Interoperability in Electronic Medical Records

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Abstract

Electronic Medical Records (EMR) is the vital and basic part of construction digitizing hospital. However the systems are well-known for their interoperability problems and a Swedish evaluation from 2010 concluded it to be the most frequent obstacle in workflow. We then wondered what techniques the organizations used to solve the problem to understand if the organizations use the right solution to address the right problem.

The paper introduces a broad approach into the distributed Electronic Medical Records (EMR) domain of Sweden. It also provides a thorough literature review that explains what Electronic Medical Records (EMR) and the interoperability concept are, as well as the technical solutions available for achieving interoperability in Electronic Medical Records. The summary of this review rendered a research model with criteria's for a fully-functional working interoperability solution.

The main research was carried out as semi-structured interviews with key personnel in the IT department within two separate Swedish hospitals under the county council of Skåne.

The analyzis and discussion that followed from the empirical investigation found that the region is implementing a standard for medical terminology, new databases to store the medical records and one common interface to access all EMR system. However the findings also showed that the interface is founded upon a technical solution that is unsuitable

Our general conclusion from this research showed that the solution used in the studied healthcare organizations didn't meet the criteria's in our research model and does not correspond to the needs of the organizations. This conclusion also shows that more research in the topic has to be done to provide healthcare organizations with supporting guidelines about the interoperability because they don't understand the problem area.

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Glossary

EMR: Electronic Medical Records

HL7: Health Level 7

IEEE: Institute of Electrical & Electronic Engineers

SOA: Service-Oriented Architecture

SOAP: Simple Object Access Protocol

SUS: Skåne University hospital

UMAS: Malmö University Hospital

WSDL: Web Services Description Language

XML: eXtensible Markup Language

Snomed: Systematized Nomenclature of Medicine

Meilor: Siemens developed medical system

1. Introduction

1.1   Background

Fölster et al (2003) diagnosed the Swedish healthcare IS to be suffering from severe "spaghetti syndrome" where to the myriad of different Electronic Medical Records (EMR) systems used in the units and the absence of a common infrastructure for IS communication, created an unacceptable situation for staff and patients.

Being among the most IT intensive units worldwide hasn't made Swedish healthcare the forerunner in EMR system integration but rather yet another in a series of organizations suffering from interoperability problems among the systems used. Unfortunately for healthace organizations EMR systems has made themselves well known to make it hard for the users to receive useful information and establish communication with other systems (Jaana et al 2012).

Aware of the problem the Swedish government at 2006 adopted its first national IT-strategy for the healthcare sector (SKR 2005/06:139). In the strategy six areas of intervention are mentioned that aim to create the conditions for an efficient IT usage within the healthcare organizations, and how to improve and adjust the IT-systems used as tools for accurate and secure patient data management. The six areas also aim to ensure that the systems used in all healthcare organizations nationwide provides a seamless interoperability with each other and with systems outside the organizations (Socialdepartementet, 2010).

The Swedish Municipality and County Council department (SKL) has by governmental mandate been allocated considerable resources to realize the national strategy and deal with the interoperability problems (SKL 2011). In their action plan suggestions is made towards a nation-width common information infrastructure to provide a radical level of information availability and usability (SKL 2011). This includes determining formats, states, coding and storage of data in a way that allows data to be exchanged and used outside the organization in a boundary less flow of information between stakeholders as showed in figure 1.1 (SKL 2011).
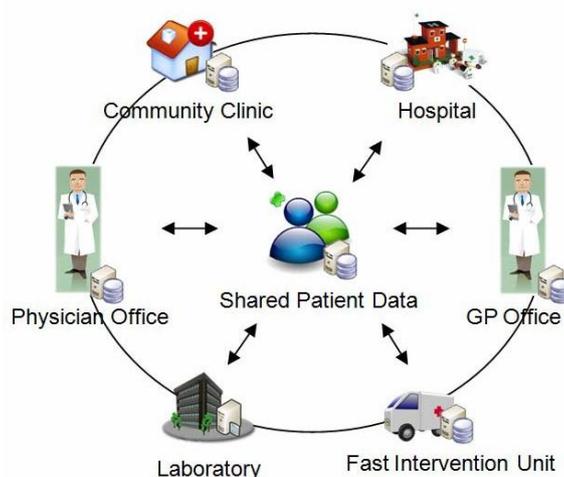

Figure 1.1: Patient Centric Approach. Information boundary-less data flows (Ruso et al, 2010 pp4)

1.2   Research Problem

Achieving interoperability in systems is essential for organizations otherwise their organizational as well as social development might be jeopardized. Reaching an interoperability level that is beneficial for the organization however can be a challenge today even for highly advanced public institutions mainly because of two reasons (Henningsson 2008).

1. Stakeholders, internal as well as external have a poor understanding of the interoperability aspect as a problem for the organization and its environment and regards it as purely software technical problems and make do with solutions that goes around it (Henningsson 2008).
2. Although most organizations internally are uniform in work processes and IT/IS usage there are large gaps in the interpretations of usage. This is due to the rapid development of new techniques and systems today which clearly out succeeds organizations ability to embrace and make use of them (Henningsson 2008).

According to Fölster et al (2003) these dual reasons are reflected in the healthcare organizations contributing to the spaghetti syndrome. First there is a convenient distance between the ones making decisions about the problem and those affected by it, secondly the systems used in healthcare are highly task specific but emerged in the organizations for different needs and purposes and therefore has been free to evolve without coordination.

The national IT strategy for healthcare is a way to manage the situation and make sure the ISs are used to improve the quality of care. During 2010 an evaluation about the IT-usage was conducted by Swedish Health Professionals among healthcare employees. It shows that the organization as well as the staff is dependent on interacting EMR systems to ensure patient safety and workflow efficiency. It also states that although the situation has improved over time the interoperability problem between EMR systems still resides among the most frequent obstacle in the workflow (Vård IT Rapporten 2010).

Healthcare organizations just like any other organization wants their IT resources to be use the most beneficial way possible and make sure that their investments pay off (Marshall 2010). Much research has been published about healthcare IS, about the reasons for the lack of interoperability in the EMR systems and about suggestions how to solve the problems. It might then be speculated about the reasons that the EMR interoperability is a recurring problem in the healthcare sector. Most likely there are several aspects that disrupt the process of finding a sustainable solution, but we are interested in whether the application of IS interoperability solutions in healthcare themselves contributes to the problem by asking the following research question.

- *What techniques for information systems (IS) interoperability is used in healthcare organizations to solve interoperability problems in electronic medical records (EMR)*

1.3   Purpose

It is mentioned previously in section (1.2) by Fölster et al (2003) that there is a lack of understanding about the EMR interoperability problem among decision makers, and we argue that this can affect how the solutions are being used.

According to Ramiller & Pentland (2009) IS knowledge based upon research all too often lack roots in the reality of practitioners, leading to a deficit of research that describes how the solutions are being implemented and used in the practical reality of the organization. We intend to study what is practically done out in the concerned activities of healthcare organization here and now.

Our purpose is to explain how the healthcare organizations use current methods to achieve interoperability among their information system. By doing so we may be able to determine whether a part of the problem resides in how the organizations interprete and use the solutions. We suggest that by answering the research question and studying the problem from a practitioner's perspective as proposed by Ramiller & Pentland (2009), the contribution in knowledge will be a clarification whether the right solutions are used to address the problem or not.

1.4   Delimitations

Problems with system integration is not a problem represented in specific organizations rather it is a phenomenon known to most organizations and in some context more frequently observed than other IS problems (Henningsson 2008). This means the problem probably is represented in every organization regardless of nation and businesses. We therefore assume that choosing a focus on Swedish healthcare organizations will provide us a fair reflection of a general problem.

In order to avoid a situation mentioned by Henningsson (2008) and Xia & Lee (2005) where problems of IS integration are regarded as a purely software-engineering problem, we will not move into detailed technical descriptions, except where it is necessary to explain a context relevant for the research. Such technical descriptions might be about HIS-architecture specifications, the SOA framework functionalities, information infrastructure maintenance, codes or protocols used in the connections and requests between different healthcare systems. Whenever moving into those areas we will mind Yin (2005) as well as Kvale & Brinkman (2009) and ask whether it benefits the interest of the target group or not.

 As described in the purpose we intend to examine what is done out in organizations to provide knowledge, not to make a critical review of the hospitals organizations solution application. Therefore the research question will not benefit from usage evaluations of different EMR-system solutions encountered within the hospital organization.

2. Literature review

In this chapter the literature that has been used as a foundation to our thesis will be reviewed to provide the key concepts to understand the problem area as well as making ourselves able to answer the research question regarding EMR interoperability solutions usage. In order to create a coherent storyline and understand the problem area further one must first understand what EMR is and does. Secondly this chapter presents the interoperability concept, while the third part provides general knowledge about interoperability solutions. The chapter then concludes by making a summary of the literature review creating and describing our framework of knowledge that will be our lens of issue investigation.

2.1   Electronic Medical Records

2.1.1 What is EMR?

EMRs throughout the health care process mean a complete and centralized recording of issued medical instructions. Their implementation aims to support all aspects of the treatment process and provide a high degree of information sharing which is the core of the hospital information system. The systems might be used and implemented according to specification of various health care providers, and clinics but has some common aspects.

EMR systems are aimed to be visible throughout the medical business activities, since it is the clinical service that is the issue of medical instruction. As the carrier of a variety of medical instruction, EMR transforms different kinds of information, service object and medical directives for the medical service agencies and health care provider in order to drive the various medical services to an accurate and rapid execution. This means that the EMRs are used to maximize the sharing of medical data in the records stored by the system. To make medical activities become accurately and efficient, the health care providers not only have to be able to receive the clear instruction of medical information. They have to acquisition a multiple use of the information and a clear and structured support in workflow to ensure an efficient data usage. (Ralph, 2009).

The EMR is a complete record of the health care process and always present as supporting documentation. Clinical service is able to issue medical instructions by the use of EMR but shall also be able to know about the medical activities of the object in clinical service. By providing a better patient overview EMR greatly improve the efficiency of the hospital and health care quality and reduce the administrative costs (Lee et al., 2005; Anderson, 2007).

The development of EMR can represent a further use of computers and the Internet as means of communication between doctors and patients. When studying a design and implementation of a clinical information system in New York Presbyterian Hospital (NYPH) at Columbia University, the findings showed that patients could view their own medical records, receive health education, and communicate with doctors using clinical information systems. Based upon these findings the study concluded that EMR systems can be used to achieve two-way communication between doctors and patients which improve doctor-patient relationship, deepen the understanding of the patients on their disease, improved patient compliance and disease control (Zeng & Cimino 1999).

EMR has played a major role in the promotion of the patient's informed awareness, actively participating awareness, and rights of protection under the law on prevention and health care. The connection between EMR and the Internet makes sustainability in the process from prevention to rehabilitation. It promotes the institution-centered health care system to the transformation into the individual-centered health care system which reflects the people-oriented service concept. (Shortliffe, 1999)

The usage of EMR also identifies the needs of data for clinical information systems to build a logical framework for comprehensive, effective, multi-perspective description of the intrinsic link between the composition of electronic medical records and complex information (James 2005).

2.1.2 The EMR system complexity

A lot of research and investigation of the EMR system have been assessed and it has been found that it can significantly improve treatment quality, and that factor has become the main reason for accepting their implementation (Dobbing, 2001; Iakovidis, et al., 2004).

In order to maintain the high level of acceptance, several scholars address the importance of getting a working interoperability in healthcare systems. Under such conditions EMR systems can distribute and share available information to patients and other physicians and do it in ways that ensure the integrity of the exchange of information content can be retained (Umer et al. 2012).

Garets and Davis (2006) described EMR as: "An application environment composed of the clinical data repository, clinical decision support, controlled medical vocabulary, order entry, computerized provider order entry, pharmacy, and clinical documentation applications" (pp 2).

The application environment addressed is a complex system consisting or various types of operating systems, databases and applications, which interact with this system through different programming languages, data structures and invocation interfaces. That makes them highly specified for their processes and making organizations implementing them to handle single tasks, thus creating a need for a heterogeneous systems environment (Kumar & Aldrich 2010, Marshall 2010, Yang et al 2011).

EMR systems are diverse systems since they were designed at different times for different needs and with different technology specification. Doing it this way ensures systems are adapted according to the local clinical needs in business processes, information level and integration content (Yang & Miao 2011). However this specification makes it hard for EMR systems to talk to other multiple access systems. Therefore, a major challenge facing EMR is that it has been hard to encourage and achieve interoperability.

Healthcare organizations also have developed a desire to keep a broad heterogeneity among the systems. This originates from the fact that most of the system users, are specialists in other areas than computer usage. Some of them admitting that they have a hard time adapting to changes in systems used since the changes do not always correspond to changes in their work

(Kumar & Aldrich 2010). It makes it hard for the organisation to phase them out since the initial costs increases when the users have a hard time unlearning the old system

EMR is the inevitable product of the IT and network technology in the medical field. It is also an inevitable trend of modern management of the hospital medical records, and its clinical application (Dearing, 2008; Goldman, 2007). At present, the electronic medical record systems in the developed countries in the world are scattered, and information standards are not uniform. Therefore, there are challenges to implement interoperability within eHealth care, which not only include technical issues but also socio-political and legal problems (Jens et al., 2012).

Although these perspectives involves a multi-dimensional complexity that adds to the problem, the above explanation provides a fair picture (presented in figure 2.1) of the complexity when achieving interoperable EMR among its diverse health information systems, which include prescription drug information system, EKG information system and laboratory systems.
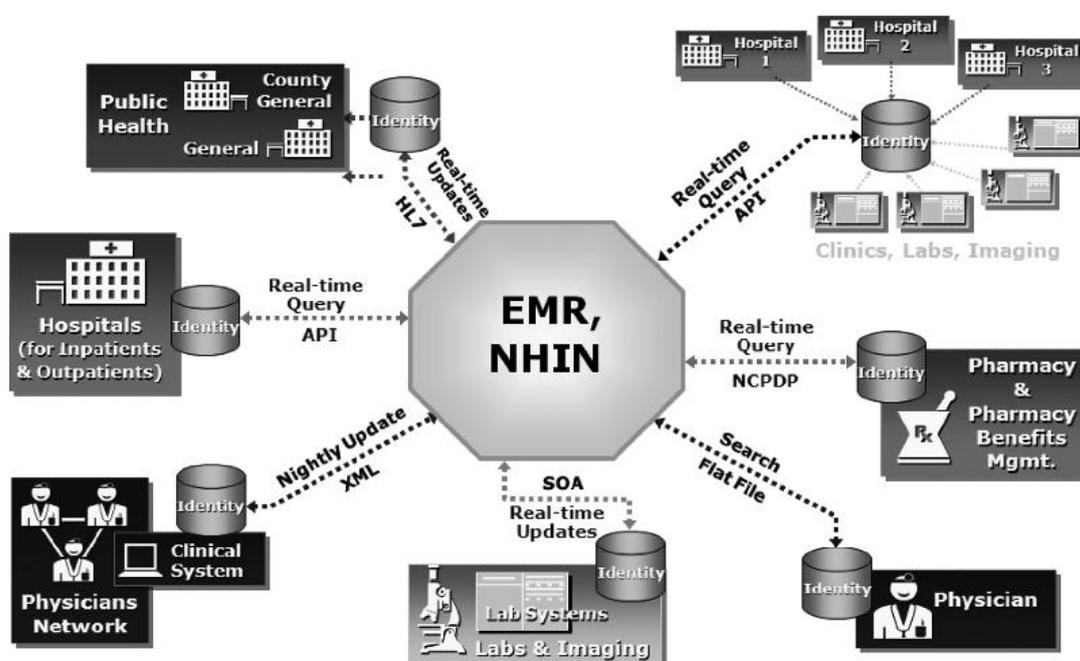
Figure 2.1: The EMR complexity (Kumar & Aldrich 2010 pp 311)

In accordance with traditional integration methods, each company must master data standards and interfaces to other systems, in order to achieve the requirements of the inter-working function. This interoperability specification demonstrates success for the future development of medical imaging, patient referral and drug distribution information sharing make the interoperability specification laid the foundation.

