Non-disruptive value-chains in home health care

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Abstract

Treatment of elderly people and citizens in need of professional care is one of the most important aspects of any society to consider that aims at support for quality of life. Support for such qualitative aspects of a modern society often manifests itself by means of value-chains. However, all activities that a business or organization uses are not included in the value-chain, it is only the activities and information that generate any kind of value for the users in a particular organization that are included in the value-chains. To that end, the locality of health care related information primarily exists at the hospital and, therefore, the care of patients is most efficiently carried out at the hospital. However, if the involved information can be accessed anywhere throughout the value-chain, a possible situation would be to keep the patients in their homes without disrupting already established work practice and related value-chains. In principle, introducing new technology must not disrupt a value-chain; it must preserve or, even better, improve it. Health care is becoming more mobile and needs support for such behavior. The quantitative value to the user is quantified by means of value-chains, so it is important that they remain non-disrupted. Consequently, the fundamental concepts dealt with in this thesis are; value-chains, health care and mobile technology. The problem domain is distributed health care and we have chosen to focus on sustainability of the involved value-chains. In essence, we want to add new technology to the domain without disrupting already existing value-chains. This in order to make the distributed health care apparatus more efficient and cost effective. The main problem we have identified is regarding how medical doctors and nurses could access the same information in patients’ homes as they can at the hospital.

Keywords: Sustainable, value-chains, health-care, service-oriented
NON-DISRUPTIVE VALUE-CHAINS IN HOME HEALTH CARE

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Johan Lindblom and Jonas Rosquist
Preface
CHAPTER 1

INTRODUCTION

In today's society, quality of life is an important aspect to support. Furthermore, treatment of elderly people and citizens in need of professional care is one of the most important aspects of any society to consider, aiming at support for quality of life. Support for such qualitative aspects of a modern society often manifests itself by means of value-chains. The term value-chain originates from the economy domain and is described as *a major tool for identifying ways to create more customer value*. Every business and organization uses a collection of activities, generally in a specific order, and this order commonly denotes their value-chain. However, all activities that a business or organization uses are not included in the value-chain, it is only the activities that generate any kind of value for the users of the organization that are included in the value-chain. An example of activities in the software engineering value-chain is requirements engineering and system analysis.

Contemporary understanding of techniques to efficiently address such support for value-chains, even in distributed settings, has been identified by the European Research Community to be of utmost importance to investigate\(^1\). Currently, such investigations primarily focus on the physical distribution of previously centralized social organizations, i.e., institutions and their capability to sustain already existing value-chains. An example of this situation can be found in current efforts aiming at home health care, i.e., treating patients in their homes as opposed to treating them in a hospital setting.

HOME HEALTH CARE

Today, people need to transport themselves to the hospital in order to receive treatment, which is a very expensive and resource demanding activity. If the patients could get the needed treatment in their own homes, it would be beneficial for all involved parties. Treating the patients in their own homes would not only improve the treatment as such, it would also limit the expenses for both the patient and the hospital and, consequently, make the entire value-chain more cost effective. However, treating patients in a decentralized setting requires many organizational changes, as opposed to a centralized setting that is used today. When the organization becomes decentralized, it is important that the involved information also is decentralized, so it can be accessed anywhere in the organization. Such changes require technical improvements within the organization; i.e., distributed organizations require mobile technologies.

\(^1\)Council of the European Union, 2002, Framework 6, 2001/0053
PROBLEM DESCRIPTION AND THESIS
The problem today is that the lack of technology makes it impossible for the medical nurses and doctors to access the required information in a patient’s home. However, by means of technological advancements, such as third generation protocol (3G), this situation can be changed. Still, the problem of introducing new technology in some particular value-chain prevails. Today the locality of health care related information primarily exists in the hospital and therefore the care of patients is more efficiently carried out at the hospital. However, if the involved information can be accessed anywhere throughout the value-chain, a possible situation would be to keep the patients in their homes without disrupting already established work practice and related value-chains. In principle, introducing new technology must not disrupt a value-chain; it must preserve or, even better, improve it. This means that the value of any (accessible) service provided to any involved stakeholder (patients and care-organizations) must be better or as good as it is today, but also that the value-chain must be of a non-disrupted nature. Health care organizations are becoming increasingly distributed and, consequently, requires support for such quality attributes. When introducing new technology in the organization it is important that the users feel comfortable with the changes, which means that the user must feel that the value is preserved or even better improved. The value to the user is measured by value-chains, so it is important that the value-chains remain non-disruptive. To that end, our hypothesis is as follows:

It is possible to introduce new technology to the health care domain without disrupting its value-chains.

METHODOLOGICAL APPROACH
The fundamental concepts treated in this thesis are value-chains, health care and mobile technology. The problem domain is distributed health care organizations and we have chosen to focus on their value-chains. We want to introduce supporting technologies to the domain without disrupting already existing value-chains, to make the distributed health care apparatus more efficient and cost effective.

Health care organizations of today are partly ineffective and too expensive, i.e., there is a need to improve the organizations in order to be able to give members of our society the qualitative care they need. To that end, our focus is the birth process, both the time before, during and after delivery. We have identified that this domain is in great need of
change, and that it is in a state where a change can be accepted by the organization. The main problem we have identified is the management of patient journals. The journals are currently stored in the hospital’s computer system or in a physical archive. Journals stored in a computer system can only be accessed from computers within the hospital organization. We want to change this; we want to make the journals accessible irrespective of locality. When transferring the care of the patients from the hospital to their own homes, it is required that mentioned journals are accessible in the homes. Today, there are some home visits performed, but not without complications. The nurses use paper and pencil to document the examination, when the examination is done, they must travel back to the hospital to document the result into the journals. Adding new mobile technology to the organization can prevent this (see Figure 1.1).

To support the organization value-chains and demands, a technology is required that is fast, reliable and secure. The organization need to access and transfer information in many various settings, it is often vital and must always be accessible. Supportive techniques for mentioned demands are the new mobile technique, such as UMTS (3G) and EDGE (GPRS). With this technology, it is possible to transfer large amounts of data fast and it is relatively cheap. This new technology makes it possible to be connected to the network constantly.

We started our research with identifying a problem existing within the health care domain; this was performed by a case study. To find the underlying problems within this domain we made some visits to Värnamo maternity ward. The findings from that visit, we supported with related publications and research articles. From such we collected all information about their work practices and processes, furthermore, we decided that a field study was not a needed. This because of properly documented work practices and processes. We divided the domain into several subsystems, and studied the interactions between these.

OUTLINE
The material presented herein is structured as follows. In Chapter 2 our methodological approach towards non-disruptive value-chains in home-health care is presented, we also describe the fundamental concept that this thesis deals with, and furthermore, it describes a background to this thesis. Chapter 3 describes previously mentioned organizations from a system perspective, this chapter defines the different systems we are working with, by means of technology, user and organization. Chapter 4 describes the interactions between these systems and defines why such is important. Chapter 5 present the solution to identified problems, i.e. how to create sustainable health care systems. Finally, in Chapter 6, we conclude our thesis, describing the implication it entails and present the findings of this thesis.
CHAPTER 2

ORGANIZATIONAL PERSPECTIVE

In the previous chapter, we described that health care has a great need of improvement. When improving an organization, it is important that already established value-chains remain non-disruptive. The general quality attributes we are striving to improve is availability and reliability. This is a precondition when improving distributed health care organizations.

The material presented in this chapter describes our methodological approach toward non-disruptive value-chains in home health care. In principle, value chains are used to describe all valuable activities for an organization and the particular sequence in which they are to be carried out. From this perspective, it is of great importance when improving an organization that the value-chains remain non-disrupted. The methodology we consider in this context is built upon the CommonKADS approach (Schreiber et al., 1999), consisting of five different layers; framework, system, practice, model and theory (see Figure 2.1). First, we describe the framework, which contains three major concepts for distributed health care organization: quality of life, mobile technology and information management. Secondly, we describe how we model our system in terms of non-disruptive systems, with focus on preserving the value to the end-user. Finally, we present our theory, and the requirements that are expected for the new system.

