Towards efficiency in healthcare processes

A case study

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Preface

In English

Now I am reaching the end of the student phase and I will have to start a new phase. A phase where I will put in practice all those things I have been working hard for during these last years. If I take a pause and look back, with a big smile on my face I can finally say that I DID IT! At the same time I become a bit nostalgic; my life as a student was great.

In this session I would like to thank to all those people who in one form or another helped me, motivated me and assist me during my studying period, especially during these last stages. First of all I am very grateful to GOD who gave me life and healthiness to be where I am right now and accomplish all that I have up till now.

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Third, I would like to give thank my friends, who were always standing there behind me to help and support me during those difficult times. Here I mention, Royla, Elyandra, Carlos, Ashmir and Tarini and all others that I have not mentioned.

Last, but not least, I want to thank my parents, Magna and Edgar Maduro, my brother Edmarginio Maduro and all my other relatives who were always there when I needed them.

Na Papiamento

Aworaki mi ta jegando na final di e fase estudiantil y mi tin ku bai kumisa un etapa nobo. E etapa kaminda mi ta bai kumisa traha y pone den práktika tur lokual ma traha duru pe durante a añanan ku ta tras di lomba. Si mi para ketu y wak djis un ratu bék, ku un sonrisa riba mi kara, mi por bisa finalmente MA LOGRA! Na mesun momentu mi ta haña un tiki nostálgia; mi bida komo studiante tabata hopi dushi.

Den e sekshon aki mi kier a hiba algun palabra di gradisimentu na tur esnan ku di un forma of otro a judami, motivami y sostenemi durante mi studio y prinsipalmente den e lastu etapanan aki. Na prome luga mi tin ku gradisi DIOS ku a dunami bida y salud pa por ta aworaki kaminda mi ta y logra tur lokual mi a logra te ku aworaki.

Na di dos luga mi ke gradisi mi guíanan di RuG kendenan ta Dr. Elad Harison y Dr. Marjolein A.G. van Offenbeek pa e tempu ku nan a hinka den mi. Tambe mi kier gradisi e personanan di Wenckebach Instituut, en especial Jan Pols, Ita Meppelder di CSO, Dr. Hoorn di Radiologie, Frank Ploeg ku tabata mi begeleider na UMC G, Annegrit Wijker y sobra empleadonan di Radiologie y CSO ku a koopera ke mi investigashon.

Na di tres luga mi ke gradisi inmensamente mi amiga- y amigunan ku semper bai tabata para tras dimi pa judami y sostenemi den e tempunan mas difisil. Aki mi ta menshona Royla, Elyandra, Carlos, Ashmir, Tarini y tur sobra ku mi no a logra menshona.

Por ultimo y mas importante mi ta jama mi mayornan, Magna y Edgar Maduro, mi ruman Edmarginio Maduro y mi tanta-, tio-, primu- y primanan y demas famia danki pa semper tei einan ora ku mi mester di boso.

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Introduction

Healthcare sectors are facing many changes these last decades. Changes are being introduced to ensure that healthcare organizations aim for process efficiency and effectiveness. As a consequence, the role of ICT has been increasing at a fast rate. The use of health information technology (HIT) could bring several benefits to both individuals and healthcare systems as a whole. However, implementing IT is not a straightforward process. Every aspect regarding the technology should be taking into account before implementing it.

This research is focused on the use of order management systems between departments/facilities within Dutch hospitals. It is based on a case study involving the Radiology department and Centrale Spoedopvang (CSO), which is the emergency care unit (ECU) of the University Medical Center of Groningen (UMCG). The objective was to gain clear understanding of the problems arising between ECUs and other departments within hospitals and how IT could help in solving these problems. This has been achieved by using theories and models from literature in which technical, organizational and project management aspects of system development and implementation are described. These theories and models were used to develop a conceptual framework which served as the guideline for conducting the case study and answering the main research question, which was: "How can information systems (IS) improve the processes between different departments and/or facilities to facilitate efficiency in healthcare organizations?" This question was divided into several sub-questions, each dealing with an important aspect of the main question.