2.2   Interoperability

2.2.1   The concept of interoperability

Interoperability is the ability to initiate action to complete exchange of meaningful information reliably and quickly among independent systems or components without errors (Moen, 2001, p.163). It has the ability to access and utilize the right data from diverse systems and sources in order to operate them together.

But to do this in a heterogeneous system environment means that the system has to comply with the specification of a different communication protocol. However this is not easy since the systems cannot directly connect and communicate with each other with different protocol specifications but need some translation service. (Ramos-Hernandez, et.al, 2001)

Interoperability technology is based on information standards which currently consist of two parts, technical standards and information standards. In the future it will be carried out on system-level, by laws, policies, and procedures (Alves V., 2005, p65). Research and information standards are structured in order to solve the problem of how to use existing standards, information exchange and sharing of medical information. Standards include metadata standards, data standards, data sets standard for data exchange standards, data represents the standard, as well as code standards, terminology standards and concepts of standards (Alves. 2005).

The technology standard is mainly focused around research and information security, transmission techniques, information security, audit, time stamp and other technical problems. System standards include the issues of patient privacy and electronic medical records legitimacy. However since EMR due to its central role as record throughout the complete medical process doesn't only require data to be exchangeable but meaningfully exchanged. It means that data must be readable as well as edited between systems and presented in understandable structures to the user. Therefore we will extend and divide the interoperability concept into two concepts of system interoperability that appears in the architectural layer.

First the *syntax interoperability* which enables exchange of data between different systems or applications and much rely on information technology, which aims to solve how to transfer data without concern of data meaning. (McGovern et al 2006).

Secondly the *Semantic interoperability* that refers to the exchange of understandable and usable information between different systems or applications. (Ruso et al 2011)

2.2.2   Syntax interoperability

The IEEE (Institute of Electrical & Electronic Engineers) attempts to define interoperability and makes the following definition: "the semantic interoperability between systems refers to two or more systems as components has the ability to use information which has been exchanged" (IEEE pp 114). The Syntax interoperability then can be described as a specific kind of level of interoperability where the purpose is to solve how to transmit date without caring about the meaning of data. It makes information exchange among different systems or different programs become possible and it is absolutely necessary to any propelling work of

in-depth interoperability because without it systems won't be able to communicate and swap data. (Nudet et al., 2010)

Nezhad (2006) explains the functionality of syntax interoperability by making a comparison with SOA service distribution. Just like SOA calls a Web Services by identifying and calling it through a service layer interface the user can obtain data stored in another system by calling an interface layer.

As an example for what it means to the healthcare Poon et al (2004) describes that when a patient sees a doctor in one institution that we called clinic A, the doctor can use the interface and download a WSDL document (XML file) which describes the site of the requested information in another system and method to transmit it to the system used in clinic A.

2.2.3   Semantic interoperability

Semantic interoperability also known as semantic collaborative work capacity is another level of interoperability. The importance of Semantic interoperability is that the data can clearly be understood by human and computer programs in a meaningful way i.e. making them able to use the information (Johnson S.B., 1999, p162).

The explosive growth of Internet information can provide an example of how difficult it can be to obtain useful information. When each organization on the same field has different understanding it results in different ontology used in the same field and between the organizations overlapping parts.

Then in order to achieve a semantic integration between the Internet information metadata external characteristics of the entity has to be analyzed in a combined way, where the similarity between the entities has to be calculated to make up for the lack of semantic understanding of the entity's internal features.

It means that the web information machine works in a comparison method based on the dictionary for the semantic identity as the method of integration to distribute readable and understandable features to the system (Coiera 1997)

2.3   The healthcare solutions

2.3.1   EMR interoperability solutions

Umer et al. (2012) address the importance of interoperability for healthcare systems in order to offer and share available information to patients. EMR systems are developed to reduce medical errors, reduce the workload of doctors', reduce duplication of services, ensure patient privacy and security and enhance communication (e.g., Ransom et al 2000; James, 2005; Poon et al., 2004). Whenever available to overcome the problem of interoperability for EMR, the value is enormous. Aware of the social and economic benefits of interoperable systems with the automatic exchange of information (Brailer, 2005b), healthcare were (and continuously are) developing or adapting different solutions to gain interoperability while preserving system heterogeneity (Yang et al 2011).

Interoperability is actually a technology roadmap to achieve information exchange and business collaboration (Machado 2006). Even in the same hospital several different EMR

system might be used, due to the limited number of widely accepted standards, vendors and developers business strategies and the huge volume of business to administrate the hospital. After all, having a strong and unified administrative leadership forced, upon the organization does not consider the application of lobbying by the hospital system interface and data mapping to share information interoperable (Abelha 2004).

2.3.2 Standardization (Enterprise wide architecture)

Standardization has provided a wide set of industries with the streamlining required to make huge contributions to efficiency, cost saving and best practice frameworks. Standardization is a wide concept that reaches from telling what and why to do as well as give exact and detailed instructions about how, when and in what order to do things (Juell-Skielse 2005).

Interoperability standardization involves a definition of how to create shared architectures, technology frameworks, coding, method, data typing and terminology for more than one organization (Jepsen et al 2010). Containing all these advantages it perhaps seems inconsistent that the arguments of section 2.2.1 were contradicting. However there are explanations to this self-contradictory situation.

The resistance towards standardization only applies to an IS standardization where the intention is to implement one system that shall be capable of managing every situation in the patient life cycle, which would mean implementation of a monolithic and inflexible system that doesn't support specified expert areas thereby jeopardizing patient security (Marshall 2011; Kumar & Aldrich 2010). However since each of the systems sometimes comes with its own message format there is a genuine wish for a standard in architecture that can handle semantic interoperability

According to Rusu et al (2010) semantic interoperability in healthcare can be established to run in two modes

- *Local*: Using independent portable medical records principles to enable intranet or enterprise internal mode operations for actors administrating and use clinical systems.
- *Network*: Based upon remote access principles accessibility to sharable and stored medical record in local databases will be possible for wide area usage inside and outside the organization.

Implementing standardized architecture layers involves building access points, provide databases and mobile device interconnection and make them work as a shared repository portals for information collection (Rusu et al 2010). The supplied portal will then need front-end technology for clients to use the services inside the systems and back-end technology for service storage and data recording (Lee et al 2010, Ruso et al 2010)

Standardization requires changes and adaption throughout the whole organization and initially becomes a very costly investment. The process also requires an organizational reconstruction with heavy managerial support, since halting or slowing the process can force the organization to start the process over again (Juell-Skielse 2005). As a consequence many standardization processes demand the organization to match it own and customers' business processes to help the standard instead of the opposite (which should benefit the organization)

(Nash 2009). In healthcare this concern is especially sensitive since the systems in use are technically cumbersome and very specially developed for their respective area and there is a general fear that when trying to create "one system to rule them al" the result will be an inflexible monolith that will be contrary to today's rapid IT development (Marshall 2011; Kumar & Aldrich 2010).

2.3.3 Service Oriented Architecture

SOA which is a new paradigm was first realized in organizations where distributed applications using web-services formed the foundation of a separate platform. This platform allowed benefits from web-services to be leveraged towards the service concept architecture style based upon three pillars presented in figure 2.2.
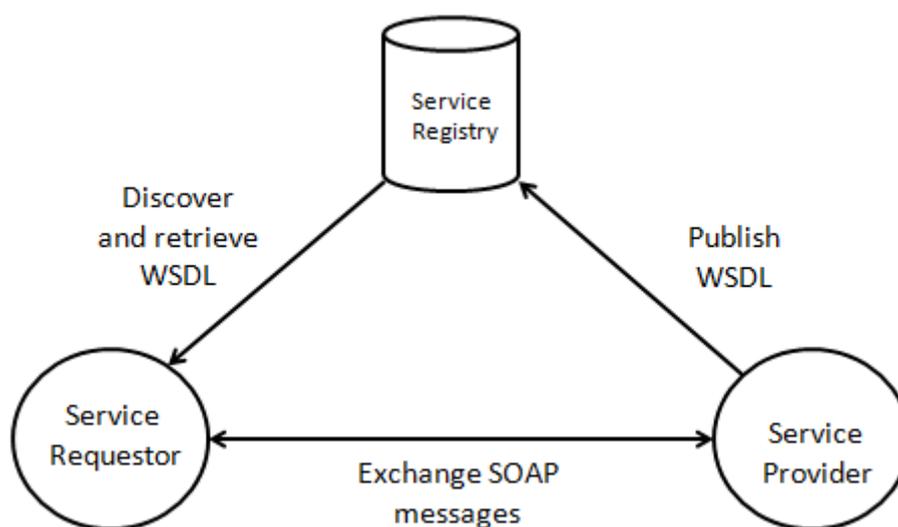
Figure 2.2: Three pillars of early SOA idea (Erl 2005, pp.75)

Defining SOA and what IS interoperability problem it solves is hard to do since it is a rather new concept that has a vast array of shifting interpretations. One way to describe service orientation is as an approach where large problems are broken down into smaller and more manageable logical units, where the logic necessary to solve the larger problem is divided into independent internal related sub-units of logic. Another description would call it a changing paradigm of logical autonomous entity that exists and is distributed independently from other services (Erl 2005, McGovern et al 2006).

The main idea is to handle syntax interoperability trough flexibility where standardized software should be changeable by reusing small software modules rather than transforming the entire system (SOA manifesto 2010). SOA quickly made a breakthrough thanks to the possibility of reusing code snippets and through the advantages of different techniques available that improves several areas:

- *Platform independence:* As long as a service is built around communication standard protocols (like XML, SOAP, WSDL), and knowledge about what their interface looks like and where to find them is available, there is no need to mind how they were implemented or what platform they runs from (SOA Manifesto 2010).

- *Loose coupling:* The services are all built around core attributes that is fundamental to their purpose. First is the service description that defines the location and name of the service that allows other services to aware of its existence and is the component used to hold connection. Secondly there is the provision of the service, or to say the service itself manifested in the code of the interface that makes it possible for users to call them (Erl 2005).
- *Discovery:* The next is the messaging mechanism that is a communication framework (like UDDI) to establish and preserving the relationship between interacting services that allows a specific service to be looked up (SOA Manifesto 2010)
- *Flexible implementation:* Implementing SOA however is not based upon any kind of special technique and can be done using CORBA, SOAP, Web-services, JAVA or .Net. When using the later two, services can be written using the frameworks respectively programming language and then accessing them from either platform (Yang et al 2011).

SOA brings syntax interoperability but also requires some level of standardization in the architecture (without being able to bring along semantic interoperability), and the usage of a middleware that handle the transaction calls from different systems (Koufi et al 2009, Yang et al 2011).

2.3.4 Web-service interfaces and XML

Interoperability is an important characteristic of Web service which has a direct relationship with the end of service providers (Tevfik et al., 2006). There are some syntax interoperability issues based on the norms of these Web services platform and Web service instances (Mykkänen and Tuomainen, 2008). These interoperability problems are mainly reflected in two aspects.

First the *problem of the SOAP message* must be resolved as SOAP message used by service interactions is XML-based, which has a simple structure. In actual communication, the content contained by the message is very complex. There will be a service receiving SOAP messages which cannot understand the contents of the message, and thus cannot respond. (Nezhad, et.al. 2006)

Secondly the *unclear specification description* used in data exchange need to be clarified. To achieve the interoperability, Web service needed to attach certain norms, such as SOAP, Web Services Description Language (WSDL) and so on (Nezhad, et.al., 2006). These norms exist many ambiguous language and examples. In this way, the realization of the agreement will bring many potential interoperability issues.

Based on the above analysis, interoperability can be achieved in two separate ways:

Either by building a well-structured and clarified content of SOAP message and models or by certain means include the interoperability issues into the process of protocol achievements.

2.3.4.1   Web services implementation

There are two types of implementation methods: bottom-up approach and top-down approach (Tevfik et al, 2006).

The bottom-up approach involves obtaining service description file according to the service implementation class file. Deploy services and service descriptions to the server. Finally, publish the service description information. (Rodriguez, 2011) This way makes the implementation becomes more efficient, but it often will bring interoperability issues in the service description.

The top-down approach means designing the service description document based on the needed function as well as generates, deploy, publish and execute the service process according to the description (Rodriguez, 2011). It effectively avoids interoperability issues in the service description. However, the design process of service description document is generally more complicated. It could run properly after modifying the generated program according to the service description, thus making the efficiency of the implementation is very low.

In summary, the implementation of the services needed to find a quick, effective way to deploy the service and publishing service information. Then we can consider the corresponding service description file generated according to the service implementation tools that under the premise of ensuring the high efficiency, combined with the related evaluation techniques to exclude the potential interoperability issues.

The implementation of SOA can choose not to be based on Web services. Web services can be achieved without going through SOA, but it is common to recognize that the Web service is the ideal way to implementation of SOA. After all, the principles of SOA are effective ways to achieve Web Service Interoperability. (Nezhad, et.al., 2006) Web services provide a set of related technologies such as XML, SOAP, WSDL, UDDI and so on. These technologies are useful mechanisms to send and receive distribution specifications for the Web service message, as well as providing a flexible, scalable language support for the message transport protocol binding. It can help people to find out the application programming method according to the specific information in order to achieve the proposed concept of SOA. (Mykkänen & Tuomainen 2008). Therefore, Web services can be seen as a series of standards, and SOA is a series of design principles.

We have come to realize the achievement of SOA based interoperability is closely linked to implementation process of service. The previously mentioned implementation methods of bottom-up and top-down have large defects. Web service provides interface mechanism as well as important areas of system application. Interactive Web services are often defined differently by diverse service provider's interpretation of the service description, which makes the appropriate interaction between them dependent on the description of the Web services interfaces. Good interface design should contain all the necessary information to interact with the service, but should not contain any unnecessary information. (Claro et al, 2006)

Web Services Description Language (WSDL) describes the component interface using the standard language syntax of XML data described in the Web, making interoperability in cross-platform and programming language on the Web truly become a reality (Booth & Liu, 2007).