DISTRIBUTED ORGANIZATIONS

The major concepts (input variables) we work with when trying to characterize the health care are quality of life, mobile technology and information processing (Coiera, 1998). This section describes the concepts briefly and gives an explanation to why they are important. Health care is a major variable/function that influences the quality of life for society. If the members of society do not receive the expected treatment, the quality of life decreases. To improve (distributed) health care, mobile technology is a need. If health care is supposed to be possible to maintain, information access in distributed environments is needed. If journal (computerized) access must be possible at different localities more than one communication media is necessary. Consequently, if only one locality is used, access of journals could be performed with one computer (one communication media).

Quality of life

In today’s society, quality of life is one of the most important aspects to support. Every society aims at improving the quality of life for its citizens and, consequently, one of a society’s most important tasks is health care. Members of a modern society need professional care sometime during their lifetime, therefore, it is important to keep health care
efficient and modern. A society consists of a set of institutions and organizations, which provide the society with vital functions; used by the members of the society. How effective these functions are and how well they correspond to the users’ requirements, characterize the quality of a society as a whole. Some of these functions are essential for the users, and create the users quality of life. Still, it is the users of an organization that judge the quality of life that the organization has achieved. The quality of life can be examined from two very different perspectives: one objective and one subjective. As an objective phenomenon, the quality of life is measurable and reportable, independent of the specific experience of individuals. As a subjective phenomenon, the quality of life is something that every person experiences but is difficult to report in a meaningful way (Atz, 1996).

Every change in technology or structure made to an organization or a society could affect the users’ quality of life. It is the institutions and organizations, by means of supporting technologies that provide the users with quality of life. Citizens strive to improve the quality of live for themselves and it is up to each individual to decide what it is. In parallel, society aims at improving the quality of life for its members, by means of adding new technology to the different organizations and institutions of society, such as introducing mobile technologies to (distributed) health care organizations.

Mobile technologies
Cellular phones have been a part of our lives for many years. At first, only a few companies used them and they were very expensive, but today mobile phones are cheap and have become an everyday item, the number of users is increasing every day. When the mobile phone arrived on the market the use was primarily to make voice calls. The mobile phone made it possible for people to communicate over long distances, and still be able to transport themselves.

The first system was developed in 1983 by AT&T and was an analog system. They expected to have about 1 million users in the year 2000, but in fact they got over 100 million users. Analogue systems usually offer a more complete geographical coverage at a cheaper service charge (Lin and Chlamtac, 2001). However, these systems are only used for regular voice calls, not for any kinds of data transmission, so in order to use data transmissions a new generation of mobile phones and communication protocol was developed.

Global System for Mobile Communication (GSM), which is a part of Second generation systems (2G), supports voice coding, digital modulation, forward error correction, and channel equalization. These features make it possible to send fax data, send messages and to place calls in many different countries and regions. The second-generation systems also allow data transmissions but with a slower rate speed. The developers of the digital cellular system (GSM) was Group Special Mobile of Conference Europeene des Postes et Telecommunications and its successor European Telecommunications Standard Institute.
Digital cellular system is a technology that uses both time division multiple access and frequency division multiple access. The standard of digital cellular systems has grown very fast and has today over 120 million users in 120 different countries. Many of the involved operators provide for roaming access agreements with each other, and because of this, it is possible to use the mobile phone when traveling to other countries.

In order to cope with large amounts of data and to be a bridge to third generation systems, general packet radio service (GPRS) and enhanced data rate for GSM evolution (EDGE) was developed. The problem with transferring data with the older systems is that they do not support easy access, high data rate and it does not have attractive prices. It is expensive to pay per minute instead of as in the third generation systems, pay per amount of data sent, which uses the existing infrastructure to provide end-to-end packet switched services and is about ten times as fast as GSM.

Information structure
Today, when health care organizations aim to be more and more efficient and organizations are distributed over more than one locality, it is important that you have access to information irrespective of locality (Schraft et al., 1998). When you need to access information from another locality than where the information exists, you need an access medium. All information is located somewhere and, consequently, if someone needs to access the (remote) information an access media is required locally. When it is possible to access information remotely this forms a resource, for example when information is stored in a database and can be accessed by a network computer. A resource can also be a process, for example, in order to get help from the doctor, he must be able to communicate with the patient, therefore the doctor and the communication form a resource (see Figure 2.2). Furthermore, an accessible information source forms a resource, by means of the possibility for a process to interact with it. An example of this is when midwives access computerized journals. When a nurse would like to access the journal database, he/she needs a computer with a network connection that is connected to the server where the database is located.

VALUE-CHAINS
In order to improve an activity provided by the society, it is important that the result of the improvement still maintain the value to the end-user. Such value are often manifest it self by means of value-chains. The word value chain is from the beginning an economical term. Kotler describes it as “A major tool for identifying ways to create more customer
Chapter 2. Organizational perspective

Every firm or organizations consists of a collection of activities, which the firm or the organization uses in a special order, and such collection of activities is called a value-chain. Considering the particular problem domain presented herein, it is possible to divide our particular value-chain into three cornerstones: user, organization and technology (see Figure 2.3). Consequently, we would like to describe the possible interactions (value-chains) between these. The organization consists of both personnel and processes. In order for the personnel to be able to communicate with each other they use some kind of technology (except when speaking face to face), for example phones, mobile phones, computers and papers. All of these cornerstones, both individually and in coordination, support our society, with quality of life (see Figure 2.3).

Structure
Health care organization provides society with support for health care related problems. It consists of several sub organizations (this can differ from hospital to hospital). The major cornerstones in the health care system are: (1) maternity hospital where women give birth, (2) medical service or primary health care that treats injured or ill people, (3) geriatric care that support treatment of the elderly, (4) pharmacies that provide people with medicine and (5) district health service that supports a local treatment for smaller cases of illness.

Process
When a nurse or medical doctor is interacting with the organization, he/she uses a numerous set of technologies. For example, when they need to interact with the journals or other documentation, this is made by means of computers or on paper. Almost every organization is dependent on working technologies, in order to have a functional interaction between and within the organizations.

The system we have chosen to study, to support our thesis, exists within the health care domain. This domain is quite large and it is impossible to focus on it in full. Therefore we chose to focus on a subset of it, which is the pregnancy system and the way the health care domain manages journals. This because there is a great need of improvements (Kjernald, 2002); (Kilman and Forslund, 1997). The birth system uses journals to keep track of the patients, so journals are also included in the birth system. Organizations (nurses and midwives) uses technology in order to facilitate the treatment of the users (patients), the technology they use today can be for example mobile phones, computers, ultrasound etc. Technology used for journal management is in some cases still paper and

Figure 2.3 Support for society: This figure displays that the society is supported by the users, technologies and organization. The society is also supported by the organization, user and technology as a whole, by use of coordination between the three parts.

value” (Kotler et al., 1999). Every firm or organizations consists of a collection of activities, which the firm or the organization uses in a special order, and such collection of activities is called a value-chain.
Non-disruptive systems

pen, but more and more use computerized journals. We have divided the pregnancy system into three parts before, during and after delivery. Before and after, deals mostly with medical examinations of mothers and fetus/baby. Birth deals with delivering the baby and the nearby preparations for delivery. Users of the birth system are typically pregnant women, and the users within the organization are personnel at the maternity hospital (midwives, assistant nurse, medical doctors, etc.) and support people (district nurse, pharmacy, insurance company, government). All these users are in some way interacting with the birth system in the health care organization. From now on when mentioning the users, we will refer to the patients and the personnel will be included in the organization. Journal management is a central part in caretaking, because the important information about the patient is stored there. Managing journals is also a very time- and resource demanding activity. Some hospitals do not even use digital journals, instead they use paper journals. To gain access to journals today, the personnel that use them must be in the same locality as the journals.

NON-DISRUPTIVE SYSTEMS

Now we have described how it is possible to describe value-chains in an organization, where the organization support quality of life. When improving and doing changes in the organization it is important that the system is non-disruptive, which means that already stated value-chains remain non-disruptive. These are the terms we would like to describe in our model of the system. We created two models of the health care system, one that identifies the value of the system and one that describe how to preserve system sustainable after improvements.