The conceptual framework developed consisted of human and organizational as well as technical and project management aspects of system development. In this framework, theories such as the stakeholder theory, the System Development Life Cycle, the PDCA Cycle of Total Quality Management, the EFQM Excellence Model and the Descriptive model of information system in the context of the organization, have been integrated to give a total overview of all relevant aspects for effective implementation and evaluation of information system.

Methods

A qualitative research approach has been chosen for conducting the research. The methods used in this research were literature analysis and field research. The literature analysis provided information about 1) the role of IT in organizations, 2) the aspects that should be taken into consideration when designing and implementing IS, 3) the difficulties organizations may encounter which make system integration difficult, 4) roles of information systems in healthcare institutions and 5) the existing work dependencies between ECU and other departments and/or facilities. The field research was divided into an observation period, a questionnaire research and interviews with stakeholders. The observation period was useful for gathering initial understanding of the situation, identifying stakeholders and for collecting enough materials to draw process diagrams. The questionnaire research aimed at revealing and diagnosing the errors encountered after the implementation of the system. Finally, the interviews served to get more detailed information about the underlying causes for and nature of the problems encountered.

The Case

The CSO characterizes itself by a multidisciplinary collaboration of workers and co-workers. Here, co-

assistants, residents, medical specialists, specialized emergency care (EC) nurses, Nurse Practitioners, receptionists and so on, work together to provide patients with the best they can. One of the supporting departments is the Radiology department, which provides the CSO with X-rays when necessary. X-ray requests which were previously written by hand can now be made semi-digitally with the use of the E.care ED system implemented in the CSO department.
There were some issues between the CSO and the Radiology department that needed attention. These issues related to X-ray requests that since February 2006 were also being requested by specialized EC nurses at CSO. These specialized EC nurses made, independently, X-ray requests for wrist, knee, ankle and other minor injuries. Radiology Practitioner Assistants (RPAs) and radiologists were complaining that too many errors were found on requests from the CSO. On April 1st 2007, they said STOP to all requests that were made by non-residents. From then on, all X-ray requests had to be done by a resident or medical specialist or under supervision of one of them. The other issue was that, as mentioned above, CSO has its own departmental system called E.care ED and the Radiology department uses X/care as their departmental system. These systems were supposed to effectively communicate with each other for among others, requesting X-rays. Unfortunately, during the implementation phase, the ICT clerks had been confronted with problems regarding linking the two systems. Therefore, up till now, requests from the CSO have to be printed on paper and send manually to Radiology.

Case results

Case study results show that the strategic reasoning behind the system implementation was too narrow, focusing too much on the CSO and leaving out of focus the interests and requirements of the members of the Radiology department. Furthermore, the implementation of E.care ED failed to realize the link with the X/care system of the Radiology department and in improving the interaction between employees of the two departments and in digitally connecting the two departments. Reasons for these failures relate to the fact that too little attention was placed on 1) human and organizational aspects such as involving all the stakeholders, users' attitudes towards and perception of the system and avoiding silo thinking and 2) on technical aspects such as following a structured implementation process and conducting a thorough risk analysis prior to implementation.
Questionnaire results revealed that only 3,26% of the X-ray requests made in the observation period related to requests containing errors. When the amount of errors found between the 16th and 30th of April 2007 were compared to those found between 1st and 15th of May 2007, the total amount of errors found in the May period showed a decrease of 50%. Reasons for this decrease could be:

a. the decrease of the amount of errors made by co-assistants and specialized EC nurses,
b. that the message that RPAs and radiologists have stopped accepting X-ray requests made individually by others than medical specialists or residents have reached most of the CSO employees in May,
c. the fact that in the May period the total amount of X-rays requested for patients visiting the CSO was less than in the observed period of April with the consequence that the amount of errors could also be less.