2.3.5 Point to point and middleware

The Point to point architecture is an efficient solution for interoperability that doesn't include costly systems changes or risk full implementations since it offers a business-process friendly interoperable platform. The technique is based on individual interfaces systems that can communicate and exchange information between different systems (Henningsson 2008).

However this kind of solution is better suited for organisations where a small number of systems need to be integrated. Maintaining the different interfaces is costly and time-consuming since they have to become upgraded or changed whenever one of the systems using the interfaces changes. There is also a risk of losing control over the architecture since the number of different interfaces used by one system easily becomes incalculable (Henningsson 2008).

Aware of the setbacks of the point to point architecture middleware was developed as a way to bring control over the situation. A middleware acts as a mechanism that coordinates communication between interfaces used by the systems or the systems themselves by making them access the middleware instead of each other. The middleware then distributes the connection between the different interfaces and scales down the number of access points making the system only requiring access to its middleware database and can therefore be used in organizations with many systems. (Henningsson 2008).

The middleware follows the logic of the point to point solution and doesn't require any kind of change in organizational activities but it does require large maintenance, high centralization and it easily becomes incalculable when the system connection points increases. It also requires upgrades and changes whenever the systems accessing it become upgraded (Henningsson 2008).

Both solutions independently or together (which is the most common) solves interoperability problems in the syntax area by creating an access point to another system. Although some would argue that the form of the interfaces can be customized to reach semantic interoperability as well there is nothing in the techniques to supports such claim (Henningsson 2008).

2.4 Literature summary

2.4.1 Research Model

This literature review began by discussing the complexity of EMR systems and the systems role in healthcare organizations and it showed.

- *How the healthcare organizations different needs causes system complexity:*
  Every healthcare organization are a unique unit whose different needs inflicts the purpose of the EMR systems. It makes it necessary for the systems as highly specified instruments to take on multiple usage areas in the organization, which creates a complex situation (Section 2.1.1).
- *How the system complexity of EMR requires system heterogeneity:*
  Complex system specification makes the system hard to replace with uniform solutions or to access each other (Section 2.1.2).

- *How system heterogeneity cause interoperability problems*:
  Since the EMR systems lack uniform standards and data formats and is specially developed they are subjects to interoperability problems (Section 2.1.2)

Next the EMR complexity was discussing with regard to interoperability, it found.

- *How interoperability problems affecting the application layer can be divided into syntax and semantic interoperability.*
  Exchanging meaningful information requires syntax (data transfer) and semantic (information exchange) interoperability (Section 2.2.1).
- *That syntax interoperability means.*
  The ability for systems to access each other and transfer data regardless of the data form (Section 2.2.2).
- *That semantic interoperability means.*
  The ability to exchange meaningful information between different system (i.e. readable information) (Section 2.2.3).

And the last part of the literature review has discussed how healthcare organizations can solve interoperability problems and has showed

- *How healthcare organizations can solve syntax and semantic interoperability problems in the application layer*
  Techniques that has been proven to successfully address a certain kind of interoperability in EMR systems as follows.
  - Standardization of systems creating uniformity in information and solves semantic interoperability (Chapter 2.3.2).
  - Web-services and XML makes data exchangeable by providing flexible data formats and solves syntax interoperability (Chapter 2.3.3).
  - SOA provides loose coupling and of services, platform independence, web-services and xml as well as a flexible implementation when solving syntax interoperability (Chapter 2.3.4).
  - Point to point and middleware that creates access points between systems to solve syntax interoperability (Chapter 2.3.5).

By combining several methods and frameworks from the field of healthcare IS we have concluded that there exists a theoretical connection between organizations needs, highly specified systems (like EMR systems), heterogeneous system environment and interoperability. We have also argued that interoperability can be represented by syntax and semantic interoperability problems that can be solved by several well tested interoperability solutions used in healthcare to handle EMR problems either separately or in combination. This theoretical summary is visualized in our research model (figure 2.3).
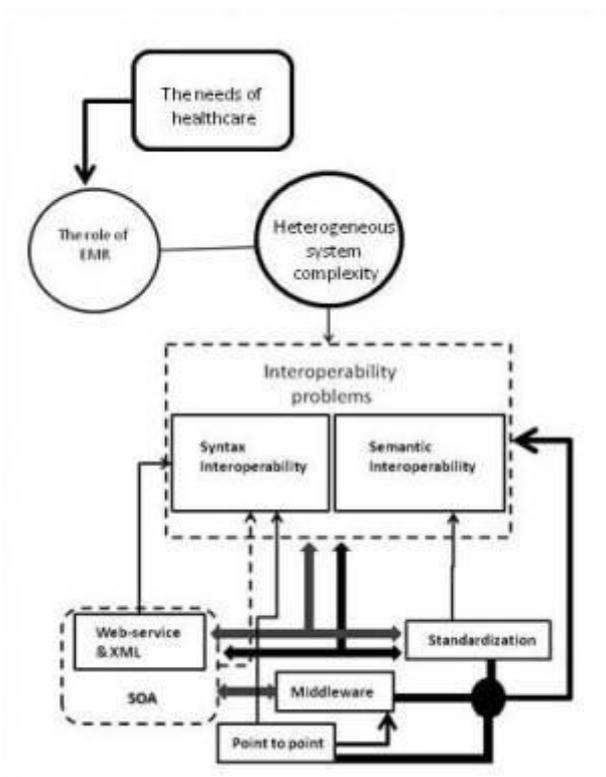
Figure 2.3: Research model

The figure shows that the needs of healthcare leads to specified heterogeneous system complexity that leads to interoperability problems between the systems used. The interoperability problems then are divided into syntax and semantic interoperability problems where the first can be addressed by using SOA or web-service and XML and the second by standardization. Web service and XML are integrated parts of the SOA technology framework found inside its area but can be implemented without SOA. SOA requires standardization and some kind of middleware to work and therefore is a part of a solution meant to address the whole problem area. Web service and XML can be used in combination with standardization to become a complete solution but doesn't require any middleware. Point to point solutions and middleware can operate together or by their own to create a solution for syntax interoperability problem but just like SOA, Web-service and XML require standardization to become a complete solution.

Since our research question is about EMR interoperability solutions that addresses both the syntax and semantic levels we will use figure as a road map to what we argues is a complete solution. That means that semantic interoperability has to be addressed with a standard in ontology (terms used) while the syntax has to include either point to point with or without middleware, SOA with middleware or web-service and XML in a way that is described in the theoretical review.

3. Research method

3.1 Research approach

Every research comes with a strategy for how to carry it through and a strategy that holds will benefit from containing several methods. Based on the research model empirical material will be collected about how healthcare organizations solve their interoperability problems through interviews. We shall analyze the interviews to discover how healthcare organizations manage their EMR interoperability problems.

Our overall strategy has its base in the research model presented section 2.4, which has a particular role in research design and data selection. Founding on previous studies we hope to ensure the quality of the study.

Our problem area represents a well known topic and usually that kind of situation means that it comes with many explanations and interpretations that has to be overviewed and interpreted in a research process.

3.1.1 Interviews

Using interviews as data collection methods requires us to put focus on to the research question itself and design the interview guide towards the summarizing of EMR interoperability solutions presented in section 2.4. Interviews also provide detailed in depth understanding of the interviewees experience and the personal interaction will expose the motivation of the respondent's attitude and believes. Following the guidelines of Kvale and Brinkman (2009) interviews could be either structured or semi-structured which provides questions open to improvisations. We prefer to use a semi structured interview where the informants feel free to express underlying contexts or examples that cannot be achieved using structured interviews. We therefore arranged the question to deal with different topics and stated them in a way that forced the respondent to go beyond yes or no replies.

To argue the alternative solutions undertaken by healthcare organizations one has to understand the problem area itself. We therefore categorized the questions in a way that corresponds to each part of our research so the interviewee can answer whether it reflects their reality or not.

The interview guide (Appendix 1) contains the following aspects

The *Introductory Questions* are meant to provide a general profile of the interviewee and if her/his working position and experiences are relevant for the interview at all and to make the informants start the interaction.

By starting the interview part by focusing on *EMR usage* we can make the informants reveal whether they feel that the roles of EMR causes system complexities in their organization as stated in chapter 2.4.1 and if the different roles requires interoperability in systems. Then we will go further into the complexity of EMR to understand the heterogeneous environment and the data sharing EMR provides to better understand how heterogeneous systems creates un-interoperable environments (section 2.4.1)

We intend to find out more about IS *interoperability* in healthcare and starts by stating whether the situation in the organisation reflects the sectioning of the interoperability concept (section 2.4.1) and if there is interoperability loses due to the complex situation. To be able to answer the research question we must be able to understand how the organisation is affected by the semantic and syntax interoperability concept.

In this area we are looking into the *solutions* that are being used by the organizations to achieve interoperability in the EMR systems. We want to find out if they use the suggested solutions from section 2.4.1 standardization, SOA techniques, Web-service and XML or Point to point & Middleware or if we are into a surprise by a solution unknown to us. We will also be introduced to how the organisation has implemented and interpreted the solutions. Receiving information about this helps us understand how the organisations perceive the problem.

3.1.2 Selecting study objects and informants

EMR systems are present in most healthcare organizations worldwide but their usage polices differs between countries as well as organization. To be able to fulfill the purpose of this thesis we must select an organization that has a mandatory policy to use EMR and share its information outside the context of where it was created as an active integrated work process in the everyday work. Therefore when selecting the organization we have used the following criteria.

The organization had to be a healthcare organization

- The organization must have a mandatory policy for EMR usage in work processes
- The organization must have a demand to share EMR information with other units
- The organization must have experienced and tried to solve interoperability problems in at least one unit.
- The selected informants had to be experienced in the work of solving interoperability problems

In this thesis we have identified one of the largest hospitals in Sweden (University hospital of Skåne Region (SUS)) that has undertaken measurements in order to create uniformity among their EMR records. We have also chosen to use a smaller hospital unit in the city of Landskrona since they are under the county council of Skåne thus undergoing the same reengineering as SUS. The smaller unit will also provide a different perspective of the EMR interoperability problems than does the larger unit.

Swedish healthcare organizations are among the most IT intensive in the world (SKL) with demands for EMR usage as work process discipline and we have chosen to select Swedish healthcare because it is most likely to reach all criteria's. Since the hospital organizations of Sweden are similar in organization and structure (SKL) we argue that what is done in this hospital is generally applicable within any other Swedish hospital.

When selecting informants to this thesis we looked for informants who have long time experience in working with EMR interoperability problems. The work could be conducted either as a user of the system, a super user (administrator), system support or system manager

regardless of other working roles (Nurse, Physicians, Clerk). Other informants can because of the IS technical nature of the topic have a hard time to understand the questions or relate it towards their experiences.

3.1.3 Recording and Transcription

There is a lot of ways to record an interview for later analysis (written, audio and video). It must be remembered that all transcriptions are not exact reflections of the conversations but rather interpretations of the interaction. It is also important to be mindful about the ethics in this situation, because the transcript material might be sensitive (Kvale and Brinkman 2009). We intend to record the interview using audio recording units and notes. The audio recording will give an exact recall of what was said during the interview and notes can be used to help understanding a context of what was said. However notes can be distractive for the interviewee and we will only use it if necessary to capture any changes in interview contexts.

When transcribing we will only use the audio recorded material, a computer with word processor and will do the transcription ourselves. Researcher that conduct their transcription themselves learns more about their interview style and can more easily recall the interview and start the analyze process. To make it more understandable we will use a more formal written style to avoid uninteresting information like laughter and pauses which is used in word by word transcription.

3.1.4 Analysis procedure

Here one has to choose a proper set of tools to handle the large amount of data accordingly and avoid the situation of 1000 pages. For our research analyze strategy we have chosen to rely on our presented research model. This strategy shapes the analysis of the empirical material through the theoretical prepositions thereby using the theoretical framework in chapter 2.4 as a peering lens for analyzing (Yin 2008).

We analyzed the interviews focussing on meaning, first meaning condensation where we tries to find the most important information and keywords provided by the respondents. From that we select briefer parts of information that will represent the general answers. These smaller parts are then used in a meaning interpretation analysis. Here we go deeper into the meanings of the findings of the interviews to determine whether they are reflected in the research model (Section 2.4).

3.2   Research Quality

3.2.1 Applying source criticism

When selecting empirical material as well as literature we have also been mindful about the four questions that according to Lincoln and Guba (1985) mentioned in Seale (1999) has to be asked about every research.

1) Value of truth: Is it possible to tell that the respondent actually is who he or she claims to be during the context of the research situation.
2) Applicability: Would the same findings in a research emerge in another similar research carried out in different context.

3) The consistency: Making the same research again with same respondents and same context, will the findings be the same?

4) Its neutrality: How to ensure the respondent not acting on behalf of a hidden agenda, hiding information or providing a false image based upon biases or attitude towards the inquirer.

Whenever we have used internet as source we have searched the information from a multitude of sources to control if there is a true original source and only trusted sites that is available through linkage from reliable access points. The term reliable access point means pages that are accessible from universities, campuses, pages belonging to governmental authorities or organizations with recognized expertise in the field of IS.

3.2.2 Quality assurance

In order to improve the reliability of our study we have considered a number of validity a test reinforcing the criteria's in section 3.2.1 and summoned them in table 3.1.

Table 3.1: Quality assurance test

Test	Problem	Concept	Solution
Internal validity	How clear is the research connected towards the reality of its participants and how many rivaling explanations are there?	The findings must be presented in a way that makes them appear realistic. Connected to a solid chain of evidence the survey holds its own (Yin 2008, Kvale & Brinkman 2009).	Create a main thread between research question, empirical findings and conclusions
External validity	To what extent can the findings be used to make generalizations and can it be used to do so at all.	Using a wide variety of theoretical sources or multiple cases (Yin 2008).	Using different scholarly publishing's
Conformability	How is it possible to determine that there is now ghost writers involved?	Language, treatments of the result must be objective towards the reader in a way that makes a recognizable personal signature (Seale 1999)	Keeping to academic guidelines and an academic language

We try to have a certain degree of research quality capacity by having informants that comes from several different roles in the organization and get more than one voice to answer.

3.2.3 Biases

Biases can enter at every stage in a research process ranging from the design, measurement, and selection of informants and when analyzing the empirical data (Norris 2007). To be aware of this until the very last stage of the research is important but unfortunately very hard to do since the researcher him/her self isn't aware when being biased (Norris 2007). In order to

maintain our research quality and increase our awareness of potential biases we did the following.

- A pre-visit where we consulted a healthcare employee that was working with the project of managing EMR systems at the third largest hospital in Sweden (SUS). We asked him to explain his work and his point about our perception.
- Created concept maps where we mapped our assumptions before reading any literature, then compared them towards what we found in our literature review.