Value chains

In the past few years, a lot of research have been put on health care, this because of the societies’ new demands on improved quality of living. But this is also a response to the new open competition from private health care companies. In order to keep the clients, more effective and better care at a lower price is neccessary (Burns, 2002). This has forced restructuring in the health care setting. To be able to make such restrucutions, the organization must know what the quality of the care is. Such measurements are often made by value-chains. With the help of value-chains it is possible for the organization to point out what parts that generate the largest value to the customer and to see what parts that cost too much. In the health care this has led to the development of the new health care value-chain, (see Figure 2.4) (Malmsten, 2001).
Chapter 2. Organizational perspective

Sustainable approach

The quality of a system is determined by its users. The users state the requirements of how the system is intended to work. If a system is working according to these requirements and corresponds to the users’ image of the system, the system is sustainable. To get an understanding about what a sustainable system is, we need to define what we mean by that. A sustainability system is defined by the Center for Sustainable Systems\(^2\) as:

“A set of integrated industrial and ecological processes that equitably meets the biophysical needs of society while maintaining the integrity of life-supporting ecosystems over a long-term time horizon”

This definition does not cover everything about sustainable system, it has a focus on the biological ecosystems, and therefore we need to redefine it more precisely:

“A sustainable system is a system that corresponds to the users’ image of the expected functionality and to the quality that the users require of the system.”

In order to have a sustainable system, it is important that we do not create conflicts in the interfaces. Such interfaces are: between the user and the system (i.e. between user and technology and between user and organization), and interfaces within the system itself (i.e. between organization and technology) (see Figure 2.5).

**ORGANIZATIONAL REQUIREMENTS**

The particular type of organization we have investigated is distributed health care. In order to improve the organization new technology is advocated. Health care is becoming increasingly distributed and needs support for mobile accessibility. When introducing new technology to the organization it is important that the user feels comfortable with the changes, which means that the user must feel that the value-chain is preserved or even improved.

Every society provides its citizens with quality of life, which is the judgment of how good the functions are and how well they correspond to the citizens’ requirements. Improving the quality of life can be done by adding or changing technology in the functions. For example, improving the health care can be done by introducing mobile technology. Mobile technology has evolved much since its arrival. It started as a voice communication media, but today it has great possibilities to transfer and access data. This

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\(^2\)Centre for Sustainable Systems homepage http://css.snre.umich.edu/
can be beneficial, since health care organizations manage much data in terms of information, for example journal management. The systems we have used to support this thesis are the pregnancy system and journal management system. The first one is a subset of the health care system, which is too big to focus on in whole, and the latter is the way the organization manage journals. These systems can be divided into organizations, users and technology. When improving a system it is important to consider the interactions, and make sure they remain non-disrupted. These interactions form together the system value-chains, which is the value to the end-user. If it is possible to keep these value-chains non-disruptive, it is possible to create sustainable systems. Our hypothesis is that it is possible to add technology to the health care organization without disrupting its value-chains. The requirements we have found are

- New technology must support information flow in distributed healthcare organizations.
- New technology must support already established value-chains in distributed health care organizations.
- New technology must support sustainable system behavior.

In the following chapters, we are first going to study our problem domain from its systems perspective. Then we are going to study it from its process perspective. Finally, we are going to establish how to construct Sustainable system.
Chapter 2. Organizational perspective
CHAPTER 3

SYSTEM PERSPECTIVE

We have now defined the major concepts and our approach to this thesis. These are used when defining the problem domain, which consists of several systems included in the health care domain. These systems must be carefully described in order to know which parts of them that are possible to improve and to understand the problem with them. The systems we have identified as important for our focus are the pregnancy system, which has as main responsibility to be a support for delivering new humans. The second system we consider to be important is the journal management system, this system is included in many other health care systems. Journals contain the medical history and medication about the patients and are frequently used in almost every health care system. To make this information flow as smooth as possible, the information must be structured made accessible and in a proper way. One way of distributing such information is active documents, which lets each user define its own structured view of distributed information.

PREGNANCY SUPPORT

Pregnancy support is in need of improvements, partly because the increasing number of humans living on earth today. As it works today, it is not efficient or cost effective, because it is very expensive to treat the pregnant women on the hospital. Also, the desire of pregnant women to be treated in their homes is important to consider. The following section will deal with the different components included in the pregnancy system, such as personnel, processes and patients. Furthermore, we will describe the different technologies that exist to support the pregnancy system. An intimate understanding of the system and its technologies is required in order to know what parts that is possible to improve and to understand what other parts that are affected by an improvement.

Organization

Firstly, we are going to describe what type of roles that exist in the organization, then a hierarchy description of the roles at different departments is introduced and, finally, we describe the different parts in the pregnancy process. In the pregnancy system there exists many different roles, but the most important ones are: medical doctor, midwife, assistant nurse, authority and insurance companies. The latter one is not included in the actual pregnancy support process, but functions more in financial and administrative purpose. The assistant nurses’ major task is to provide the medical doctors and midwives with support when performing examinations or deliveries. A pregnancy should contain both doctors’ and midwife visits. Today, the midwife have the greatest role in the pregnancy support process, as a result from routines for examinations and deliveries in pregnancies.
The National Swedish Board of Health and Welfare (Socialstyrelsen) recommend at least one doctors visit per pregnancy, where a gynecological examination is performed. Problems with the expectant mother, which are discovered during the gynecological examination, could often be discovered at the first examination, hence the few number of required medical doctor visits. Midwives perform all other examinations of the mother and the baby.

The pregnancy support process is divided into two separate locations: maternity welfare and maternity hospital. In both these localities, there exist role hierarchies into which the responsibilities of different tasks are divided. All departments we have studied have some medical superintendent and a midwife coordinator, jointly responsible for education and competence progress for the personnel. They are also responsible for the recruitment of new midwife etc. There are also gynecologists (medical doctors) who are responsible for surgery at the clinic and as consultants and supervisors for the midwives. The midwives have the main responsibility for the primary health care work. There are also assistant nurses that support the gynecologist and the midwives when they need help. These responsibility distributions could differ depending on the county council you work in.

- **Process.** We have divided the pregnancy process into three sub processes, which are before delivery (maternity welfare), the delivery (maternity hospital) and after delivery (maternity welfare).

- **Maternity welfare.** The maternity welfare process initially focus on medical pregnancy surveillance. The expectation on a happy exit of the pregnancy is today very big, hence the high requirement on the treatment at the maternity welfare. It is not often a medical examination during the pregnancy could prevent a complication, what they could do is to intervene early and therefore decrease the injuries.

- The medical pregnancy surveillance should:

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3 This according to an evaluation performed by the Swedish society for Obstetrics and Gynecological and the Swedish Midwife association

4 Mödrahälsovårdöverläkare och samordnade barmmorskor, 2001, Basprogram för mödrahälsovård i Stockholms läns landsting.
identify specific factors that could increase the risk for complications during the pregnancy and delivery.

(2) if possible take care of critical illness, but otherwise make sure that the woman gets special surveillance.

(3) by general and correct examination identify illness and complications, where adequate actions could decrease or eliminate injuries for mother and child.

• Maternity hospital. With the delivery, we mean the time from when the mother arrives to the maternity hospital to the time when the baby is delivered and she leaves the hospital. The major parts of the work that should be done in this case are mostly related to the midwife. The assistant nurses help the midwife with both preparations and the work after the delivery, but it is the midwife that is responsible for the work with the delivery. Another work task that is a very big part of a midwives work in the delivery is the documentation. Everything that happens in the delivery should be documented in the journal.

• Maternity welfare. Traditionally the recommendations say that the follow-up meeting needs to be already in week 6-8 after the delivery. Today when getting home earlier after the delivery, it is quite common that an earlier follow-up meeting also is needed. The maternity hospital is responsible the ten first days for follow-up meetings after the delivery, then it is the district nurse that should carry out the examinations, he/she is located in a maternity welfare.5

Technology
When working with delegations and information in the pregnancy process there exists a lot of technology to make work easier. Many of the examinations are performed with small medical equipment such as injections and blood-pressure gauge but bigger equipment, such as ultra sound apparatus is also used. Another technology used is the journal management systems. These system are described in a section of their own. Other tools that is used are not directly related to the physical treatment, could be papers, pencils, books or computers for documentation, depending on if computerized or handwritten documentation is used. More about this in next section, were we study the journal management system. When studying the pregnancy system and the process a lot of information is handled, the information handle is (Kjernald, 2002):

• Instructions from nursing personnel to patients, relatives and external personnel could be for example, information from the midwife to the patient (pregnant woman) about recommendation in the pregnancy.