The top four types of errors made were that 1) too little information was provided about what has occurred to the patient, 2) the requested X-ray did not belong to patient's lesion or disorder, 3) wrong body part was indicated, for example left hand instead of right hand and 4) declared reason was not enough for the amount of images requested. These errors resembled those obtained in the previous research conducted by RPAs of the Radiology department in which could be concluded that most specialized EC nurses were requesting better X-rays than medical specialists and residents. Despite of this, no action plan has been developed for dealing with the errors made

by medical specialists and/or residents. Results obtained from the current questionnaire research show that 66,67% of the requested X-rays containing errors have been requested by or under the responsibility of residents. Only 12,82% of these requests have been requested by non-residents (co-assistants and specialized EC nurses). Results from this questionnaire also show that, though the decision had been made to stop accepting X-ray requests made individually by non-residents, the same errors are still found on X-ray requests and most of these errors pertain to residents of the STRP specialty of the CSO. A possible explanation for the errors made by residents or medical specialists was given by radiologists who are of the opinion that specialists and residents have too much tasks to carry out nowadays and they do not have that much time to fill detailed data into the system. Another explanation could be that the E.care ED system is quite new at the CSO. Medical specialists and residents working at the CSO are from many other units or departments and might not be that familiar with the system. The second most frequent found error could be related to protocols of the radiology department for X-rays and knowledge of these protocols by CSO employees. Here, the frequent change of workforce plays an important role.

From the research conducted, it could be observed that the implemented system had little influence on the errors that were being found on X-ray requests. The system partially digitalizes and coordinates the X-ray request process, but the quality of these X-rays depends on the users' attitudes and use of the system. It is not clear whether E.care ED has enhanced efficiency of services provided to patients at the CSO. What is clear is that the system has improved coordination of processes at the CSO, but has not added value for radiologists and RPAs.

Conclusions and recommendations

Failure to link the systems was due to unstructured system implementation process; no adequate risk analysis was conducted and no modeling diagrams were used to get detailed overview of processes taking place within and between these departments. Further research is needed to find out if the E.care ED system and the X/Care system of the Radiology department can be linked to each other. The Actor Activity Diagrams (AADs) developed in this research (Appendix 4) would then serve as the starting point for analyzing the existing processes and developing other object-oriented modeling diagrams.

From the questionnaire results it is clear that the errors found have little to do with the technical aspect of the E.care ED system, but more with human and organizational related issues. Due to lack of cooperation from residents it was not possible to interview them and find out why they are making these errors. A research could be conducted to find this out and also to obtain information about the degree of satisfaction of the CSO workforce with respect to the system itself and patients satisfaction with services delivered.

Management of the CSO and the Radiology department could enhance interactive communication within and between the CSO and the Radiology department by organizing monthly evaluations for employees of both units to discuss what has been done well and what needs to be improved in the X-ray requesting and delivering process. X-ray requests protocols have to be made and/or reviewed locally (between the two units) with respect to who does what tasks and how these tasks should be carried out. Members of both units have to agree with the protocols that would be made. These have to be written and signed agreements. The units have to make sure that each and every employee knows these protocols and work according to them.

Further research is also needed to find out if the E.care ED system and the X/Care system of the Radiology department can be linked to each other. This can be done by one or two students with knowledge of business and technical aspects of system implementation. If this is not possible, other alternatives can also be evaluated.

Chapter 1: Introduction

1.1 Introduction

Developments in information and communication technology (ICT) are increasingly influencing healthcare (Cramp and Carson, 2001). Medical organizations could benefit greatly from these developments, since they influence the cost, quality and access of healthcare delivery. Nowadays, radical changes with respect to legislations and consumers' demand are occurring and a great emphasis is being placed on taking healthcare nearer to the patient (Haux, et al, 2002). However, despite of all these developments, a large volume of patient information is still being recorded on paper. This phenomenon occurs since many organizations have not been able to make steps towards implementation of information systems that would support digital recording of patient information due to cost related issues or lack of information technology (IT) knowledge. Others, who tried to implement order management systems in their organizations, were not able to fully complete the implementation process.
The use of paper medical records could complicate things, as handwritten orders get stuck in queues waiting to be communicated and transferred to the appropriate department or records get displaced. Healthcare organizations face a considerable challenge to eliminate these inefficiencies, break down barriers to communication and enable clinicians to actively collaborate (McGurking, et al, 2006).