3.2.4 Ethics

Researcher shall be mindful about the ethical issues in research partly as a way to prove that they themselves are serious about the quality of their research and partly to ensure that their research doesn't cause harm to those participating in the study (Creswell 2003, Kvale & Brinkman 2009).In a qualitative research where interviews are the central theme ethics should be focused around consent and confidentiality (Kvale & Brinkman 2009).

To maintain a high level of ethical standard throughout the whole thesis and focusing on consent and confidentiality we made a pre-visit to the selected case organization and informed the participants about the purpose of the study before the interviews. Later before the real interview we e-mailed them the questions beforehand and asked if they wanted to participate in the study. During the interview we informed the participants that they could choose themselves whether they wanted to participate with name or be given a name like informant (X). We also made an agreement with the informants that we after the interview once the transcriptions where done mailed them the material so they could determine whether they had been cited in the right way and give approval to be published in their real name.

4. Empirical data presentation

There are a few categories of the results received from the interview. These categories are based on our interview guideline. These results are important parts based on our interview transcriptions (Appendix 2A and Appendix 2B). The categories are Electronic Medical Records (EMR), Interoperability and Solutions.

4.1   The Organization studied

In 2009 the regional council of Skåne made a decision to merge the two great hospital units in the city of Malmö and Lund into one coordinated unit. 2010 the Skåne University hospital (SUS) opened as the third largest university hospital of Sweden with more than 12000 employees. The cornerstones of the hospital is to provide the best advanced medical care, employee training and education and be a center of research in the medical area (Skåne University Hospital 2011).

The vision of the hospital is to be the best healthcare provider available and therefore working with continuous improvements through adopting Lean Healthcare business philosophy in throughout the entire operation. The internationally used philosophy means that the employees develops the work in a way that benefits the patient by focusing around a core value, the respect of the individual as presented in figure 8

In recent years the hospital has developed its research investments together with the University of Lund and the hospital campus in Malmö to create a meeting place for scientists, students and care personnel. The investment aims to benefit the patients in the southern region through improved methods, new pharmacies, new techniques and specialist care that is developed in coexistence rather than competition (Skåne University Hospital 2011).

In the hospital unit of Malmö (UMAS) mainly focuses on emergency healthcare and is among the largest emergency departments in the country. Research at the hospital focuses around cancer, diabetes and blood coagulation. The hospital also educates about 500 healthcare students every year (Skåne University Hospital 2011).

The hospital unit of Landskrona is known as the small countryside hospital with the greatest potentials. It is a unit working mainly in the primary healthcare offering highly specialized care in the surgery area. The characteristics of the hospital are to provide an individually based care (Region Skåne 2012).

The first interview (a group interview) was conducted at the IT-department of SUS Malmö with employees from the EMR-systems administrative staff. The respondents were responsible for the maintenance of every system used at the Malmö unit in general and the Siemens developed Meilor medical system in particular. With them we could focus our questions around the EMR system and the interoperability challenges of the organization. Then we could ask about how the system was used as solution to interoperability challenges.

The second interview was performed in Landskrona Hospital with an employee involved in the Meilor reform program that aims to implement Meilor as the overall EMR system used in all healthcare units in the entire region of Skåne. With her we could focus our questions around the system integration and syntax interoperability.

All of the respondents are represented in table 2 with their name, their representation in the text, working title and responsibility.

Department	Informants	Working title	Responsibility
SUS Malmö: IT support	Jose	IT project manager	Meilor Administrator
SUS Malmö: IT support	Annette	Informatics manager	Meilor Administrator
SUS Malmö: IT support	Lena	Informatics manager	Meilor Administrator
Landskrona Hospital: IT Management	Eva	Project manager	Meilor Implementation Project Coordinator

4.2   Electronic Medical Records (EMR)

First of all, we focus on our interview to access the complexity of EMR system usage, to find out its function when diagnosing and to understand the different roles of the system. To do this is necessary when studying how the systems versatility leads to a situation with syntax and semantic interoperability obstacles.

The respondent Jose answers that EMR is used for recording patient and treatment information so it could be used by other physicians. He especially pointed out that it was not a single system but rather a large set of systems that was accessible by other systems and thereby shared the information. Respondent Eva explained the usage of the system to be purely information recording. She explained the information to be stored in databases that are accessible through other systems. None of the respondents are however willing to provide any other description of the roles of EMR systems but instead reject the claim that it can be used as decision support by nurses and doctors when diagnosing, as Eva explains.

"*even if we could it is against the legal to have a system telling a treatment.*" (Appendix 2B Row 8)

When answering whether the EMR systems improved the quality and efficiency of the treatments Jose made examples from a historical point of view. He told that before using EMR and during the time before they were really inside the system, when it was pen and paper and a lot of archives. Patient files then could either be missing because they were used somewhere else, didn't hold the updated information or was missing parts of information. Once the organization adapted however it was a great help when the information was centralized and sharable among physicians. Respondent Eva also provided this picture but was a little more modest when explaining that the hospital could not measure whether the diagnosing accuracy. She agreed that the time used to find information had decreased and could be better used to treat the patient.

The respondents then had different interpretations whether the system enhanced the communication between doctor and patient. Since the patient holds no access to the system at all Eva claimed that it couldn't while the other respondents found it to be no problem because the doctor must provide the information if the patient asks for it.

When asked if the system was accessible for patients through internet the answer was NO in unison. Thus, when considering access via internet it was a concern about the authority of when and which people could access to one patients electronically journal, it was also

conceder about privacy and security issue. It was clarified and explained that the security and patient privacy legislation was determining the demands to not allow internet access

We categorized our findings first by focus on our interview to access the role of EMR and if it is used for decision in decision making process when diagnosing, improve patient contact, monitoring etc. Then we questioned them about whether it improved the quality of the treatments, if it helped in the communication between physician and patient and if it was accessible through internet. The findings are summarized in table 4.2 where the categories are represented at the horizontal line and the respondents at the vertical line.

Table 4.2: The role of EMR findings

	EMR usage	Treatment quality	Communication	Internet
Jose	Record patient's medical information	To provide much more information It takes much time to find out the key information needed.	Patient can view the EMR as well to get the information needed.	Discussions have been taken about safety issues to find out the best way.
Lena			EMR is helpful to both physicians and patients.	
Annette		"It's a lot of pieces of a system and that of course improves it for the doctors."		
Eva	A record and reference system. The information database storage and distribution. No legal support to do so	Physicians are the decision maker based on their medical experience. It has made the recording more easily and has made it possible to gain information needed.	The patients are not allowed to use the system. The patient is allowed to know the information recorded. Strict security for authorized physicians to access the system within the region.	Cannot be seen on the Internet. No technical ability to coordinate information

We broadened our understanding in how the EMR usage was linked towards the complexity of the system in the organization and if this complexity caused any interoperability issues that affected the workflow of the organization. We asked whether the EMR supported transaction between different kinds of medical data and the fact that they once were developed for different purposes by different vendors. We started out by asking about the different medical data transactions that comes with the use of different systems.

Respondent Annette gave us examples of several different kinds of medical data that was distributed through the system

"I think about all the modules, pieces of the system, Medicine, Lab, X-ray, Documentation, Warnings." (Appendix 2A Row 14)

When asked to clarify about the data transactions Jose provided an example about how X-ray images was called from the radiology system to the Meilor system used by the physicians in another department. Jose than broadened that perspective by telling us that physicians had access to systems used outside the hospital organization. This didn't only include systems used in other hospitals but extended to the national pharmacy registers.

When talking about this subject he proceeds by telling us that this is done by using three systems the X-ray system, Meilor and a middle system.

"So in fact for radiology there are two systems… From this middle system I can se what they have done. I can choose to go into the middle system look at the answer.. I can go from Meilior to the radiology system to se at the picture to. So there is three systems here." (Appendix 2A Row 53)

When questioned about that EMR system are developed for different purpose by different vendors using different specifications and how that could affect the workflow, the respondent answered that it caused redundancy in systems. The problems this situation caused for the organization was explained as inconsistencies in program versions and to some extent threatened the patient security.

"There are a lot of problems with different systems used but doing the same thing." (Appendix 2A Row 186)

The problem was then explained by respondent Jose as a legacy problem from the time when the hospitals themselves decided what systems to use or as respondent Eva told us

"We had it like that system before. Every unit was responsible for their own system and the contracting procedure of development or purchase. There was of course some central purchasing as well but mainly they could have a better insight in how the procedure was done in that hospital. Today in the region we have centralized that knowledge so we know how to contract systems that can cover the needs in a more sustainable way." (Appendix 2B Row 18)

4.3   Interoperability

In the later part of the interview we moved into the area of interoperability and characterized it by asking whether there was a uniform network standard for data exchange. Then question about the concept of interoperability if there was any kind of answer to how interoperability is reached in the hospital. Putting this question does mean that we talk about the interoperability as term not as problem area, that means discussing uniform language and information as terminology and file structure.

The question about IS interoperability then became to ascertain if there was a standard in language or information level like standard in network platform systems. This question then proved to be beyond the knowledge of our respondents even as it was explained in Swedish and clarified. The common answer from the interviews was that there currently exists no such standard for any hospital under the county council of Skåne.

Focusing then on the concept of interoperability we wanted to know what was used to enable data exchange between systems (syntax interoperability) so we in the later parts when talking about solutions knew which one to dig deeper into. We did in this way since we in chapter 2.4 concluded that there is only one solution (standardization) to semantic interoperability while three other when talking syntax.

The respondents initially told us that they didn't know what kind of techniques that was used in the system to achieve an interoperable IS environment. However respondent Jose was able to explain that the concept used was to use Meilor as an interface on top of the other systems and in that way making them able to reach the information stored in the system. It was explained that Meilor was going to be used as a uniform IS solution in every hospital but the hospitals themselves at the present was developing their own local standards for system integration. The respondent Lena told us that Meilor for the moment was used only in the SUS units Malmö and Lund and that it was better to work under one system. The respondent Eva and Jose also replied that there is going to be one database only for the hospitals in the region replacing all of the other databases within time to handle all records.

However Jose manage to give a brief explanation of how the system do exchange data using mailor when talking about the databases of the hospital.

"*What we often sent from Meilor when we want to reach something, user name, patient name, patient personal number. We send that in string. Most of the time, the strings go directly to the other systems.*" (Appendix 2A Row 156)

When further clarifying what he meant he moves into details describing that the Mailor system sends a string to a receiving EXE file in the other specified system. He explains that the receiving system then uses the information in the string to search the other systems database and send it back through Meilor. Jose is also very distinct that it is not a question about service being used since they cannot use the same string to access another system.

" *For this system, the string must compile in that way for X system, the string must look like this. For other system, the string must look like this.*" (Appendix 2A Row 158)

It is in the same answered confirmed that if a middleware was involved the same string should have been used to access every system or access point.

When asked about the how to create meaningful and understandable data exchange among the systems the respondents immediately replied that they were going to create a structure of terminology being used in the hospitals. Hereby they referred to the freehand writing of physicians in different text fields in the system. At the moment there is nothing that regulates what is written or how it should be structured. The respondents explained it as an unfortunate old habit but on the other hand the text provided rich information about individual observations. The hospital was to implement a common standard known as SNOMED at every hospital in Skåne. The standard aims to create a common terminology and is described by the respondents to be internationally supported in Canada, Germany, Australia and Denmark to mention some.

Respondent Lena told us that the standard should be used in the system to provide translation between terms in different national language and provide a structure in terms that is the opposite of today. It was explained that the board (Socialstyrelsen) had decided SNOMED to be a standard used at SUS because it was internationally recognized and used in the nearby hospitals of Denmark. Eva explained it from an organizational point of view about how the free hand writing the doctors did should be standardized.

Jose then proceeds by telling that although the standard brought uniformity in terms used it could still become problems due to the use and development of different dialects of the SNOMED standard.

" *( ) Then there are and this is not good about this SNOMED. It is that there are some local dialects to. So the standardization has like.. Otherwise with the dialects it get more difficult to use it as it was intended to use*." (Appendix 2A Row 131)

The interview then moved on to determine the problems of un-interoperable systems and whether there had been problems with system interoperability at SUS. First we wanted to know about the manifestation of the problem and how it affected the organization.

According to respondent Eva the impact on the organization was limited to be a question about how to create efficiency in the otherwise time consuming process of finding the right information.

"*Of course we were capable of gaining information. I mean that the entire operation of a patient didn't go down because the systems couldn't talk to each other*." (Appendix 2B Row 20)

The problem with the systems according to her lies in the fact that there are too many systems used in the different hospitals that the upgrading and maintenance becomes heavily and expensive. There has to be a coordinated structure of the systems used in the organizations because if they are not the same version an integration will become impossible.

The respondent Lena also pointed out the difficulties in maintenance and the increasing cost when having several databases and systems doing the same thing. She also mentioned that the systems were unable to communicate at all but could not provide a working example of how it caused workflow obstacles. The respondent Annette agreed to that the systems were incapable of communication and that the large number of system was problematic because of the lack of control over what system was used, where it was used and how.

Then we asked what interoperability problems the organization had experienced. The answers are showed in table 4.3. The horizontal headlines represent the interoperability issues while the vertical shows the respondents.

Table 4.3: Interoperability findings

	IS interoperability	*Interoperability Concept*	*Interoperability problem*
Jose	A local uniform standard yes And in some hospitals there can be one standard in clinic A and one standard in clinic B	After 2013 we will have one database for all the medical records, so you don't have to jump up. We have [ehhr] we are looking at a standardization called Snomed... It's a worldwide standardization method for terms Using Meilor This means that we have to have a regulation that tells people that this is what we are going to use.	We are trying to get rid of some of those systems now. When we do that at the same time, we want to have common databases for all the clinics to use that kind of systems too. No, they (the systems) don't communicate with each other.
Annette			No, they (the systems) don't communicate with each other. A big task we have now is that we don't know the systems used in each clinic. We have to figure out what kind of systems do they have. What they are using and what they are using for
Lena	A local uniform standard Then when we wanted to use it (Meilor) on the whole hospital.. now we are two hospitals within the same system. It is better whit that.	Lund has one standard and Malmö has one standard and now we fusion them. Snomed is under () I think it is technique that Snomed that when we are talking standards today in our systems it is for the user	We have three databases with three different maintenances They (the systems) don't communicate at all. our doctors is also very good at [fritext] to write freely in the medical records.
Eva	Ohh. Yes. I can order results from other systems. I use a part of Meilor to access other systems	It is a part of the whole strategy. Our idea that we believe will be the best to have integrated systems while making it cheaper and more efficient for the organization to use it.	We have a lot of systems today that can do the same thing in different hospitals. It is hard to maintain the systems consistency when there are redundancy in systems.

4.4   Solutions

Finally the empirical findings will deal with what the interviewees could tell about how interoperability problems between systems were resolved by the healthcare organization. First we asked about whether there was an overall IS standardization used to manage syntax interoperability to clarify whether Meilor is intended replace every other system.

Jose explained that Meilor is the system to be used as a standard system to make an overall access to other systems or for the big systems to integrate with.

Eva explained in a different way that Meilor is going to be a common interface to reach other systems so the user can use it as an integrated part of the system. The systems are still separate systems she explained.