• Instructions to personnel regarding how to perform a different task could be for example when midwife instructs the assistant nurse to do something.

• Messages between the different organization level and employees could be for example information between maternity welfare and maternity hospital.

Reference information could be for example when information about some treatment method is needed.

**JOURNAL MANAGEMENT**

The organization part of the journal system could be divided into two parts, one that describe which organizations that use the journal system, and one that describe the organization in the system. When performing journal management in a computerized setting the technology is a essential part, without the technology the system would not work.

The journal management system is very essential for the completely health care process, this because it stores information about all patients and is therefore used continuously throughout the care process. It is included in other systems, such as previously mentioned pregnancy system. Today, the system has been identified as a source of great problems, including distribution and accessibility problems. To get a better understanding of journal management we have created three questions with enclosed answers.

- **When should a journal be created?** A journal should be created when care of a patient is carried out in health- and medical treatment. Health- and medical treatment means medical preventions, investigations, and treatments of illnesses and injuries.

- **What is a patient journal?** A journal is the notes that the treatment personnel create about a patient’s state of health, also included in the journal are other documents related to the treatment. Notes about how the treatment has been accomplished should also belong to the journal.

- **What is stated in a journal?** In the journal, the essential information to give the patient good and safe treatment should be stated.

**Organization**

There are two different organizations that we are going to discuss; one about which organizations that use journals, and one about the organization into the journal system. The whole health care organization uses the journal management system, therefore is it very important that this system works properly. The usage of accessing information from the journal system is very different, dependent both on organization and locality. For example, the Maternity hospital in Värnamo uses computerized journal and the home health care in Ronneby uses handwritten journals. In our work, we have chosen to focus on journal systems that are computerized, but we will compare the handwritten journal system with the computerized system in order to see the differences between these. The journal systems’ own organization works as follows; all journals are stored at some place. If the system is computerized, it has some type of database on a server. On this server, only legitimated personnel have access to create and read journals. The computerized system lets you access the journals from different places as long as you are within the organizations. If the system is handwritten, the journal is stored in some archive. If you need to send a copy of a handwritten journal, this must be performed manually.

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With usage of the journal system, we mean personnel that read, use or write the journals. It is generally so that it is only personnel that is legitimated to perform health care, and are involved in the treatment of a patient, that have right to create a journal still, there are some special cases where other people could read and add information (this is left out of our focus).

The pregnancy organization in Värnamo uses a computerized journal system called Obstetrix\(^7\). The system is divided into four modules: maternity welfare, maternity hospital, ultra sound and time booking. The modules could work independent of each other, they could also interact with each other to add and get information, and the reason for this is the need to have a system, which could be used in the whole pregnancy process. The maternity welfare and the maternity hospital in this case are placed at different localities.

When a pregnant woman first visits maternity welfare and an examination or an important decision is performed, a journal must be created by the midwife. During the following examinations at the maternity welfare, they continuously add information to the journal. When it is time for delivery the mother visit the maternity hospital instead, still the same journal is used. However, the information cannot be added to the journal until the delivery is performed, this because it is not possible for the midwife to access the journal system. These result in that the midwife must memorize everything and document it afterwards, and the disadvantage of this is that some information can be forgotten or erroneously documented. Also all information about examinations before the mother and her child getting home is added to the journal. The follow-up meeting is performed at the maternity welfare. As stated earlier the same journals is used, which makes the work easier and more effective. This because of that they not should ask the same questions twice, also illustrated in Figure 3.2.

Technology

With technology in the journal system, we mean all medium or physical devices that are used to access and managing journals. When working with journals there are three tasks that need to be supported; create a journal, add information and read an existing journal.

In the computerized setting, you need a device that could access the departments in the pregnancy organization, today the devices are represented by computers. They also need the software that lets the computer access the server. In the handwritten journal system, they need papers and pencils as stated before, they also need some type of structure about how they store the journal in the archive. When they would like to read a journal that is placed at another locality they need to use some type of medium to send a copy. The medium they could use then is a fax machine or by internal mail. In the journal management system the related information is:

- Journal information could both be information that should be added in a journal or information that already exists in a journal.
- Instruction from other personnel could for example be information about how to use the journal system.
- System help could for example be information about how to use the journal system (Coiera, 1998).

\(^7\)Siemens Elema AB, 2000, Obstetrix Förlossning Användarhandbok.
Reference information could for example be information about the journal law.

**ACTIVE DOCUMENTS**

Today, documents have become more and more important components in work processes. Every organization with decent quality of their information flow is trying to get control of how digital information in the organization is passed from one actor to another. One of the main concerns when it comes to work processes is therefore how we represent, interact, and share information participating in the processes. As states above, journal management is one information flow that exist in the health care domain. Active documents are a way to solve this in proper way:

> Active documents can be characterized as a model for the automation of handling and control of documents, by making them a combination of service-providers and resource in the form of autonomous agents residing in a service-oriented architecture (Fredriksson, 1998).

There exists an implementation of this concept in a project called Madox8. The problem domain Madox is build upon is the health care. The problem the system solves is when different department would like to view same journals, it is performed by having each department define its own view of the journal. The department that creates the journal is the owner of it, the other departments that would like to see the journal could only get a view of it, and only information relevant to the department is displayed. The purpose of the system is only to point out the possibility of viewing a journal at different localities without transferring the physical document.

**Organization**

Like the journal system, we would like to describe the Madox system from two perspectives, one from the users of the system and one from inside of the Madox system. The organizations represented in the system are the *Emergency award*, *Orthopedic clinic*, *Surgery* and the *Chemical clinic*. It is not a problem to add another department’s view of a journal. The information in the system is managed as follows; when creating a journal there should only exist one copy of it, when the users of the system would like to see a journal they should view the original, they should not create a copy of it. The reason for

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8Madox student project, 2000, more info http://www.ipd.bth.se/pt/project/2000/madox
using different views is to allow each department to view the information needed by them, not the entire journal. A journal contains very much information and it is complicated to create a view suitable for all occasions.

The users of the Madox system are licensed health care personnel that have access to read and create journals. There is no functionality for the patient to read his/her own journals, but it is simple to add functionality to the system that lets the patient have their own view of the journal.

Technology
The technologies that the system uses are network components and computers. In these systems there exists many other techniques such as Jini components, which is a little bit more from a technical perspective, which makes them irrelevant for our work. The specific information in this system is:

- Instruction from other personnel could for example be information from other personnel about how to use the system.
- System help could for example be information about how to use the system.
- All information in the journals.
- User information.

SYSTEM REQUIREMENTS
The systems described in this chapter are the pregnancy system and the journal management system. The purpose with the pregnancy system is to deliver babies in a safe manner, the expectations on a successful delivery is today very high. To deliver a baby the future mother will need help, which she gets from midwives and doctors. They make several different examinations on the mother and fetus in order to prevent injuries or illness. These examinations differ from time to time, for example are the examinations held before delivery performed at a different location than the actual delivery. Almost every examination uses some kind of tools and techniques. For example ultra-sound and journal management. The journal contains information about the patient, such as personal information, medical status and essential information to perform the treatment. To gain access to a journal the person must have a legitimating to perform health care and be involved in the treatment of the patient. The journal management system can exist in either a computerized system or a handwritten system. An example of a computerized journal system is Obstret-

9Jini is a java based component for networks communication

Figure 3.3 These three pictures describes different interactions between organization, user and technology.
ics, which is used by Värnamo maternity welfare and hospital. Another example of a computerized journal system is Madox, which only exists in a conceptual stage. Madox is a way of structuring information dependent on what interest a user have. We have found that nearly all work performed in the pregnancy system uses some type of information. Our focus is how the pregnancy organization manages information. We have created a model where we describe which interactions in the processes we focus on (see Figure 3.3). The requirement about which components the systems need to support for:

- Journal management, task delegation, books, instructions.
- Examinations, deliveries.
- Blood pressure, injections and alarm.
CHAPTER 4

PROCESS PERSPECTIVE

The previous chapter discussed the different systems in health care. In this chapter, we will describe the different parts of the system and how the current systems interact with each other. A modern hospital uses a lot of different systems in order to provide the society with health care services, such systems involves many technologies and techniques in order to be as efficient as possible. These systems are today in need of improvements (Kjernald, 2002), but improving and adding new technology does not always make the systems more efficient. It is important that the users still feel comfortable interacting with such systems. Interaction between systems and interaction between the different components (users, organization and technology) occurs all the time. Changing, removing or adding components is difficult, since the users are used to a function working in a certain way. Consequently, this chapter will discuss the interaction between the components described in the system (see Figure 2.5). To be able to see the connections between these parts, we need to look at the intersections between them.

