- All health care organizations should use the same system.
- From country to country there is a need to use same medical language in all health care organizations.
- To overcome the patients information and record security issues there should be some special rules and regulation for all the health care centers either they are public or private. When they will follow these rules and regulation by heart then we think that patient’s information and record security issue will also be resolved.
9.3 Future Work

Our research is the effort to solve the issues of interoperability among the health care centers and hospitals. We think that our suggestions will be helpful for implementation of interoperability among the health care centers and hospitals. We analyze many things by our interviews and questionnaires and we think there are many maybe deficiencies in the study and it needs more detailed research and work for the better of interoperability among the healthcare centers and beneficial for the people of the county of Blekinge. In future there is need to work on smart cards and RFID systems in eHealth fields. We think that if there is some work on the RFID and smart cards technology for medical purposes it will be much beneficial for the patients and as well as for the health professional.

The smart card technology will also help to reduce the extra burden of health care professionals like documentations and maintain the record of patients manually.
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Appendix 1: Interview

A-Interview with Medical Administrator

Question 1: Is your primary care is connected with other primary cares?
Answer 1: Yes

Question 2: Is there is any interoperability among primary cares and hospitals in Sweden?
Answer: No.

Question 3: Is there any interoperability is expected in the near future?
Answer 3: Yes

Question 4: Do you think that interoperability is beneficial for patients?
Answer: Yes sure

Question 5: Is interoperability beneficial for health care professionals?
Answer 5: Yes sure.

Question 6: Do you think that the Swedish health care centers are following the eHealth standards?
Answer 6: No, not at all, but in future it is possible.

Question 7: Is there any interoperability among the health care centers in EU.
Answer 7: No, not at all.

Question 8: Do you have any idea that why Government of Sweden not implementing interoperability among health care centers?
Answer 8: Not sure it’s a big project so I think it’s a money problem and patient record and information security problem.

Question 9: How patients can get benefit through interoperability?
Answer 9: If there will be interoperability the patients can get fast and quick response.
Question 10: Do you think that Smart card or RFID technologies can be implemented in healthcare centers?

Answer 10:- Yes, it's a good idea but also costly

Question 11: What do you think that how can we implement interoperability among health care centers?

Answer 11: Systems should be same.

Question 12: Can patient access his/her health record in any other country?

Answer 12: No at the moment, but in future I think it will be possible using health standard.
B-Interview with Health Service Planner

**Question 1:** What are the advantages of interoperability among health care centers?

**Answer 1:** We always need updated information at short notice but it should be secure otherwise we can’t implement it. We can’t afford giving patient wrong therapy.

**Question 2:** How patients can get benefit through interoperability among health care centers?

**Answer 2:** The patients can get much benefit due to interoperability by getting their medical history and quick response by the health care professional when they will go to any health care center.

**Question 3:** How health care professionals can get benefit through interoperability among health care centers?

**Answer 3:** Faster response from patients, less time in telephone and more quality time with patients that need IRL time with us.

**Question 4:** Do you have any idea that why Government is not implementing interoperability among health care centers?

**Answer 4:** Security of patient health record and cost is the major problem.

**Question 5:** Did Government ever ask some suggestions about interoperability implementation from health professionals like you?

**Answer 5:** Yes Government asking about the suggestions and different methods of implementing the interoperability in health care centers.

**Question 6:** What you think that interoperability among health care centers should be implemented or not?

**Answer 6:** I think interoperability is the future we have to work smarter and be able to do more with less resource. I don’t think we can ignore it so much longer, but security of patient health record and information is number one that has to be solved first.
**Question 7:** Can you tell us that due to some social and political issues are the hurdles in implementation of interoperability among health care centers?

**Answer 7:** Cost is the biggest problem it over rules everything.

**Question 8:** Is there any interoperability among health care centers is expected in near future?

**Answer 8:** We hope that our booking service will be able to start before summer. Then it will be possible to make appointment within healthcare services on internet any time, if you have had contact with the unit before. New patients always will have to talk with a live person to book time.

**Question 9:** How many your branches of health centers have interoperability among each other?

**Answer 9:** The units in the hospital all have the same patient record so they can send messages and documents between each other. In primary care they have another patient record but we will implement the same as in hospital within this year, then they all are interoperable.

**Question 10:** Is there any interoperability among the health care centers especially in EU?

**Answer 10:** No, not that I know of.

**Question 11:** How many primary health care’s and hospitals in Blekinge?

**Answer 11:** We have 2 houses for hospital care but they are one administrative unit. We have 12 primary care centers but they are organized in 9 administrative units.

**Question 12:** Is your system connects with the national database?

**Answer 12:** No, our system is not connected with the database, but in future it may be possible.
C-Interview with Strategy Maker

**Question 1:** What do you know about interoperability?

**Answer 1:** Interoperability is the exchange of information between two or more systems.

**Question 2:** What is the Swedish national health strategy?

- Creating a common infrastructure between health care organizations.
- Adopting eHealth standard.
- Interconnecting different primary cares and hospitals with each other so they can communicate with each other.
- Facilitating interoperability between different primary cares and hospitals

**Question 3:** Are you agree that all health care centers should adopt the eHealth standard?

**Answer 3:** Yes sure, and then I think it is possible interoperability among health care centers.

**Question 4:** What do you think that why Government of Sweden is not interested in implementing interoperability among health care centers.

**Answer 4:** I think patients health record security and cost is the main problem, but in the next year in the county of Blekinge we will be able to interconnect with all primary care and we hope also with other counties.

**Question 5:** Is there any interoperability among Sweden health care organizations and EU health organizations?

**Answer 5:** No, at this time. But we are trying to implement Health Level 7 standard. There are many cross-country programs are working the most important one is epSOS. The main goal of this program is the patient health record security, transfer of patient summary and the information across member states.
Question 6: Do you think that Electronic Patient Record (EPR) is the basic step towards interoperability?

Answer 6: Yes sure, in many counties it is implemented, but now we are implementing it at regional level.

Question 7: Do you think that interoperability is beneficial for health care professionals?

Answer 7: Yes sure, why not. We can get fast and quick response and can check all patient history.

Question 8: How we can implement interoperability between Sweden and other EU countries?

Answer 8: First of all we should use eHealth standard and second we should adopt the same medical language in all Europe, because every country has different culture and different language. We are trying to use the same specification in all Europe it is called Snomed and it is implementing quickly in Europe.

Question 9: Do you think that patient information security is the main cause that’s why interoperability is not implementing in health care organizations?

Answer 9: Yes I think patient security is the main problem. But in Sweden I think it is not the big problem, because we Swedish believe on trust. But in other countries it is difficult like in Germany in Second World War Nazi misuse information security against their own citizens.

Question 10: Do you think that Smart card technology or RFID technology can be a good idea in interoperability between health care organizations?

Answer 10: No, I don’t think so but in Sweden it cannot be implemented because we as Doctor cannot believe on Smart card without diagnose of patient. But if any citizens go another country then it can be helpful.
**Question 11:** Do you think that Blekinge eHealth strategy is dependent on European Union eHealth strategy?

**Answer 11:** Yes, but all county councils had IT in their own way.
Appendix 2: Screen Shot  Ronneby Primary Care System Overview
Appendix 3: Screen Shot   Landstinget Blekinge, Wämö Center,