"*It is not suppose to be a system to replace all systems in the region. All the systems shall be accessible through interfaces in Meilor and they are so today most of them*" (Appendix 2B Row 26)

As shown in the subchapter 4.2 there are plans to create a standard for semantic interoperability using the SNOMED standard. However it is supposed to be implemented in 2013 (one year from this thesis writing) and for the present days there are no standard used to address any of the issues due to historical context.

As shown in the subchapter 4.2.there is a strategy to integrate system in order to achieve syntax interoperability. We then asked about what kind of solutions that was used in the organization to reach system interoperability at the present moment and what techniques founded the solution. Jose answered that it was every system used at present date and included systems used post Meilor implementation. It was then further explained that the solutions was containing some kind of middleware to handle the communication but that middleware was not used as an overall engine although there was an expressed will to use it.

"*But if you use it, some kind of middleware, some kind of service.. I think it is used in somewhere but not many.. most systems doesn't use that kind of of [today]. But I know that they want to do this kind of things*." (Appendix 2A Row 156)

When questioned about how Meilor interacted with the systems if it was only an interface or if it was a integrated part of the other systems (or the other way around) the reply was that they write data using Meilor while storing it locally and central.

Jose than explained this procedure somewhat deeper and clarified why it was done

"*The original lab results are stored in Meilor system, not the lab system. The lab system only stores them as long as they have the space*." (Appendix 2A Row 220)

Eva explained the middleware solution to be services built around a technical framework that was provided by a system supplier. Eva then gave a different more specified answer and told that the region was implementing service orientation in their systems as solution to interoperability

"*The ones we have contracted for is providing a technical framework to build around and have as a way to integrate the systems as service […] Right now we are making the data interoperable in the whole region using service orientation. And the framework will be used as the middle solution [the middleware]*" (Appendix 2B Row 32)

It was also clarified that the solutions used was developed to manage the situation as god as it gets. For the future there would be a better solution whit Meilor as the common interface and a middleware to distribute the communication between systems. However they can't successfully address all the interoperability problems in the hospital especially if the systems were specified systems used on few units.

"*Now we try to integrate all the things and sometime the solutions are not what it should be by the book.*" (Appendix 2A Row 161)

Annette replied that the most important thing was that the systems could communicate with Meilor rather than between each other.

Jose also gave a clarification on how the system was integrating with Meilor and that the string solution used could only provide access to one other system each time and that some systems couldn't be reached.

"*Also the systems for economic system for patient payment and registration systems can be jumped freely. But we have other systems cannot jump that way. You have to open the systems in another window and so on.*" (Appendix 2A Row 204)

The respondents agreed that the problem of the system interoperability was decreasing, that the organization spent vast resources to solve the situation and held faith in the solutions suggested by the board of the organization. However there was a slightly disagreement on the purpose of the solutions. Jose, Annette and Lena answered that the aim of the efforts was to create interoperability among the systems, cheaper maintenance and system coordination. Eva suggested it to be a way of gaining better coordination among systems and decrease the number of systems used.

Questions about interoperability solutions provided us with a set of solutions used and the information about how they were used in the organization and why. The answers are presented in table 4.4 where the respondents are showed vertically and the solution topic horizontally.

Table 4.4: Solutions finding

	Solution	*Semantic*	*Syntax*	*Implementation purpose*
Jose	SNOMED	X		Terminology Interoperability
	Meilor		X	IS interoperability
	Middleware		X	Maintenance costs
Annette	SNOMED	X		Terminology Interoperability
	Meilor		X	IS interoperability
				Maintenance costs
Lena	SNOMED	X		Terminology Interoperability
	Meilor		X	IS interoperability
				Maintenance costs
Eva	A uniform	X		Terminology Interoperability
	structure of			System integration
	freehand			Maintenance costs
	writing			System Coordination
	(probably			
	refer to			
	SNOMED)		X	
	Meilor		X	
	Service			

Table 4.4: Solutions finding

5. Analyzing and discussion

5.1 The Role of Electronic Medical Records (EMR)

First we will analyze the general role of the EMR systems in healthcare organizations to determine whether they improve the treatment quality, help the doctors when diagnosing, improves communication between physicians and patients and is accessible through using the internet. We do this to determine whether the EMR usage leads to different system roles as described in section 2.2.1 and if those roles leads to system complexity as suggested in 2.1.2. Then focus will move toward the topics of EMR systems and the effects of the systems being developed for different purposes using different specifications.

5.1.1 The usage

First our empirical findings have shown to us that EMR records patients' relevant information and data. Our literature review in (section 2.2.1) suggests that EMR is not only used as media for transforming paper records to electronic versions, but also includes static as well as dynamic medical information. However our respondents strictly consider it to be a recording tool for storing patient data.

Secondly it has also become shown that EMR usage is not automation of decision making. The same section in our literature review also includes Electronic Medical Records (EMR) to provide complete information and data of patients. It can be regarded as reference which is assisted to develop treatment plans for patients. Our findings in the empirical data reject this claim, due to the law it is mandatory for physicians to have to make the final decision by themselves.

Thirdly it was shown that the treatment quality may be improved as EMR always provide updated and current information. Electronic Medical Records (EMR) includes all the information in paper medical records, which is the main information source during the medical service. Our findings agreed with the theory since the information in the records always was updated and available. However the improvements in treatments were linked to a high demand for an improved system among the users. In order to reduce the time cost and increase the treatment quality a standardized and unified system was requested. This finding contradicts the arguing in section 2.1.2 that healthcare organizations wants to keep a broad set of systems.

Furthermore EMR is used for communication when providing a convenient method for both physician and patients to get information needed. Physician can receive timely information with different aspects for corresponding disease. Patients are able to know about their health conditions and treatment progress by detailed information within Electronic Medical Records (EMR) if they request such information when visiting a hospital. Although our literature review suggests that EMR records may improve the communication between patient and physicians by being available for patient through the use of internet there was no support for this from our empirical findings.

In our literature review we found that EMR systems could have multiple usages within the organization (Section 2.1.1) which to some extent is opposed by our empirical findings. Our findings support that EMR is a recording system that follows through the whole medical process but it was contradictory whether they improved communication between physicians and patient or not. It was however definitely proved that the healthcare organizations weren't going to regard the systems as decision support systems or use them accessible through the internet for self care use as suggested in section 2.1.1. We didn't find any support in our empirical findings that different roles of EMR systems in healthcare organizations lead to complex IS situations.

5.1.2   The complexity of EMR

EMR Supports transactions of different kinds of medical data. It is possible to reach information in other systems through the use of different modules of the system and to reach information outside the organization. Our empirical findings showed that the organizations where capable of receiving different kinds of medical data from systems used outside the organization.

There were workflow obstacles caused by the situation, mostly in time and system maintenance. The empirical findings showed that the greatest effects on the workflow was the time consuming procedure of getting hold of updated and right information and supporting the different systems. The situation also meant that several different systems where purchased although they might be similar in function. Having this redundant situation means high costs to the organization. In the worst cases this could eventually affect the patient security if some vital information couldn't become reached. It is mentioned in section 2.3 that the workflow will be negatively affected by time-consuming activities but never mention system maintenance as a main problem area of EMR systems.

5.2   Interoperability

We wanted to find out more about interoperability in EMR systems, and what the concept of interoperability meant to the healthcare organizations and what kind of interoperability problems that was encountered in the organizations.

We found several factors causing Information system interoperability obstacles. First different systems in different hospitals and clinics have *different standards*. Thus, there are many different systems with many modules. The different systems provided by different vendors with *different standards* and specifications. Each hospital or clinic is not able to know if its system is same as others. Historically there was never any uniform centralized coordination from the county council which gave the hospitals the mandate to choose the systems they wanted to use themselves. All of these symptoms is mentioned by Fölster et al 2003 in section 1.1 as factors that caused the spaghetti syndrome of Swedish healthcare.

Secondly we found that different databases are using for different systems. They are used with different maintenances at the same time which lead to increase the cost. There seems to be no central coordinating of the databases and they have been allowed to grow independent for every hospital unit, which has created a problem of data sharing.

Different systems are not able to communicate with each other since they are provided by different vendors with different specifications. It's time-consuming to figure out each system used by each hospital or clinic. The systems doesn't seem to have any common structure in execution or belonging to system families. As the numbers of systems has been growing it seems that the ability to control what they do (and can do) has become lost. The interviewees all mention that different systems have the ability to do the same thing or are similar in function. It seems that another major problem was that there was not uniformity in the standard system of Meilor. Some hospitals had newer versions than other and the upgrades where not consistent within the region

There is no uniformity in terms as mentioned in the empirical findings the physicians and nurses can add free hand notes in the records. It seems that these notes contain important information about what was done during a visit or treatment observations. However there is nothing that indexes or structure to them that makes them useful to other. For the present there is no uniform standard among the systems or in data that is aimed for creating a semantic interoperability between hospitals. Every hospital has developed their own standards so the units inside the organization can make use of the information.

It's important for Electronic Medical Records (EMR) to achieve interoperability. The interoperable Electronic Medical Records (EMR) is able to automatically exchange and share clinical data among different systems with maintaining the integrity of information content (section 2.1.2). Thus, our findings shows that the diagnostic code issued by a computer can be received, translated and stored as a diagnostic code by another computer.

Our theoretical premises showed that EMR systems are developed for different purposes using different specifications and therefore causes the myriad of systems known as the spaghetti syndrome (section 2.1.2). This becomes confirmed by our empirical findings that also showed that the problems experienced by the system were a lack of system overview, and that the systems couldn't communicate.

Meanwhile as stated in section 2.1.2, interoperable Electronic Medical Records (EMR) can reduce the time for staff to find the relevant information but we must add as our empirical findings showed there has to be a coordinated IS structure to make it work, otherwise there will be redundancy in systems . Interoperable network can improve the cash flow by allowing the organization to reduce the workload when maintaining, upgrading and supporting the systems databases (section 2.3.1), but in our study the general idea seemed to be to just get hold of the information in an acceptable way.

5.3   Interoperability solutions

As for solutions that are actually being used to obtain an information and system interoperability in healthcare the empirical findings showed us that in order to create EMR interoperability the studied organizations has undertaken several measurements as follow

- *Unified databases.* From year 2013 there will be one database for all medical records in the region. The organizations will try to scale down the number of databases used to cut maintenance costs. It also means that physicians will be able to get information in time without demanding the system to do searches in different databases.

- *Semantic interoperability: A uniformed and worldwide standardization* (SNOMED) will be implemented. The standard is aimed to make medical information understandable among hospitals and clinics around the world. The standard shall be implemented in Sweden on a nationwide scale and made uniform in order to prevent the development of dialects in standard. In the studied organizations the SNOMED standard will be used to categorize terms, perhaps as a way to gain a common language and index structure of the free hand notes.

- *Syntax interoperability: A standard system* (Meilor) can be used within medical process. The organizations are striving to make some kind of standard usage of the system Meilor as a top domain system. The system *acts like an interface between systems* providing the possibility to access the other systems and is therefore very close to being a standard system to the organisation. However as respondent Eva tells it cannot replace the systems being used and is not to be mistaken for one system that can do everything.

- *Data interoperability* with systems outside the organizations. The clinical decision can be made as possible accurate by data needed sharing in time. The most significant information seems to be that the organizations can reach the national pharmacy register to see what medicines a patient uses.

The design of network is certainly very important but it is not sufficient to achieve interoperability for Electronic Medical Records (EMR) within medical information systems. Interoperability requires the use of standardized language (terminology, data model and file structure) and information, which can retain the integrity of the exchanged information content which was discussed in section 2.2.3. To share and interoperate numerous standards and medical content, there must be a complete technical reference system shared, to define the files and content that can be exchanged between the network participants. In order to reach an interoperable environment in the healthcare organization the syntax and semantic challenges has to be solved.

The contents in the scanned files usually cannot provide data to the database. The encoded data only can be exchanged and interacted by using standardized terminology, content information, data and information model. Then systems can speed up to store and process data without intervention by achieving interoperability on semantic level. However this requires that there is a indexed structure to what is written. In this study semantic interoperability is supposed to become achieved when implementing a uniform (dialect free) SNOMED in the studied organizations, as their only standard for most of the medical information exchange among medical institutions, medical registration systems, pharmacies, physicians and patients which agrees with the literature review (Section 2.3.2).

The systems also must be able to share data among each other regardless of the form of the data if they are to be interoperable on a syntax level. To reach the syntax interoperability there are several ways (IS standardization, SOA, web-service and XML, point to point and middleware). It means that there has to be some kind of platform for transacting the data. It could be a interface or a middleware that transform the data into a interface using XML (Section 2.2.2) or a SOA with middleware (Section 2.4.1).

In our empirical findings the hospital organisations under the Skåne county council has solved the situation using the Siemens developed healthcare system Meilor as a common platform for accessing different medical systems. The findings also showed that the organizations are using a solution with an interface in Meilor that sends a string to another system. This shows similarity to the point to point solution explained in chapter 2.3.5. However there seems to be a limited use of middleware to coordinate the systems which means that every system actually can have a "one too many connection" with other systems. This assumption is further strengthen through the statement that a two system communication could mean that three system was involved.

However it was also explained that this solution are to be changed and that some kind of technical framework that will provide a service to distribute the communication through a middleware will be used. It gives the expression that the organization tries to reach a service oriented technology framework to distribute the communication. It might seem as they are implementing a SOA but according to our theoretical findings, they are not, since there is no encapsulation of business logic and there seems to be no loose coupling which are characteristics of SOA (section 2.3.3). Mainly it seems like they once developed the method using the string execution with a interface as a way to reach the information in the databases and now implements the middleware to provides some kind of overview and coordination of the "one too many" connections.

Our theoretical premises opposed the thought of a standard system for healthcare simply because it is considered impossible for a system to cover every aspect that has to be addressed in healthcare while being flexible enough to support the processes of the organisation (Section 2.3.2). In our empirical findings it was confirmed that the use of Meilor as common platform was not to be regarded as a way to gain an enterprise wide architecture in information systems used.

5.4   Summary

The most significant findings of our study in the hospital is that the EMR systems are regarded as *information recording and monitoring systems* that should not be used for decision support. They have historically been *developed and purchased independently* by the different hospital organizations without any central coordination. This has caused a situation with *redundancy* where different systems have similar functionality, and *time consuming difficulties and additional cost for the system maintenance*. It has also meant that the systems have *no common structure* that makes them *capable of communicating* with other systems.

To master the situation it seems as if they have developed the Meilor system to act *as an interface* between systems using the *point to point architecture*. It has solved the syntax interoperability and made it possible *to share data between the hospital systems* regardless of systems used and their upgrades. It may actually be argued whether this solution is a sustainable option since the architecture according to Henningson (2008) in chapter 2.3.5 is adapted for smaller networks and requires high maintenance resources, which was one of the organizations major problems.