OVERVIEW

A part of treating patients is about distributing tasks and information to different users and locations. By looking at the intersections between the different parts of the organization, it is possible to improve the organization and make the whole value-chain more effective, but still have a sustainable system. It is important when constructing new systems that the current one is examined and to see how the users (in this case the personnel of the hospital, not the patient) interact with other users, with information and technology. A system constructor must be aware of the effects of introducing a new technology to an organization or by changing the way the users interact with the system. To make changes to an organization, an understanding of the existing organization is needed. From this perspective we have identified six different interactions (see Figure 4.1) in the system. If changes are made to one part, it affects several others.

The first interaction (A) is the one between organization and technology and the second interaction (B) is between technology and organization. These two interaction treats how the personnel in the hospital deals with journals, instructions, tasks and medical books. The third interaction (C) is between the organization and the users of the organization, and the fourth interaction (D) is between the users and the organization. The C and D interaction contains information about how the personnel of the hospital work with the patients and vice versa. The fifth interaction (E) is the one between user and technology
and the sixth interaction (F) is the one between technology and the user. These two interactions are a way for the organization to interact with the user when they are in different localities and the other way around.

**ORGANIZATION V. TECHNOLOGY**

The organization uses technology in order to be more effective, to provide the users with better care, to store and manage journals, to delegate tasks among the personnel and to treat the patients (see Figure 4.2). This interaction also includes communication between the personnel, which often is based on some form of technology.

**Journal Management**

Journals are used by the organization to keep track of a patient and to document each treatment a patient has received. They contain information about medicine, treatments, status, personal information and medical states are stored.

Such information must therefore be treated in a secure way, according to Swedish law. Today, a journal can only be accessed by the person involved in the treatment of a patient and the person that have a legitimacy to perform public medical service (Socialstyrelsen, 2001). Every department has its own journals and they are not distributed among other departments. For example, journals in the maternity hospital cannot be accessed in the surgery hospital. This results in problems for the patient, the same test needs to be taken twice, same questions asked several times; and also problems with not knowing the history of the patient. Though journals can be transferred to other hospitals, for example if the patient moves to another city, but it cannot be transferred unless the patient gives his consent.

Another problem with journal management is that the journals are stored and localized within the hospital walls, and cannot be accessed from another location (outside the hospital organization), except if it is moved from the physical location. The two ways of storing journals is in archives (hand-written journals) or in a database (computerized journals). In the first case, all the folders must be carried around when the nurses make home visits, and in the second case, the nurse must print all journals he/she needs access to. In both cases, the procedure is ineffective and makes the work difficult for the nurses. All updates are made when the nurse gets back to the hospital, and this result in several problems. These problems can be for example; large amount of information that the nurse must remember (or temporarily write down), it is easy for the nurse to forget the information or remembers incorrect information. Another problem with journals and journal management is that it is only possible for the journals to contain text. Sound, pictures and movies
Technology v. organization are not possible to store, nor in the hand-written journal system or in today’s computer system. However, with the hand-written journal system it is possible to add x-ray pictures, which is not possible today in the computerized system.

Process
Today, when almost all treatments are located in a centralized setting, the distribution of tasks are distributed between the personnel by voice or, if the person is on the field, the tasks is assigned before the person leaves the hospital. If an emergency occurs, the person can be reached by a mobile phone.

Interaction
Information exchanged between personnel is a foundation for a functional organization, if the personnel cannot interact with each other, the treatment are poorly performed. Such problems occur when the personnel are distributed to different locations. A problem with transferring one of the personnel to a patient home is that the persons interacting are in two different locations. To cope with that problem, there exist supportive technologies, such as mobile communication. Some techniques like mobile phones are already used in home health care today.

TECHNOLOGY V. ORGANIZATION
Technology provides the organization with support for accessing information. In order for the personnel to manage, store and access the information, it must be distributed to the place where it is going to be used. The information used by the personnel is; reference books like medical reference literature and telephone directories, instructions to personnel about how to perform different tasks and instructions to patients, relatives or external personnel (see Figure 4.3).

Figure 4.2 Intersection A. This figure describes the interaction between the organization and the technology used by the organization, such as the journal management system.

Information management
The problem with the existing way of managing information is partly caused by the large amount of information that needs to be handled, which implies that the existing paper based information systems are inappropriate, and partly that the information stored at different locations making it hard to keep the information consistent and updated. To support the hospital personnel’s daily work, not only patient specific information must be accessed, but also more general information like instructions how to perform a treatment, medical reference books or how to act in case of fire (Kjernald, 2002). Kjernald has looked at ways to distribute information in an efficient way, to facilitate the daily work for the hospital personnel and to make a better treatment for the patient. However, she has not
focused on patient specific information and focus more on the general information. It is important that the information exists where the treatment takes place, and if the treatment takes place in the patients’ homes, so must the information. An organization that is distributed among several locations must have a system that support such. She proposes that an intranet would be a good solution for distributing information, we do not disagree, but it requires that the intranet can be accessed from all kind of locations.

Process
There are many kinds of documents and they are stored in different places. The journals in Värnamo hospital are stored in a database, only accessible from the organization computers. It is a form of a client/server solution, where the clients are located in the midwife offices. Documents like medical books and reference papers are spread all over the organization, they are not organized and can sometime be difficult to find. Some of them might only exist in one single copy. Documents that describes how to perform a certain task is often located in many places all over the hospital, which makes it difficult to keep updated and it is not sure that the documents exists in the place where the treatment takes place.

Interaction
To access the journals the users must log on to the system, in Värnamo maternity hospital, all users use the same user id and password. The problem in Värnamo maternity hospital journal system is that the journal added by one user not can be extended by another user. Therefore, the only way to solve this problem is for all users to use the same user account. This resulted in more problems; they did not know which user that had added the information. They solved this problem by letting all users sign each part of a journal. However, the system is now not working the way it was intended to do, because of that it was not adjusted to the users’ needs.

If the organization gets more distributed the system that manages journal must be that too, it must be possible for the personnel that use the system to interact with the journals when they are working at the field. These problems go for all documents, one problem with the books is that they do not exist in a digital format, and must therefore be converted into a digital format.

ORGANIZATION V. USER
This interaction corresponds to the treatment process, in our case the pregnancy process. It describes the way the personnel of the hospital interact with the patients (see Figure 4.4).
The expectations on a successful outcome of a delivery are today very high, which leads to very high demands on the maternity welfare. To support these high demands, a process is carefully drawn up. This process involves several visits to the hospital (normally around 13 visits) for the expectant mother. A lot of research about how many visits that is recommended has been performed by the National Swedish Board of Health and Welfare (Socialstyrelsen, 1996). They concluded after the study that the number of visits is not that important; it is the contents in the visits and also to ensure that the visit retains high quality. They have also presented a proposal for when and what type of examinations that the expectant mother require. The first visit to the midwife takes place between week 8 and 10 of the pregnancy. The first and hopefully the only visit to a medical doctor take place between week 10 and 12. In week 17, the expectant mother gets the opportunity to make an ultrasound examination (note that this is optional). During the week 20, 31, 33, 35, 37 and 39 both a midwife visit and a group meeting with parents and labor preventions takes place. In the week 25, 28/29, 41 and eventually more depending on the status of the fetus only a midwife visit take place, these visits continues a few times after the baby is delivered. The number of examinations can vary between mothers to mothers, it depends if it is the woman second (third etc.) baby. If the expectant mothers have delivered a child before, not so many examinations are required, as if it is the first child.