This research focuses on the use of IT between departments and/or facilities within Dutch hospitals. It is based on a case study involving the Radiology department and the Emergency Care Unit (ECU) better known as the Centrale SpoedOpvang (CSO), of the University Medical Center of Groningen (UMCG). Last year, an order management system has been implemented in CSO which was supposed to eliminate the paper work by digitalizing CSO's processes.
However, the system has not been fully implemented due to problems encountered. Up till now, there is an interconnectivity problem between the systems used in these two units, which is why ICT employees have not been able to link these systems to each other. Furthermore, too many errors were being found on X-ray request forms originating from the CSO. Radiology Practitioner Assistants (RPAs) argue that since specialized EC nurses have started to request X-ray diagnostics, the amount of X-ray requests and the amount of errors found has increases.

The aim of this chapter is to introduce the reader briefly to the topic under discussion. The following sections will lead you through and give an overview of the problem definition and the structure of the report.

1.2 Problem Statement

The first step in conducting a research is defining a problem statement or research question. The problem statement is a clear and concise statement (or question) that describes the symptoms of the problem to be addressed. This research is centered on a research question related to IT implementation in healthcare organizations. The research question sounds as follow:

"How can information systems (IS) improve processes between different departments and/or facilities to promote efficiency in healthcare organizations?"

This question is divided into several sub-questions which are defined as follows:

1. What roles does information technology play in organizations?

2. What organizational and human aspects should be taken into consideration when designing and implementing an information system?
3. What may be the difficulties hindering the adoption and diffusion of information systems within an organization?
4. What functions does information technology have in healthcare organizations?
5. What are the work dependencies between an emergency care unit and other departments and/or facilities and how are these affected by IT?
6. How can efficiency in healthcare organizations be measured?

These questions served as the foundation for conducting the case study and for answering the following management questions:

7. What are the problems employees confront with regard to X-ray requests?
8. Did the implementation of the E.care ED system bring improvements?
9. How can the problems be solved?

The answers to the sub-questions and the management questions served as small steps in order to provide the final answers to the main question.

1.3 Research objectives and scope

The objective was to gain clear understanding of what kinds of problems arise between ECUs and other departments within a hospital and to which extend and especially under which conditions, IT could help in solving these types of problems. The research should help organizations and/or institutions that confront similar problems to deal with it in the best way possible. Those organizations/ institutions that have a greater chance of meeting similar types of problems could also anticipate them and resolve these in the early stages.

Part of the research had much to do with the implementation of a system. However, the research did not go into details of technical issues of system implementation. Those remain outside the scope of the study. The research dealt mainly with the human and organizational aspects of IT-related changes and system design. The following section goes into details of how the research has been given structure.

1.4 Report Structure

The report consists of seven chapters, including this introduction chapter. In the next chapter, chapter 2, literature on information technology and organizational issues were reviewed and are described. Relevant information, methods and models are highlighted, which served as the basis for doing the case study analysis. Special attention has been given to what IT is, what the benefits of implementing IT are, which important aspects would have to be taken into account when implementing IT, which instruments are mentioned in literature for guiding the implementation process and, last but not least, what kind of risks and barriers are there that could obstruct the implementation process. All these issues are related to the sub-questions mentioned in earlier section.

In chapter 3, the ways in which IT has been implemented in healthcare institutions, especially hospitals, and their effects on performance are discussed. Also the relations between the CSO and the Radiology department of the UMCG are presented in the case study. Here, a thorough description of the existing work processes is given and the links between the two units are described.