It is also told that there is use of a *service oriented framework* that should act as a middleware to distribute and coordinate the communication between the systems using the interface of Meilor. It seems to be a solution that is suppose to *develop and replace* the point to point architecture, however since *just a few of the systems are using this solution* for the moment it might also be a question of locally developed solutions. To gain a semantic interoperability there seems to be no specified solution for the present but there will be a *standard implemented* to create common terminology for all hospitals in the region. The standard will also be internationally accepted and used in the neighbor country of Denmark.

Even if the solutions as described by one of the respondents are not by the book they are included in our theoretical conclusion (section 2.4) as defining working solutions of interoperability problems at both semantic and syntax level.

6 Conclusion

When we started this thesis our purpose was (and still is) to provide some knowledge about what solutions that are used out in the healthcare units to solve interoperability problems in the EMR systems (section 1.3). We therefore based this thesis upon the research question, *What techniques for information systems (IS) interoperability is used in healthcare organizations to solve interoperability problems in electronic medical records (EMR).* Our empirical findings from our study that was conducted in two hospital organizations within the county council of Skåne, showed us how interoperability solutions are being used in hospitals today.

We found that region Skåne has experienced the problems with EMR systems that was developed for different purposes using different specifications. The systems were unable to communicate with each other and brought costs for the organization in maintenance difficulties, but we also found that it could cause redundancy in systems doing the same things.

It was also found that there has to be a standardized terminology to reach semantic interoperability and that the healthcare organizations are going to implement a uniform way to express medical terms in both the EMR fields and the note field. In the case of our empirical findings the uniform standard chosen was SNOMED because it was used in the neighbor country of Denmark. It was also told that even the standard could become inconsistent if different dialects of the standard were developed.

But solving the semantic interoperability is only one half of the problem; the systems must be able to communicate with each other on a syntax level. This can be done using several solutions as shown in our research model (subchapter 2.4). In our empirical study the hospital used a point to point architecture to gain access to the systems with Meilor as common interface. Furthermore it was told that they are aiming to use some technical framework with service orientation as middleware but since they lack important aspects of the SOA (like platform independence, loose coupling and flexible implementation), it is still a point to point architecture using the middleware to get a better coordination of the communication.

We answer the research question by stating that the healthcare organizations in our study uses SNOMED to solve semantic interoperability level and a point to point founded interface called Meilor to solve the syntax interoperability level.

Our general conclusion based upon our research model and empirical findings is that the right solution to address the semantic interoperability area is used when implementing SNOMED as standard for terminology.

However according to our research model the application of the point to point technology to solve syntax interoperability makes the healthcare organizations themselves enhance their problem. Point-to-point is suitable for small networks with few connections not an HIN with hundreds connections, thus is not a suitable solution for the needs of the studied organizations to achieve interoperability.

We therefore suggest that part of the interoperability problems in healthcare comes from their application of IS solutions and has to agree with Fölster et al (2003) that the organizations do not understand the problem they are trying to solve. Most likely more research about IS in healthcare has to be conducted and greater efforts has to be done to make decision makers understand that the solving of EMR interoperability is a part of their vision of a working boundary less patient centric healthcare.

6.1   Study limitations

Our study is based upon two sets of interviews since the respondents in the interview in Malmö preferred a group session rather than answering on their own. We respected their wish although it might not benefit our research strategy. At some point the respondents also points out that they lack knowledge in the area and that someone else perhaps would be better suited to answer. However they have when talking about something else been able to give rich descriptions in the problem area. However this circumstance affects the generalizability and transferability of the work.

Appendix 1: Questionnaires

General question

Department:
Working position:
How long time have you been working at the position:
What level of confidentiality do you prefer

- Open: Name of the informant will be published
- Closed: The informant will be given title informant (x)

EMR:

1. **The role of EMR**
   Is the EMR system helpful for the physicians in the decision making process when diagnosing?
   a. How is it used at SUS? To document, monitor, and manage health care delivery, decision support etc?
   b. Is the EMR system significantly improving the quality and efficiency of the treatment?
   c. Is it helping in communication between patient and physicians?
   d. If so, how? Is it for example accessible through internet
2. **EMR Complexity**
   a. Does it throughout the medical process supports a high degree of different medical data transactions (i.e. supports sharing of data)?
   b. EMR systems are developed for different purposes by different vendors using different specifications. This can cause problems when using multiple accesses like negative workflow effects (long response times, data mismatches). To what extent does the interoperability affects the workflow at your hospital?

Interoperability:

1. **IS interoperability**
   Gaining interoperability requires standardized language and information (terminology, data model and file structure).
   a. IS there a uniform standard used by SUS on language and information level?
      i. What standard does SUS uses in their network platform? (Network systems like Oracle, IBM, MS-server, XML,
2. **Interoperability Concept**
   a. What techniques are used to enable data exchange between systems and applications regardless of data meaning (syntax interoperability)? SOA or other techniques (like web-services alone)?
   b. How is understandable and meaningful data exchange conducted? (Semantic interoperability)
3. **Interoperability problems**
   a. Is there now or has been any interoperability problem in EMR systems at SUS?
      i. If so how is/was the problem
      ii. Has it increased or decreased during time?
      iii. How large resources are spent to manage it?

Solutions:

1. **Standardization**
   a. Would an overall standardized system be beneficial for SUS or not?
      i. Why would it be so (regardless of yes or no)
      ii. Is SUS using system standardization to solve semantic interoperability problems
      iii. IS the HIN of SUS built around a international standard like HL7?

2. **SOA techniques**
   a. SOA means encapsulation of process logic not merely the use of web-service or XML like component based architecture.
      i. Is SOA implemented in SUS organisation?
   b. Does SOA enable an exchange among platforms?
      i. Is platform independence reached

3. **Web-service and XML**
   a. How is Web-services used? To build interfaces or to access different systems and services?
   b. IS XML, SOAP, WSDL the standard communication protocols

4. **Point to Point & Middleware**
   a. Is this architecture used at SUS
   b. If so what is the effect? If no why?

Appendix 2A: Transcription SUS interview

SUS interview 23/4 2012

Interview type: Group Interview

Interviewers: Ai Jin & Lars Ahlfors:

Respondents: José Gonzales; Annette Hansson; Lena Andersson

Bold text = Interviewee

Italic text = Respondent

Row	Person	Sentence	Special context	Time (Minute)
1	**Ai**	How is EMR used here at SUS. Is EMR used for decision in decision making process when diagnosing?		00.00
2	*José*	Well (.) They record everything they do with the patient and the findings. :: And that's what they use it for. And they can reach other physicians findings to and : systems. But it is not only one system they have a lot of systems. As I showed you last time*from one system you can reach some of the other systems and you can see what they have done and what they have found out about the patient. But if you are meaning if they have a automatization for getting what they have to do with the patient. Then NO they don't have that kind of help they have to read , find out think and do. The system doesn't help them to make a decision the decision making is for them to do.	* José refers to the initial visit	00.09
3	**Ai**	They just provide sort of reference		01.20
4	*José*	Yes		01.25
5	*Annette*	[mm:::}		01.26
6	*Lena*	Yes		01.27
7	**Ai**	Okay. (.) Please		01.28
8	*Lena*	Could you please tell us..	Lena asks us to tell more about the thesis. Ai explains.	01.35
9	**Lars**	Would you say that the use of EMR do improve the treatment here and the workflow (.) If you would for example se it from a historical point of view before they where there, during the time before they were really inside the system, when it was pen and paper and a lot of archives.		03.04

10	*Jose*	Yes. (.) as old time. Old time we talk about just before year 2000, the patient could come and you have to find the medical record and the medical record was not in the archive because some doctor hade them in the room and you didn't get the record. For example. Another example are the EKG (Electrocardiogram)		03.38
11	*Annette*	( )		04.22
12	*Jose*	Those were not in :: available electronically before. You know they print out the paper and then put it in the medical record in paper and then to the archive. Well for some people or patient that came by the emergency department. You couldn't reach that paper because you didn't have it. And then you have to put the patient for 24h in a department to see if the EKG curve changed or not. Today you have this electronically then you can see if the curve is the same as that the patient has now and then you can send him home.		04.37
13	*Lena*	And lab results		05.28
14	*Annette*	And all.. I think about all the modules, pieces of the system, Medicine, Lab, X-ray, Documentation, Warnings..		05.30
15	*Jose*	If the patient come ( ) is allergic to something		05.53
16	*Annette*	It's a lot of pieces of a system and that of course improves it for the doctors.		06.02
17	**Ai**	So reduce the time consuming?		06.09
18	*Jose*	Yes		06.10
19	*Annette*	Yes		06.11
20	**Lars**	And give them a better overview		06.12
21	*José*	Yes. And a lot more to read to, that is also a problem. That you have a lot of information before you could say I have this well I have this information, I make my decision on that. Now I have a lot of information, what I'm going to read here. Think if I make a decision that is not good because I have the information that is in that and that system. So you have more information to take into consideration when you meet the patient today. That's good to but it takes a little to.		0613
22	**Ai**	Take a little time to pick..		06.55
23	*José*	Well in this system I don't have it I look in that and that, Ohh I see I have some information here to, I look what that is. That's good for the patient because there are more security but for the doctor they have to go		06,57

		through a lot more information today.		
24	**Ai**	Do you think it also help in communication between physician and patient		07.30
25	*Lena*	( ) The EMR you mean? I think it helps. On both sides. And more safe of course. You know what I mean.		07.36
26	*José*	Today it is possible for the physicians to reach the national register of all the drugs that the patient has come to pharmacy to pick up. So when you ask a elderly patient what you take:. Oh I take something for the blood pressure and another white pill that I don't remember what it is called. Well they can look here and they say ok you can look. Then they can watch what they have been at the pharmacy to pick up. And that's good to.		07.56
27	**Lars**	And the patient as well can go to his or her site and..		08.49
28	*José*	In the pharmacy yes.		08.50
29	**Lars**	In pharmacy only?		08.51
30	*Lena*	Can you do that*	* Authors translation from Swedish.	08.52
31	*José*	Yes. But most patient doesn't know that. That is possible you can do that to.		08.54
32	*Lena*	Okay		09.01
33	*Jose*	You can reach web [uhh] 1177. Now you learned something?		09.02
34	**Lars**	But the general for the EMR is that the patient can't get any access to it through internet		09.17
35	*José*	No		09.28
36	*Annette*	No		09.29
37	**Lars**	Why.		09.30
38	*José*	There are many discussion about this. Everywhere they want that it's the safety issue. How to do that the best way and so on.		09.31
39	**Ai**	Privacy.		09.42
40	*José*	Privacy yes. They conceders that I don't shall be able to see your records instead and so on. That's one thing the other thing is that the language in the medical records are not that easy to understand always and could be interpreted wrong sometimes. But that is a smaller issue the bigger issue is security so that I only I will reach my		09.43

		record in a safe way through the internet. And not have people out there pick up information.		
41	**Ai**	So when conceder about the authority of when people could access to one patients electronically journal also have to conceder about privacy and security issue.		10.33
42	*José*	Well if you are inside the firewalls of the Region. Everybody that takes care of that patient is allowed to get the record. If you treat the patient you can get the record. But it's available to me to get every record in the region but I'm not allowed to get it. So we have some controls every month, every month random. Random controls. Let's see what José Gonzales has read about the patient, did he treat that patient yes/no.		10.49
43	**Ai**	Okay. So that's some guarantee for the patient to get secure		11.55
44	*José*	Yes, We always got that and say watch out it could be your turn next time.		12.05
45	**Lars**	How does that control works		12.25
46	*Lena*	Chief they are responsible. Every clinical chief.		12.28
47	*José*	Every clinical chief they are responsible that they do this control, I don't remember how many , but hundreds I think per months. Randomly.		12.30
48	*Lena*	There are rules for it but it is a manual work. You have to go inside and look at every log file		12.55
49	*José*	You can pick up, do it by automatic random scramble you know. Its my name.		13.16
50	**Lars**	Does the system through the medical process support a high degree of different medical data transactions that means, does it share different kinds of data among, for example an image from a X-ray. Can that be brought up in another department.		13.30
51	*Jose*	It could be brought up in every department but you have to call on the module for x-ray. So I can be in Meilior and I want to see the picture taken and I click on another button and I get that picture		13.52
52	*Annette*	It's another system or application		14.15
53	*José*	So in fact for radiology there are two systems. There are one that the radiologist work in and one that is for the use for those who wants to order a picture. So I order a picture and the radiology takes the picture. So all the picture I use there is a system for that. I can use meilior to, if I use melior I order in melior it goes to this:: Order system and from the order system it goes to radiology		14.23

		system to take the picture ( ) and the pictures are there. From this middle system I can se what they have done. I can choose to go into the middle system look at the answer. Today you cant se the picture but we are working on it so you can se a picture shared to and I can go from Meilior to the radiology system to se at the picture to. So there is three systems here.		
54	*Lena*	Was that answer to your question or would you like us to give it from another different perspective to?		16.00
55	**Lars**	Another perspective to		16.03
56	*Lena*	At different computers at different sites and we could.		16.05
57	*José*	We can do it from every computer		16.10
58	*Lena*	At some time		16.12
59	**Lars**	So there are basically no limitations in that field. No one that saves in their mode or packs it in file formats of their module.		16.23
60	*José*	No I can see if I go to the radiology system and look at it there I can see the answer before the doctor has signed it ok. They make a preliminary answer, then I can look at it there. If I don't want the preliminary answer I can wait a little while and the doctor will sign it in the xray department and then I will get the real answer in my system. So if im in a very hurry and has a very bad patient I can look at the preliminary answer to.		16.39
61	**Ai**	So is that you don't have to get the answer from a central main major system but you can get the answer from every different system.		17.35
62	*José*	Yes and that's good to. Because sometimes if the patient is very ill the physicians or the doctor taking care of it can call up the radiologist and they can discuss the picture and on the radiology system to, so to talk about it ( )		17.44
63	**Ai**	I see. So the next one. EMR system are developed for different purpose by different vendors using different specification s this can cause problems when using multiple access like negative workflow effect. To what extent does interoperability effects workflow on your hospital.		18.00
64	**Lars**	This could be both positive and negative. Interoperability means the ability to actually have a common communication so don't interpret the word to just be mentioning the problem area. It is actually the ability to share data so you don't get confused about terminology.		18.36