The different visits have different contents, the whole chain of visits starts when the expectant mother visits the antenatal clinic and finds out that she is pregnant. After that visit, the expectant must visit the midwife a couple of times, during these visits, the midwife:

- controls and tries to identify certain specific factors that can lead to pregnancy and delivery complications.
- performs general and commonly performed examinations and taking of specimens to prevent and detect diseases or complications, and in such cases, take adequate proceedings to eliminate the damage on mother and fetus.
- tries to, if possible, attend to direct illness.

During the psychosocial meetings, the mother gets psychosocial support in order to:

- contribute to a positive experience of pregnancy, delivery and infant period.
Chapter 4. Process perspective

strengthen the future parents own resources to deal with certain strains.

lower the risk of disturbance in pregnancy and delivery.

keeping track of pregnancy and delivery experience.

decrease the risk of a defective mother-child adjustment and also for upcoming disturbances in the family relations.

Interaction

Traditional personnel-to-patient interaction is the treatment of the patient (which is the purpose with health care). However, in order to do this, large amounts of information is exchanged between the patient and the personnel. The patient uses the personnel’s knowledge, which is a kind of usage of information.

When transferring the personnel to the patient homes, the interaction between the user and patient remains unchanged. It is still possible for the patient to interact with the user, and vice versa, because they are in the same locality.

USER V. ORGANIZATION

For the user to feel comfortable with the health care organization it must be possible for the user to get in contact with the organization when needed (see Figure 4.5). When an event occurs, which the user needs help with; the user contacts the organization in order to get help with the problem. When that is performed, the treatment process is started and the user is a part of that process. However, it is not only in the beginning the user needs to contact the organization to get help, such contacts can be needed during the process and even after the treatment is completed. For example if something would happen during the pregnancy, or something would happen to the baby after the delivery that would cause the user to seek help in the health care organization. Then it had been a good thing if the user could activate an alarm (press an alarm button) that is directly connected to the hospital in order to get help as fast as possible.

Another possible interaction is to know whether there exists a problem that the user needs help with or if the problem will be solved by itself. The user must be able to ask questions to the hospital staff in order to know if the problem needs medical attention or not. Such interaction could save a great deal of time for the users, which would be able to stay at home instead of transporting themselves to the hospital.
To perform treatments on a patient, the hospital personnel use a set of tools, such as ultrasound apparatus, blood pressure gauge etc. (see Figure 4.6). Some of these tools are transportable and some of them need to be localized within the hospital. The interaction we have put in focus is the information flow, which will sometimes go by technology to reach the user. The technology can be used to bridge the gap between the different locality of the personnel and patient. If a doctor needs to interact with a patient in a different locality, he/she is dependent on technology. The technology must preserve the quality aspects that the user gets in a hospital (such as accessibility and reliability). Note that this is not intended to be a suggestion to move the patient to the homes and leave the personnel back at the hospital, but to work as an extra resource for smaller cases of interaction. Other possible interactions is when the user needs to be reminded of several events, operations, examination or when they need to take medicine in a regular intervals, a reminder controlled from the hospital can remind the patient when it is time to take their medicine and how much.

When the user is in a different locality than the organization, the user needs technology to be able to interact with the organization. The technology must support the different ways interaction used by the user (see Figure 4.7). For example if the user needs to get in contact with the organization, the user could call the hospital by the use of telecommunication (mobile or regular phone).

Another important aspect of treating the patient is that the user must be able to alarm the doctors if something is wrong. Such alarm functions are implemented in the hospitals today, by use of alarm buttons. It is important that such functionality exists where the user shall be treated.

The health care system is divided into three components: organization, technology and user. This chapter treats the interaction between these components. Most of the interactions are two-way interaction, but we have divided the two-way interaction into one-way interaction, because of the need to identify all interactions, not only the most obvious ones. The interactions we have identified are:
Chapter 4. Process perspective

Figure 4.7 Intersection F. This interaction describe the way the users uses technology to interact with the information, such as alarming when something is wrong or needs support with a problem.

- **Organization to technology.** - This interaction contains the management of journals, distribution of tasks. It is the tools the organization uses, and it is also a method for the organization to interact with a user that is on a different locality.

- **Technology to organization.** - This interaction contains the information the technology support the organization with, such as medical reference books, informations from journals, instruction’s how to perform a specific task.

- **Organization to user.** - This and the “user to organization” interaction is the treatment process, in our case the delivery process. The one-way side of this interaction is the way the organization treat the patients.

- **User to organization.** - In opposite to the previous interaction, this interaction is from the user perspective. It deals with the quality the user experiences from the health care organization. The user uses the organization to get a treatment.

- **Technology to user.** - The technology helps the organization to interact with the users, for example by the use of reminders (alarm, medication routines etc.).

- **User to technology.** - The user uses the technology to pass information or to contact the organization, when they need help. A patient may need to contact the hospital in order to get information about a complaint.

The requirement for our theory about our new system must support:

- The interactions stated above need to be preserved.

- The chains in the interaction must not in any way be broken.
In previous chapters, we have described our theory, the problem, a system analysis and the background to this thesis. In this chapter, we will introduce a possible solution to the identified problem, by means of non-disruptive value-chains, the creation of sustainable systems, and new mobile techniques.

In our case, the health care has to deal with more patients, the number of humans living on Earth and that the average length of life increases. To cope with the problem that each person requires of the health care organization, i.e., to provide them with better care and still a limited cost, the need of supportive technologies to render the care more effective increase. When introducing new technology to the organization it is important that the quality of care is unchanged. This requires the organization to remain sustainable after the change is introduced, which in practice means that the value to the end-user must not be disrupted by the new system.

VALUE-CHAINS
We have identified the most important value-chains in the health care system. These chains describe the functionality that creates the value to the end-user, in our case, the patient. It is the patient that decides if the treatment maintains high quality. In Chapter 3 and Chapter 4, we identified several important systems and we also identified important relations and interactions between these. Together, these relations create a value to the end-user, which in our case is the patient. In this case, the value is the treatment or the awareness of a possible treatment if a complication occurs. It is the organization’s responsibility that this value to the user remains unchanged or more preferably, improved. The value-chains we have identified are:

- Information accessibility. When the organization is distributed to another location, such as the patients’ homes, the organization must be able to access the relevant information as it was they were localized within the hospital. The information the organization must be able to access is; journals, medical reference books, instructions how to perform a specific task and task delegation. To make accessibility of this information possible, must such accessibility be supported by the organizations techniques.

10 These books must be converted to a computer format.
• **Information management.** By the same premises as above, it must be possible for the personnel to interact with the information, which today is localized at the hospital. It must for example be possible to add information to the journals and to create new journals. The personnel must be possible to interact with colleagues localized at the hospital, when they perform a home visit. It is impossible to have the same level of interaction between colleagues when they are at different locations, as they can have when both are localized at the hospital. However, when introducing new technology the interaction must be as unchanged as possible. The techniques that support such interaction today are mobile phone and mail systems.

• **Patient interaction.** The most important chain of them all is the interaction with the patient, this interaction is generated by the previous chains and by a personal contact between the patient and the personnel. The users usually require a personal contact with the doctor, since it is a matter of trust. Not all treatments can be performed in the patients’ homes; sometimes the treatment requires equipment (for instance the mammography equipment) or access to resources that cannot be transferred to the homes, such as surgery personnel.

**SUSTAINABILITY**

This section will investigate the meaning of having a sustainable system, what it is and how to achieve it. We will point out the importance of having the health care system sustainable by means of non-disruptive value-chains, and how to ensure that future systems will be constructed in that manner.

**The meaning of sustainable organization**

In Chapter 2, we have defined what a sustainable system is, but we have not yet identified the meaning of having a sustainable health care system. We claim that a system, as important for the humanity as the health care, must always be available for the members of the society. The health care system must always be available to the citizens, since good health care is a part of their quality of life. The measurements of how good the quality that the users receive, are measured by means of value-chains. In a sustainable system, the value-chains are of a non-disruptive kind.