65	*Lena*	When we started to implement melior . Before 2010. Two years ago we were two hospitals in Lund and one in Malmö and in Lund Melior was a system for just one clinic. Then when we wanted to use it on the whole hospital of course the response time was to long in the beginning but now I think it has improved and now we are two hospitals within the same system. It is better whit that.		19.08
66	**Ai**	Sow which means the systems get integrated		19.58
67	*Lena*	Not yet.		20.00
68	*José*	Do you remember what I showed you last time*We have one big database in Lund and one in Malmö. Those two databases is reachable for everyone to so it is possible for one to look what is done with the patient in Lund and what was done in malmö. And then we also have a big platform or view for all the databases, melior databases in the region so you can reach everything from the city of Kristianstad, Ystad, Ängelhom, Helsingborg and so on. There is a lot of information and it is reachable for everyone and its reachable fast. You don't have to wait 15 minutes to get in the system.	*José refers to the initial visit	20.05
69	**Ai**	So this means that the systems are parallel but is reachable at the same time.		21.17
70	*José*	Yes. This parallel system we have today we have if I remember 10-12 databases (.) we have B. We are going to have one instead I think it will be during 2013. And that means that we are going to start up one new empty database, and the old records will stay where they are and will be reachable by this viewer that we have today. So after 2013 we will have one database for all the medical records, so you don't have to jump up.		
71	**Lars**	Is that also for smaller units like the local smaller hospitals		22.14
72	*José*	Yes, They will also be there but the primary [vårdcentralerna] house doctors out in the town the village they have a common system today to. So there will be one system for the hospitals and one system house doctors. In general. Then there are all the private physicians that work for themselves they can have what systems they want, such systems will not be reachable for us. But the primary out in the village yes.		22.23
73	**Ai**	So the new one going to be built next year will cover as many places as it can.		23.30
	Annette	Yes		23.31
74	*José*	Yes.		23.32

75	**Ai**	Are there other advantages for using the new one		23.35
76	*José*	The advantage is that when we in the system look at one patient we will get all the record the whole record in a view so don't have to figure out it in another place. I look and click and see if it is in another place I can see that at once. It's a small advantage I think. Save some minutes and you don't have to dig and se ohh I have to do that to		23.37
77	*Annette*	Look at the same facts again.		24.20
78	*Lena*	And only find it in one place		24.22
79	*José*	And the information that is put in the system will be structured in the same way so I don't have to think if they have another structure in another place.		24.25
80	**Ai**	So then there is uniform standard		24.50
81	*Jose*	yes		24.51
82	**Ai**	By the new one. Which means that it is not uniform standard now right. So there is going to be a uniform standard in the new one.		24.53
83	*Lena*	A local uniform standard		25.10
84	*José*	A local uniform standard yes. Today there are places that has a standard and places that doesn't have a standard but we don't have the same standard.		25.13
85	**Lars**	You mean that two units have different standards		25.24
86	*Lena*	Like today. Lund has one standard and Malmö has one standard and now we fusion them.		25.32
87	*José*	And in some hospitals there can be one standard in clinic A and one standard in clinic B because they have the power to do that then back in time.		25.40
88	**Ai**	So as you know what kind of problem there will be by the different standards		25.55
89	*José*	Well the problem is that the [You could] It is not that easy for physicians or doctors to know what kind of standard they have in Ystad or Kristianstad or in another hospital. They could think well this kind of information I will be able to find here but you don't because they keep it in another place. So if you have a standardization of information in the structure how to put it in. Then you will be able to:: You will know where to find different kind of information.		26.00
90	**Ai**	So without standardization this can have a negative effect on the decision making for physicians		26.46

91	*José*	Yes it have.		26.58
92	*Lena*	Could have.		26.59
93	*José*	We have [ehhr] we are looking at a standardization called Snomed. Do you know about that?		27.00
94	**Lars**	A little bit but could you extend it a little bit		27.10
95	*José*	It's a worldwide standardization method for terms. That makes a standard about for example that a bed is a bed where a person are laying on the bed than it's a bed. So when you say a term you will know what kind of term it is and how it is used and what it's for. And this standardization are not only for Sweden its used in Denmark in Canada Australia and Germany. It is only used where the hospital wants to uses it so it is not the whole Canada or the whole Germany. It is in that hospital or in this department or the other department. So what we are looking at is if we can take in that standard and make it in a slow mode so we don't lose control. Because we have today we have some kind of standard that we are going to use in the new journal and local made standard but we would like to have one [an an] recognized instead.		27.15
96	**Lars**	So you are saying that SUS now is following an own standard that's not supported even national		29.16
97	*José*	No. That's correct. We don't have a national standard		29.25
98	*Lena*	Snomed is under () I think it is technique that Snomed that when we are talking standards today in our systems it is for the user. Do you know what I mean Snomed is under the back [eehhh] It is behind*	*Translated from Swedish	29.27
99	**Lars**	Back-end it is called I think*	* Translated from Swedish	30.05
100	*Lena*	In the system. In the system the use the (.) Snomed terms at that way that we are talking about. But when we are talking standards today it is where we use different terms. Then it is very important that all doctors use the same term at the same way because Snomed is for we can [eehh] our information in our system perhaps we want to share it with Germany one day and therefore Snowmed is good for it can translate the terms between the two systems. And not for the users at the same way. Do you know what I trying to say		30.10
101	*José*	If we say that an inflammation in the lungs. Well we could that Snomed term and let's say that this Snomed term is called 100*. Its that and what its mean that you have an inflammation bacterial or whatever. When the doctor here uses that they could use pneumonia they	*José draws a map.	31.00

		could use that word and that word refers to that term 100.		
102	**Ai**	So this means corresponding numbers to corresponding terms		31.55
103	*Annette*	Yes.		31.56
104	*José*	Pneumonia and it could be a for example a bacterial disease lungs at [blablabla] refers also to that. So in another different medical journal they could use another term here that means the same thing. They could refer to that. This kind of thinking is Snomed thinking		31.57
105	*Lena*	It means the same things		32,20
106	*Jose*	And [Lunginflamation] referes to a bacterial disease in the lungs and its refers also to this [blabla] so you get a standard, do you get what I mean.		32,25
107	**Ai**	Common language yes?		32.50
108	*José*	In the [eeehh] If you think this will be the great thing in the world then you could think that well I put that in a translation and I send my medical record to China and in Cantonese then we will get out what the heck this is. But this is in paradise you know. Thinking that ( ) this will not be that way.		32.54
109	*Lena*	Right now we like to [ehh] all the doctors in the different [speciallities] they must agree [get along] and get a deal so (.)		33.32
110	*José*	This means that we have to have a regulation that tells people that this is what we are going to use. So in the region* we have now a regulation that we will use Snomed. That we all have also said that we will implement it in a slow way. So the first thing that will be implemented is issues around the family and things like mother, father, social status and so on because those facts we are using for all patients that we have. So that's a good way to start with that. Then we will go on and change out our old standard with this new standard. And it is also good because it is possible that we could have more ( ) pre-done information so we can choose pre-done information instead of writing it into the system.	* Country council of Skåne	33.43
111	**Lars**	And this will be done at the same time as the new database		35.17
112	*Lena*	Yes		35.18
113	*Annette*	Yes		35.18

114	*José*	Yes		34.19
115	**Ai**	So as you know the new standardization will cover whole Sweden, Swedish medical systems or only in one region		35,20
116	*Jose*	No		35.41
117	*Annette*	Oh no		35.41
118	*José*	The region of Skåne		34.43
119	**Ai**	The region of Skåne		34.44
120	*José*	Because we cant tell to the others what they have to do. That Snomed is one of the big standards that everyone is talking about, is it good is it bad, does it cover everything or not. Well it doesn't cover everything but it is a standard that is growing. And its alive. When ohh we don't have this term we need that term then you put in a (.) or what you call it and send it to the Snomed organization in Sweden and then discuss it in the national [yeea]. and they say yes this is a good term we don't have it anywhere else so we have to make it.		34.46
121	**Ai**	So which means in other Nordic countries also uses		36.41
122	*José*	Denmark		36.46
123	**Ai**	Only Denmark?		36.47
124	*José*	I don't know if they have something in Norway but Danish they (.) to use it		35.48
125	**Lars**	Finland		36.55
126	*Jose*	I don't know. We are so near Denmark so we look at them		36.57
127	**Ai**	So as you mention this can be implemented in Canada or Germany or they are some possible countries		37.05
128	*José*	No. No there are hospitals that are using it. Also in the US They have some hospitals there to. But it's not a standardization though the world. Snomed. It is through some hospitals and some countries. But it is one of the big standardizations because there are not many standardizations in the hospital world. And every doctor want to do what they want to do. its no boss you know. So there is no standardization		37.16
129	*Lena*	I think it came from (.) it started there		37.54
130	**Ai**	So which means. In the whole world there have several different standardization		37.59

131	*José*	Yes. ( ) Then there are and this is not good about this Snomed. It is that there are some local dialects to. So the standardization has like::		38.01
132	**Lars**	It is not uniform in itself?		38.30
133	*José*	Not quite. Uniform but not (.)		38.31
134	*Lena*	That's the problem you have to (.) to get along in the same way. Otherwise with the dialects it get more difficult to use it as it was intended to use.		38.35
135	*José*	But in Sweden there will be only one dialect, the Swedish one. For now on there are no dialects that can tell you. Because to have a dialect then you have to use it first in an extended way, so that people say that [I must have this term in that way because I don't or can't perform what I have to do with that other]. So we have to see what happens.		38.54
136	*Lena*	Hmm. One more difficulties is that our doctors is also very good at [fritext] to write freely in the medical records. Standardization is also, it is more that you have to		39.26
137	**Ai**	Make them limited		39.52
138	*Lena*	Yes		39.53
139	*José*	There is a limitation in every standard		39.54
140	**Ai**	Then there comes one question. Why do you choose this standardization?		39.58
141	*José*	Because. I think that it is the only one		40.04
142	**Ai**	The only one.		40.07
143	*Annette*	Yes. The biggest?		40.08
144	*Lena*	yes		40.09
145	**Ai**	ok		40.10
146	*José*	There are other kind of standards for example for the nurses. They use some kind of standard to, but if you see it in the. Like a big standard that it could be used everywhere then it's Snomed.		40.11
147	*Lena*	Sweden has decided that in Sweden we shall use Snomed. [Socialstyrelsen] you know have		40.38
148	*José*	In the national plan		40.46
149	*Annette*	Yes the board		40.48

150	**Lars**	We are a little curious now since we are talking about the future. For the present, when you are sharing the data, regarding to the meaning [syntax interoperability], what kind of the techniques are used today?		40.50
151	*José*	: Well, that's the problem with us. We don't have technical skills or answers for that. But we know that for example, the answer from X-ray will reach Meilor and the information will be posted in one way or another to Meilor. The information will be in two places in the radiology system, middleware system and the Meilor.		41.12
152	**Lars**	you answer the question a bit. You are using some kind of middleware as interpreter?		41.54
153	*José*	Yes: yes. We are using interface and application in the middle to make it possible to read. But we don't know how the information from that system goes to Meilor, if it is XML, or some kind of web-service or what. We don't know.		42.02
154	*Annette*	We don't know and we are not sure.		42.40
155	**Ai**	It is the web-service, the surface is web based right? I remember you showed us last time.*	* Ai refers to the initial visit	42.43
156	*José*	Last time I showed you how to reach different things. What we often sent from Meilor when we want to reach something, user name, patient name, patient personal number. We send that in string. Most of the time, the strings go directly to the other systems. Well they have some kind of		42.53
157	**Lars**	You are not going to database?		43.32
158	*José*	No. They don't go to the database. They go to the other system , there is a receiver* The system opens up and show us about this patient graphically in a viewer or something. That system will get down to the database to get the things we want to see and put it to make us could see. If this is Mailor,** then we send string, over the internet inside the firewall. We send the personal number and so on to this system. This system, we can say radiology system. They have small exe-file but this will reach. When reach there, the radiology system goes down to the radiology database reaches what we want have then to show me. This is not for sure, but for the most system, we don't have a service here that the string goes to. You want radiology system, I put this. I don't know. Could be web-service or another service. For this system, the string must compile in that way for X system, the string must look like this. For other	* Translated from Swedish ** Jose draws a picture.	43.45

		system, the string must look like this. But if you use it, some kind of middleware, some kind of service, you can always send the same kind of strings here. I think it is used in somewhere but not many. Then you have to talk to technical persons but most systems doesn't use that kind of of [today]. But I know that they want to do this kind of things		
159	*Lena*	We can say that every clinical in our hospital, for some years ago, all of them decide what kind of different system you should have in their own clinics. And now we have different way to see, the region to make decisions today, to put all system together, so we can know what system we use, how they can integrate, doe the users use the same system perhaps. And a better ::		47.32
160	*José*	Then we have a control all over		48.33
161	*Lena*	Yeah, the better control with all systems in the hospital. For some years ago, we didn't know which clinic they use for their own systems, just what they want. And next clinic used other systems. That's why we have this problem today. Now we try to integrate all the things and sometime the solutions are not what it should be by the book.		48.35
162	**Lars**	This makes us go to question number 3 here. Could you please state and tell more about this situation?		49.15
163	*Lena*	You mean the problem we have.		49.21
164	**Lars**	Yes		49.22
165	**Ai**	The interoperability problem		49.31
166	**Lars**	You touch it in a good way. Could you extend it		49.36
167	*Lena*	Lets give an example. We have a department here. Emergency. * In this clinic they use several different systems**. For example, one is EMR, which is not Meilor for this kind of specialty. Then we have 5 different systems. Clinic A and Clinic B are using totally different system. We have 50, 60 different specialty and clinics. You can quite understand that how many different system we have. Now we are trying to have so many different systems and it's very expensive. Perhaps this one is same as this one system but with different vendors with different databases. So to get cheaper, we could use in one database, also get cheaper in maintenance	*translated from Swedish ** Lena draws a map.	49.39
167	*José*	We want to have few systems and same systems. The system we need, we must have, but not different systems for the same purposes.		51.45

169	*Lena*	And as cheaper as possible.		52.05
170	*José*	We are trying to get rid of some of those systems now. When we do that at the same time, we want to have common databases for all the clinics to use that kind of systems too. When we can do that, we will get easier with interoperability and sharing information too.		52.08
171	**Lars**	So the systems have hard time to talk to and communicate?		54.40
172	*Lena*	hmm they don't communicate at all		54.41
173	*José*	Some of them are used by a few people. It never been an issue to get reach the system. If those few people could get the same system, it will be nice to have that information available too.		54.45
174	*Lena*	You could say this one used in Helsingborg, SUS and Ystad which Jose said. We have three databases with three different maintenances. Now perhaps they could use the same database.		53.20
175	*José*	To make it consolidation		53.46
176	**Ai**	We could say that may be this one system is same as this one but provided by different vendors, even though do they still hard to communicate with each other or?		53.51
177	*José/Annette*	No, they don't communicate with each other.		54.02h
178	*Lena*	They don't at all.		54.03
179	*José*	Because this is provided by one vendor, and this is provided by another. This system is called A and this system is called B		54.04
180	*Annette*	and they don't know B is the same system as A.		54.09
181	*Jose*	This is heritage from the time when everybody has their own in their city with what they want. But now the region has the hospital and they care as the big a large corporation. As the big companies, which must be able to talk to each other, to do it cheaper and safe. We can't have a lot of different systems but doing the same thing.		54.16