**Creation of a sustainable system**

In our case, the health care provides the society with a set of functions; the functions provide the user with quality of life. These functions consist of interactions between previous mentioned components, i.e. organization, user and technology. Together these interactions forms the value to the user, hence the value-chains. In our case, the treatments of the patients are transferred to new localities, it is important that the identified interactions (value-chains) remain stable and fully functional, i.e. the value-chains must remain non-disruptive. It must be possible for the hospital personnel to interact with information, like journals, medical reference books etc., when treating a patient in its home. This generates new requirement on the organization. It must have a supportive infrastructure, created by new technologies (such as GPRS, 3G) and small personal devices (such as PDAs and laptops). However, even other quality attributes like high availability and reliability must be supported.
How do we maintain high reliability of the health care system? The systems have several quality attributes that must be fulfilled in order to provide the end-user with quality of life. It must be possible to access the system independent of location, it must grant high availability and it must contain the functionality required to treat the patients, which is the functionality existing today. These problems can be solved by creating a distributed system, where the information is accessible on several different locations (computers). For example when all departments are connected to each other to share journal information, then if same journal service is distributed to different department it is possible to use one of them if another is busy. The need of reliability could also be performed by having a service-oriented approach in mind when designing the system. With a service-oriented approach, it is possible to heal the system if a service goes down. By this, we argue that if the service is shut down, it can be replaced by an equal service. Such an approach is also supported by service-oriented systems. It is essential that the organization can grant almost 100% availability of the system, because a failure can lead to miss-treatment of a patient, which in turn, in worst case can lead to serious injuries of the mother and fetus, or even miscarriage.

COMMUNICATION TECHNOLOGIES
As we describe the techniques used in the new system, we will do it in terms of a distributed service oriented system. Such system will need many different mobile techniques to work. We will describe these techniques to point out that the model can work in practice and not just in theory. We have, in our framework, described the evolution of the mobile systems and we have described techniques like Bluetooth. This section will deal with how such techniques can be used to construct the new health care system. However, to use these techniques, the system needs to use some clients. These clients can be a PDA, laptop, mobile phone etc.

Bluetooth
The term Bluetooth™ refers to an open specification for a technology to enable short-range wireless voice and data communications anywhere in the world (Miller and Bisdikian, 2001). It is a small and cheap radio solution that links mobile computers, phones and other handheld products together by radio communication. With Bluetooth technology, these devices can communicate without wires over a single air-interface, using radio waves to transmit and receive data. Bluetooth are designed for a short-range communications (normally 10 meters), which result in a low power consumption. This makes this technology well suited to use with small, portable devices that typically are powered with batteries.

Bluetooth is mainly used by the devices to connect it to internet or to a mobile phone. When the personnel is working on the field they need support by small devices, such devices do not always have a network connection included. By using Bluetooth, it is possible to connect the device via a mobile GPRS phone, and by this receive an internet connection. Bluetooth can also be used to connect a device to the internet by connecting the device to a Bluetooth node (a Personal Computer). The benefit to use Bluetooth, compared to other communication techniques, like infrared communication, is that the Bluetooth use radio-communication. This results that the connector (mobile phone, Bluetooth node) can be kept in a pocket or bag while the device is being used.
GPRS / 3G
To correspond to above mentioned requirements, a technique that could transfer large amount of data at a high speed and guarantee high reliability and availability is needed in the health care system. The system also requires the users to be connected to the network continuously in order to bridge the gap between the different localities. The new mobile techniques, such as 3G and GPRS support all of these requirements.

ACCESSIBILITY TECHNIQUES
To be able to use the system and mobile technologies discussed earlier, it must be possible to access such. As mentioned, technologies for transfer information do exist today. Now, when we have described the underlying techniques of such transfer, we will describe some possible clients to use them. We are going to discuss more about existing devices and their possibility to access and display the actual information that the techniques could offer. The device we have for accessing the information is the Motorola accompli, which is a relative small GPRS phone, Compaq iPaq which is a handheld with color display, anoto which is a computerized pen and pencil, and a finally solution is to use a laptop.

Cellular phones
The Accompli 008\(^{11}\) is a mobile phone with a handheld integrated. The advantages with this is that you do not need to have two different devices for phone and handheld. This device is good to services like task delegation, but because of the small screen and little memory it is not good for manage journals, read books etc.

Handheld devices
The iPaQ\(^{12}\) is a small handheld with color display. Some versions of the iPAQ contain integrated Bluetooth chips. An iPAQ is in our opinion, a perfect handheld for distributed health care. Implement an application where you could send and receive work orders is relatively easy. Programs, like Microsoft Outlook already exists where you could read your E-mail and manage your tasks. We would not like to use Outlook, because it does not fit our needs of a distributed service-oriented environment, it is not possible to rebuild Outlook after own requirements. However, we argue if that it is possible for Outlook to present a calendar and work task, then iPAQ would be a suitable device for the services required in a health care system. By the same premises as stated above it is not a problem to read a computerized book or instructions on the device. The iPAQ is suitable most of the services, but we do not think that iPAQ is suitable for managing journals, since they require that a lot of information is displayed at the same time and the iPAQ has a relatively small screen.

Digital paper and pencil
Anoto\(^{13}\) have presented a solution were normal paper and pencils could be replaced with computerized versions thereof. They have used three components that together compromise a magnificent solution. The components are digital paper, digital pencil and a server. There is a small camera in the pencil, which communicates with small grids into paper. When the information needs to be stored send is pressed at the pencil or at the formula and

\(^{11}\)Motorola homepage http://www.motorola.com
\(^{12}\)Compaq homepage http://www.compaq.com
\(^{13}\)Anoto homepage http://www.anoto.com
the information is sent using Bluetooth from the pencil to a phone or a computer. The information is then transferred as pictures. These devices could be very useful in the journal management system. Forms could be used as templates for the digital paper. When personnel at the field get the information from the patient, they could add it to the journal system directly instead of adding it when they return. The major disadvantage with this device is that it is impossible to send information to it, which makes it impossible to use for other services than journal management.

Laptop
A device that can manage all services is a laptop (portable Personal Computer). A PC has many benefits such as better memory capacity and good display possibilities; the disadvantage is the size, weight and power, since it is much heavier and larger than the previously mentioned devices.

WEB OF SERVICES
A system, which is distributed to several different locations, and shall function as if localized at a centralized setting, creates very specific requirements. By considering these requirements and that the system must be available all the time (high availability and uptime); the need for a new way of constructing systems is motivated. We believe that a distributed system based upon service-oriented architecture is the solution to these problems, which we will try to prove ahead.

Distributed system
To argue for a distributed system, we need to know what it is:

A distributed system consists of a collection of autonomous computers linked by a computer network and equipped with distributed system software. Distributed system software enables computers to coordinate their and to share the resources of the system - hardware, software and data (Coulouris et al., 1994).

The reason why a distributed system is a good solution in our case is that we would like to distribute the identified functions and information to several computers, to make it more reliable and available. Instead of the classical client/server solution, where the system ceases to work if the connection to the server goes down, the functions in the system is distributed to several different locations. If one function fails, the remaining functions are still accessible (see Figure 5.1).

Service-oriented architecture
We need a paradigm that could provide functionality in our system irrespective of locality and the paradigm must also guarantee 100% availability. Therefore service oriented programming (SOP) is a possible solution to our problem. Object oriented programming (OOP) focus on what things are and how they are constructed, but SOP focuses on what things can do (Bieber and Carpenter, 2001). A service oriented system, which is built with a distributed system as a base, has possibility to heal itself, which means that if a function (service) goes down it is possible for the system to locate an alternative service that provide the system with corresponding functionality. This will also lead to higher availability
and reliability of the system. For example if the journal service cease to function, it is possible for the system to identify another journal service that has the same functionality and provide the user with such.

**SUSTAINABILITY REQUIREMENTS**

In this chapter, we have discussed possible solutions to our identified problems. We have identified several important interactions between user, organization and technology. These interactions form together several value-chains that generate a value to the end-user, which in our case is the patient. To support the problem with transferring personnel and treatment to the homes of the patient, it is important that the interactions (value-chains) remain non-disruptive. If it is possible to create such system, it is considered sustainable.

To make the system sustainable after the transfer to the patients’ homes, the techniques must support such transfer. It is also important that the system can guarantee high reliability and availability. Possible techniques that support such are 3G and GRPS, but these techniques must be supported by an underlying architecture. To make sure that the system is available at all times the system must be distributed to several locations, instead of having the classical client/server solution. However, a distributed system does not solve all problems; it is still possible for a function to cease working. This can be solved by having a service-oriented architecture, which means that a service that ceases working can be replaced with an equal service. Furthermore, personnel must be able to interact with the system by some form of mobile client. Such clients can be Motorola Accompli 008 (mobile phone and handheld in one), Compaq iPAQ (handheld), Anoto (a computerized pen and paper) or a laptop. We believe that the handheld is a little bit too small and a laptop too large to work as a client. The requirements that need to be supported are:

- A technology which enable communication and distribution of information.
- A device that has the ability to access the information through the technology stated above.
- A system construction that have the ability to heal it self.
- A system construction that could guarantee availability and reliability.
CHAPTER 6

CONCLUDING REMARKS

Now that we have reached the last chapter of this thesis, we will conclude our work. Firstly, we will summarize the whole thesis by explaining very shortly the background, problem and our hypothesis. Secondly, we will discuss the implications of our work, what it will have for effects on society. Thirdly, we will present our results of this thesis, what our understanding about the problems is. Finally, we will present the parts we left out of the thesis and what is left to do.

SUMMARY
This thesis started by introducing the concept quality of life, where we identified the importance for a society to provide its members with functions that generate quality to their lives. It is the members of the society that judges how good the functionality (services) of the functions are. By improving these functions and make them more effective, must this results in improved quality of life for the citizens. Furthermore, it is also possible to improve the quality of life for the citizens by identifying new functions and provide them to the citizens. When improving these functions, it is important that the value to the users remains unchanged or better improved. In order to know whether these functions are improved or not, the value-chains for the function must be identified. A value-chain is according to Kotler “a major tool for identifying ways to create more customer value” (Kotler et al., 1999). This can also be used to measure the value that the citizen receives. Therefore, if the improvements to the function preserve the value-chains non-disruptive, the function is sustainable. A sustainable system is a system that corresponds to the users’ image of the expected functionality and the quality that the user requires of a system. In order to test and prove our thesis we have created two models of the health care system, one that identifies the value of the organization and one that describe how to preserve system sustainable after improvements. When working with improvement of an organization, where new technology is a big part of the improvement and when the user is in focus in the system, it is very important that you view all perspective of the improvements. If sustainability exists from all perspective, then the improvements have been successful.

One of society’s most important functions, in order to provide the members with quality of life, is health care. The health care today must, for economical and efficiency reasons distribute the care to the patients homes. This results in a set of new requirements on the system, such as distribution of information and personnel. It must also still be possible for the personnel to interact with each other and the documentation as they did before. We have chosen to focus on a subset of the health care organization, because the whole domain is too big for us. The sub-organizations we have focused on are the maternity hos-
Concluding remarks

The maternity hospital has as a primary purpose to deliver babies and make sure that the delivery is performed as safe as possible. This is done by regular examinations and careful preparations. The maternity hospital stores all information about a patient (expectant mother) in a journal. The journal contains information about the patient’s medical status, history and other essential information. These two systems can be divided into three major components: user, organization and technology. A user is anyone that is directly in need of the process provided by the hospital, such as expectant mothers, future fathers and relatives. The organization contains the processes, such as the delivery process or the examinations. It also contains personnel, such as midwives, nurses and doctors. The technology component contains journal management systems, ultra sound equipment, computers etc. By studying the three components, you will notice that there exist several interactions between these. The interactions we have identified are:

- **Organization to technology.** This interaction contains the management of journals, distribution of tasks. It is the tools the organization uses, and it is a method for the organization to interact with a user that is on a different locality.

- **Technology to organization.** This interaction contains the information the technology support the organization with, such as medical reference books, information’s from journals, instructions how to perform a specific task.

- **Organization to user.** This and the “user to organization” interaction is the treatment process, in our case the delivery process. The one-way side of this interaction is the way the organization treat the patients.

- **User to organization.** In opposite to the previous interaction, this interaction is from the user perspective. It deals with the quality the user experience from the health care organization. The user uses the organization to get a treatment.

- **Technology to user.** The technology helps the organization to interact with the users, for example by the use of reminders (alarm, medication routines etc.).

- **User to technology.** The user uses the technology to pass information or to contact the organization, when they need help. A patient may need to contact the hospital in order to get information about a complaint.

These interactions forms together the value-chain provided to the patient and when transferring the care of the patient to another locality (the home) this requires technological improvements. Nevertheless, when introducing these improvements must it still be possible for all these interactions to remain intact in order to create a sustainable system. Our thesis is that it is possible to introduce new technology to the health care organization, and still have the value-chains non-disrupted. Our theory points out the importance of keeping the health care sustainable after distributing it to the home of the patients. This, since the value to the user must remain non-disruptive in order to preserve the user with quality of life. To create a sustainable system and organization there is need of new available and reliable techniques, which makes it possible to access information by use of techniques and to create a new distributed infrastructure for system.
IMPLICATIONS
Our solution clearly states that it is possible to distribute the health care organization to the patients’ homes. We argue that such distribution is possible from technologies perspective, it exist supportive technologies. The most important issue when creating a sustainable health care system is to preserve the information flow within the organization. Hence our focus on the value of information distribution. Furthermore, we argue that a distributed system, based on the fundamental ideas of service-oriented architecture, is the solution for creating a sustainable health care system. This because such technological solution enables high reliability and availability. A distributed environment makes it possible to access the network even if one link goes down. A service-oriented approach makes it possible to find equal services to the one that cease to exist.

We have identified the need for mobile communication techniques in order for the health care organization; to keep its value-chain non-disruptive. Possible mobile techniques are GPRS and 3G, supported by the use of thin clients. Some of the clients existing on the market today are Motorola Accompli 008, Compaq iPaq, Anoto and Laptops. None of these is optimal for the use in the distributed health care organization, the Accompli and iPAQ are too small to cope with the large amount of data flowing through the organization. Anoto is incapable of displaying data and the laptop is too large to function as a mobile client.

To summarize the work in one sentence: Improvement of the health care by focus on information management as stated in our theory is possible to perform in a distributed environment without disrupting the value-chain.

RESULT
We have found several requirements that must be fulfilled in order to be able to distribute the health care organization to the patient homes. The system ...

• ... must be able to access journals, books, instructions and perform task delegation. The personnel must still be able to perform examinations on patients, such as deliveries. This requires also that they must be able to interact with technologies such as blood pressure, injections and alarm systems.

• ... must preserve all interactions that were possible in the old system, in the new system. This because the value-chain must not in any case be broken.

• ... must have a technology that supports communication and transferring of large amounts of information. Furthermore, the personnel must have a device to interact with the system.

• ... must be able to heal it self, by means of identifying equal services to the on ceased to exist. This can be done by a service-oriented approach. The system must also guarantee very high availability and reliability.
**Glossary**

**Active documents.** Can be characterized as a model for the automation of handling and control of documents, by making them a combination of service-providers and resource in the form of autonomous agents residing in a service-oriented architecture.

**Bluetooth.** A technology that makes it possible to communicate between devices with a wireless connection.

**GPRS.** A bridge between GSM and UMTS which let you be connected to internet with GSM technology.

**Information processing.** The way information management is performed when accessing information from different localities in mobile environments.

**Journals.** A document where the information about a patient and the treatment of a patient is stated.

**Madox.** A project, where an implementation of the concept active documents is made.

**Maternity welfare.** The place where the pregnant mother visits when she need to be examined before a delivery.

**Maternity hospital.** The place where the mother gives birth.

**Midwife.** Has the role as a nurse in the pregnancy process.

**Non-disruptive.** When something remains non-disruptive means that it is remains unchanged.

**Obstetrix.** A computerized journal system that is used at Värnamo maternity hospital.

**Pregnancy system.** The whole pregnancy process, form the time when the woman has been pregnant, to the time when she visit the maternity welfare the last time.

**Sustainable.** When the system is stable and the system is comfortable with the functions of the system and the quality of them.

**Thin client.** Small client such as handhelds

**User.** The patients in the health care, could also be relatives.

**Value-chains.** The important activities in the health care, which makes the quality of life for the patients.

**Quality of life.** A measurement about how satisfied the member of a society is.
BIBLIOGRAPHY