182	**Ai**	with this situation, does it also cause the security issue as well or?		54.45
183	*Jose*	Of course. If I can't reach that information, then I can't share the information then I can't reach the information I want. Then my decision cannot be made as possible good as it could be. Then I cannot get the needed information on time.		45.47
184	*Lena*	Another difficulty is that there are three different systems but doing the same thing. That's unnecessary. I think it's more expensive		55.38
185	**Ai**	it's the money issue and time issue.		56.08
186	*Jose*	Well, money issue, maintenance issue, security issue for information, small system cannot get attention as big system can get, IT department too. There are a lot of problems with different systems but doing the same thing. It's better to have one system for one thing.		56.10
187	**Lars**	Is the problem increasing?		56.50
188	*Jose/Lena*	It is decreasing		56.55
189	*Jose*	We have had no regulation for this before but now we have. If clinic B prefers one system, we have to see if the region has it existing with agreement		57.05
190	**Lars**	Are large resources to spend to manage this situation and problem? Such as working time, equipments and systems		57.52
191	*José*	No ( ). One ( )of our working tasks is to reduce the problem. We have time to do it within our work. All the systems have these problems, some systems disappeared, the less problems left. With new requests come from the clinics, we have to address them too. I think it's normal situation for any company. It's a company and a big company.		58.12
192	*Annette*	A big task we have now is that we don't know the systems used in each clinic. We have to figure out what kind of systems do they have. What they are using and what they are using for. Perhaps we know this one is not using but we are paying for its maintenance and so on. That's the task we have to deal with		59.13
193	**Ai**	So it is processing but not finish yet		60.12
194	*José*	We don't have exactly knowledge of all the systems are used in the hospitals or the region. We have better knowledge today but we don't have the full map yet		60.14
195	**Ai**	So it is a procedure of exploring		60.46

196	*Jose/Annette*	Yes		60.48
197	*Lena*	We are in the changing progress we could see. The clinics have to know it's not up to them anymore, not self-decide. They must all go this way. We have the decision here. Then we have much to do		50.50
198	*José*	Another problem is that all the systems that have some kind of EMR, we cannot just close it and throw away the data because we have the archive. We have to do that in the way for secure. We could reach the information forever. For that we also have the project to make the standardization to archive for all systems		61.25
199	**Ai**	So there is also problem with data		63.08
200	*José*	Yes. We cannot close it and we have to maintain it because we must reach the data. We don't use the data but the data must be reachable. We cannot throw it away. We must archive the data. It's not that we could decide we want to or not, it is the law. We have to put the data alive. For the hospital systems is forever here but not private one		63.10
201	**Ai**	So the goal is to make the data interoperable?		64.12
201	*José*	yes		64.14
203	**Lars**	For solutions, in mailor system, in question 2b. Can you use Mailor system, do you have to swift to another system or you can use it to reach other system?*	* Lars repeat the question in Swedish.	64.15
204	*José*	: It depends. Some systems for example, you can do that. If you are using Mailor, and you want to use the system for operation/ surgery system, then you can go to Mailor and jump into the surgery system to write the things you want and click back. Also the systems for economic system for patient payment and registration systems can be jumped freely. But we have other systems cannot jump that way. You have to open the systems in another window and so on.		65.17
205	**Ai**	So it is some not total?		65.30
206	*José*	Not total. Not all.		65.34
207	*Annette*	The most important for big system is to integrate with Mailor, as you can jump between them		65.35
208	*Lena*	But for this one, you cannot go through		67.05
209	*José*	Some small systems are used in few places then you can't. It could be as small system used in one or two places but for them it is important system maybe		67.07

210	**Lars**	Is there anything telling how Mailor accessing other systems?		67.28
211	*José*	Almost by sending a string and exe-file in other systems.		67.52
212	*Annette*	Lab systems [are they not the same way *]	*translated from Swedish	67.55
213	*José*	It is not making assessing laboratory system but the laboratory result will integrate with Mailor system but also post by Mailor system, every few regular mins.		68.12
214	**Ai**	So it is atomization		68.47
215	**Lars**	When you are writing, you writing in Mailor right?		68.49
216	*Jose*	Yes		68.52
217	**Lars**	But when you store it , as a file belong to another system		68.57
218	*José*	Yes, the lab results will be put in the database every 10 or 15 mins. When I see a patient, after I write some results, it will come after few minutes.		69.02
219	*Annette*	lab results are in lab system. This is just viewing the lab results in Mailor. Am I wrong?		69.42
220	*Jose*	The original lab results are stored in Mailor system, not the lab system. The lab system only stores them as long as they have the space.		70.02
221	**Lars**	We forgot to ask the general questions. One of them are the confidentiality you prefers.		71.05
222	*Jose*	If we can read it through first there is no problem. You can put our names there.		71.08
223	**Lars**	And this goes for all of you		71.15
224	*Annette*	Yes		71.20
225	*Lena*	Yes for me to		71.22
226	*José*	And for working position. Well we are some kind of. [Project management. Well strategy and maintenance but based on functions. The operational level of the hospital.]*	*Translated from swedish	71.25
227	*Lena*	On informatics level not as engineers. We don't have the title you want perhaps		73.09
228	*José*	Informatics and administration. Will that do?		73.27
229	**Ai**	For how long have you been working on the current		

		position?		
230	*Lena*	Since 2001 I think		73.46
231	*José*	[Actually since 2001 but do you mean here at SUS or at this position. Then it will be 2004.]*	* Translated from Swedish	73.48
232	*Annette*	That would mean since 1998 for me then*	*Translated from Swedish	74.09

Appendix 2B: Transcription Landskrona Interview

Landskrona interview 30/4 2012

Interview type: Regular Interview

Interviewers: Ai Jin & Lars Ahlfors:

Respondents: Eva Edstrand

Bold text = Interviewee

Italic text = Respondent

Row	Person	Sentence	Special context	Time (Minute)
1	**Lars**	You are working in the IT department right?		00.00
2	*Eva*	Yes. For region Skåne* as IT coordinator that is. It is for the moment in a project group that has the strategic overview of the IT resources of the Region.	* County council of Skåne	00.05
3	**Ai**	And you agree to have your name in the thesis?		00.18
4	*Eva*	Well. What do you want to know because I think I would like to read it first		00.21
5	**Lars**	We would like to ask about the EMR systems used at the hospital and the role of the [The] system.		00.26
6	*Eva*	You mean Meilor ( )		00.30
7	**Ai**	Do you use it as decision support or document tool or monitor.		00.34
8	*Eva*	It is a record system. You see every patient that we treat has to have a :: some kind of reference in the system. Meilor was originally used in Lund I think it was and we are using it as record system all over the hospital organization. You can document everything about a patient using the system and the information is stored in a database. That database belongs to the hospital and can be used by other systems as well. So it only record the patient information and what treatments he/she received during the visit in our hospital. ( ) It is not that the system is making the diagnoses here [Ohh No no. what would that look like]. We can't coordinate information like that and even if we could it is against the legal to have a system telling a treatment.		00.36
9	**Lars**	Does it improve the treatment quality		02.05
10	*Eva*	I cant provide you with any numbers or so. I mean we are not measuring the accuracy of diagnoses since it is the doctor that gives diagnoses based upon working in the field for years [their experience]. It has made the recording more easily and has made it possible to gain information when you needs it. Before you know many years ago if a nurse had the record of a patient and another nurse needed it they either had to solve it using phones or had to search for each other and so on. That meant that we lost a lot of time searching for information. Now we can access that information in Meilor regardless of if anyone other uses the same information. It is also complete information or more complete now. Sometimes there could be updated information that was missed if you took the journal before it was updated by the physicians, and sometimes it was redundancy or things that didn't belong inside the journals. You don't see these things in Meilor.		02.08
11	**AI**	Can it improve communication between physicians and patient we mean like::		03.21
12	*Eva*	No. How could it do that? I mean the patients are not allowed to		03.25

		use the system.		
13	**Lars**	We mean is the doctor using the system to communicate medical information for the patient. Like the patient's medical history.	* Lars explains the question in Swedish	03.34
14	*Eva*	No. It is a difference. The patient is allowed to know what is said [recorded] in the system about his or her condition if they want a summary of their own record of course. That is their right to now. But you can only access the records from inside the regions systems and if it is asked by a patient and if you treat that patient. I mean like ( ). I can make a summary of a patient if they give me their social security number and if the patient exists in our systems. But then if I'm not treating the patient it will be questioned from the region why I was using that record. So there is very strict security to these things. So it's not like in films where doctors sends email with a diagnose or you can see it on internet or things like that.		03.50
15	**Lars**	Is there a high degree of different medical data transactions between different EMR systems in the hospital? Is that supported?		04.46
16	*Eva*	Ohh. Yes. I can order results from other systems. Like lab results I can order them. I use a part of Meilor to access the system for the lab results database and from that system I can order a for example a lab-result. I uses the personal Number for the patient and goes to the Module for Lab-view and searches for a Lab-result that belongs to the personal number. If I had the system here now I could have showed you how it works. I can actually see the progress of the result before it is finished and signed by a physicians. So I can use that lab result before it is signed but of course it is better to have them signed first but if I ask a doctor available to approve to use them I can do so if the time is urgent.		04.54
17	**Ai**	When EMR is developed it could be for different time and purpose by different vendors having different specifications. Have the organization experienced problems in workflow because of low interoperability in systems.		05.58
18	*Eva*	We had it like that system before. Every unit was responsible for their own system and the contracting procedure of development or purchase. There was of course some central purchasing as well but mainly they could have a better insight in how the procedure was done in that hospital. Today in the region we have centralized that knowledge so we know how to contract systems that can cover the needs in a more sustainable way.		06.44
19	**Ai**	So the organization then experienced some kind of problems in interoperability.		07.50
20	*Eva*	No.. Lets separate apple and pears. Of course there was nothing like today but let's not misinterpret something. Of course we were capable of gaining information. I mean that the entire operation of a patient didn't go down because the systems couldn't talk to each other. It was that I could take some time to get the right information or to know if the information was updated. It was as I said not integrated in each other but we could get the information. The main idea then was that it should be available fast for the physicians that needed the information but now after the health reform and the general strategy we have to adapt and develop the systems to integrate. For example we are going to implement Meilor as our main system in the ( ) in the entire region and all major units in the region. You know :: for example that it also includes the physiatrist. So in the future there is going to be one database for all the records in the region. So that means that we will have an integrated		07.58

		environment for the doctors to work with. It will be cheaper and more efficient that way to .. to [what is it named again] support and run it efficient. The advantage of doing so will give us a better patient security and make us more flexible when gaining information. So it will save us a lot of time that can be used to treat the patient instead. That what we do in the organization today. We use something called Lean Healthcare in the region for continuous improvements that shall benefit the patients.		
21	**Lars**	Isn't it uniform? The system?		10.03
22	*Eva*	To get an integrated environment we have in the region decided that there shall be a common structure. We have several databases now and there is no uniformity for the systems. So if they shall upgrade we have to upgrade locally and we want to be able to do it more coordinated. It will be better that way. If we upgrade in Malmö and they don't have anything for doing so in Ystad that means that Ystad will follow their own plan of upgrade. Things like that causes problem when the systems shall be integrated because they don't work together if one is not upgraded.		10.05
23	**Ai**	So you are doing it to have syntax interoperability in the system so they can be integrated.		11.14
24	*Eva*	It is a part of the whole strategy. It is to make it ( ). We have a lot of systems today that can do the same thing in different hospitals. Perhaps small differences are there but sometimes there are even three systems in the same hospital that does the same thing or two systems in different hospital doing the same thing. As you can see that makes it hard to maintain the systems consistency when there are redundancy in systems. Our idea that we believe will be the best to have integrated systems while making it cheaper and more efficient for the organization to use it. It is as you might know :: savings has to be done in the whole region. So we look at all solutions that support the operations of the organization and are cheaper and smarter.		11.20
25	**Lars**	Can you tell us more about the system integration in Meilor. How is that to be done for all systems?		12.48
26	*Eva*	(.) [Ehhh] well. It was ( ) but how to say it still is ( ) Meilor is a system that :: It is not suppose to be a system to replace all systems in the region. All the systems shall be accessible through interfaces in Meilor and they are so today most of them. But the problem is that the organizations don't have uniform Meilor modules and structure in the notes. That's a problem for us. The doctors and nurses has to make notes in the journals about their findings and how they diagnosed. In those notes there is no categorization so they are not searchable (.). When we make Meilor uniform there will be a clear structure for notes and a standardized way. That's the first step of our common system. The next step is to upgrade every hospital version and make sure everyone has the same starting point. And in the later versions there will be a new function in the pharmacy module so the national pharmacy register will be reached.		12.56
27	**Ai**	So you are going to have a common standard		14.31
28	*Eva*	Yes. We are going to standardize way of working that is common to the whole region. And with the new categorization of freehand writing [the notes I mean]. When there are common ways to express and make sure all relevant keywords are mapped in a structured way everyone can find relevant information.		14.32
29	**Lars**	So when you use Meilor to access other systems? Is it done through the use of Web-service or by a middleware or what solutions are used?		14.58
30	*Eva*	[OOhhh] now that :: You know that question is better suited for		15.12

		the technical staff. Im more at the strategically level of Meilor and the systems of the region. I don't know what techniques that are used in the systems or the network. I can't answer that.		
31	**Lars**	No no.. Can you give a general example for when Meilor integrates with another system. Is it a service or is it done through a database. *	*Explanation in Swedish follows	16.02
32	*Eva*	[Aha]. Ok. I understand. In the region we have contracted for having a solution that shall make data interoperable. The ones we have contracted for is providing a technical framework to build around and have as a way to integrate the systems as service. Have you been to our homepage and looked there. There you will find a lot of information about the contracting and what solutions we will use. Right now we are making the data interoperable in the whole region using service orientation. And the framework will be used as the middle solution [the middleware]. But this is under development so its not implemented in the whole region yet. We have to make it step by step and implement things careful so people can get used to the change and learn how to navigate in the system.		18.45
33	**Lars**	So you are going to use service orientation and standardization on the hospitals		20.03
34	*Eva*	No. I mean [not like that]. This is something that will be done central for the region. We are going to standardize the regions healthcare units :: The hospitals both in how terms are used and the structure of the recorded information. There is going to be a central database for the journals that will be reachable for all systems using Meilor. And inside under the hood so to say there will be a technical framework that distributes services for the users of Meilor so they can use every system-module when they need it. That also means that we limit the numbers of systems used so we get rid of the redundancy as well. We have a consolidation program for how to phase out systems. In the past year we scaled down [what was it again]. Some 50 systems 2010 and over 60 for 2011. We have hundreds of systems in the whole region so if it is not centralized we will lose control again. We are opening two server halls one in Lund and one in Helsingborg for this.		20.09
35	*Ai*	So is SOA the solution right now to gain platform independence and interoperability.		22.17
36	*Eva*	As I said I'm not the person to talk to about that. On the homepage of the region there is a lot of information about this. Look at the pressroom and the information contacts there. For the technical parts you should contact Tieto*. They are in charge of those parts. But look at our homepage because there is a lot of information about what the region is doing and the Meilor project and other parts of the it work that will be done in the region. Im sorry but I can't get you any further	* The solution provider company.	22.25
37	**Ai**	Well thank you for your help and time		23.40
38	**Lars**	We will send you a copy when transcribing is done and		23.45
39	*Eva*	And don't forget to look at the homepage. It is really good and informative. Good luck.		23.52

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