Chapter 4 describes the methods used in conducting this research, including the different phases of the research. A description of the questionnaire research that was done as a single part of the main research is given. The reasons for conducting it, the procedures and list of questions that was developed for the RPAs to fill, are presented in this chapter.

Furthermore, the interview procedures are defined and the persons that were interviewed and the reasons for interviewing them are described.

Then, in chapter 5, the results of the questionnaire research are presented followed by important information gotten from the interviews. At the end of the chapter, all the obtained data and information are put together and discussed.

Chapter 6 will evaluate theories reviewed in chapter 2 based on results of the case study. In chapter, researcher will discuss what have been learned from theory and the case study and try to bring some new theoretical insights which could help in further researches.

Final conclusions are drawn in chapter 7. These conclusions provide answers to the problem statement and the sub-questions presented in chapter 4.

And finally, chapter 8 presents some recommendations for the departments in which the research took place and other general recommendations that could be used in other organizations dealing with similar problems regarding the use of information technology.

Chapter 2: Information technology and organizational issues

2.1 IT and the organization

2.1.1 IT defined

In these last fifteen years, billions of dollars are being invested by organizations in information technology in the hope that their efficiency, effectiveness and innovative capabilities will improve. Jorgenson and Stiroh (1999) point that, in 1996, "*U.S. businesses spent over $ 160 billion (in 1992 dollar) on new computers…*", while Mooney et al. (1995) cites that organizational investments in IT account for about 50% of annual capital investments. Suomi and Tähkäpää (2002) argue that 40% of European industrial and commercial investments are put into ICTs.
Existing literature contains several definitions of technology and information technology. These concepts are sometimes used interchangeably. One of the definitions that attract attention is that of Murmann (2006) in which technology is being defined as "*a man-made system constructed from components that function collectively to produce a number of functions for its users*". This definition can be complimented by Lucas (1993). In his article, Lucas defines some of these components as consisting of computers, communications, video conferencing, artificial intelligence, virtual reality, fax, cellular and wireless phones and pagers. Further, he categorizes the IT components in four different groups which are structural, work processes, communications and inter-organizational relations. Structural components are those virtual components that can be used to create components that in reality do not exist in conventional form; electronic linking (e-mail, video conferencing, fax, etcetera) and technological leveling which can substitute IT for layers of management and management tasks. Work processes are divided into production automation and electronic workflows, while communications consist of electronic communications and technological matrixing. The last category, inter-organizational relations, draws the electronic customer/supplier relations.
Renkema (2000) describes the importance of infrastructure and defines IT-based infrastructure as "*the shared system of staff/skills, tools and procedures in the field of IT which is used for a longer period of time, and as such is underpinned by organizational commitment and top management ownership*". IT and IT infrastructure are very important for an organization to succeed in the market. The role of IT will be described in the following section.

2.1.2 Role and benefits of IT in organizations

During the last decades the role of information technology in organizations has changed from being a facilitator to an enabler in the development of business processes (Huizingh, 2002, Eason, 2001 and Beynon-Davies, 2004). IT not only helps a process to take place (facilitator) but it also makes it possible (enables) for people to do things they were not able to do before. Orlikowski and Robey (1991) give an example in which access to a database enables customer service personnel to respond quickly and intelligently to customer queries. Huizingh (2002) analyzes the role of internet in facilitating electronic business processes and Beynon-Davies (2004) writes about IT supporting internal processes and linking the business through Internet. The search for success and survival has made organizations increasingly dependent on IT. Not so long ago, IT played an essential role in rationalizing routine business processes in the organization's 'back office' (Renkema, 2000). It was considered as an administrative expense or liability, as Renkema suggests, and its main function was to improve efficiency through cost savings and cost displacements.

Nowadays, IT plays a key role in organizational development. The focus of organizations has changed and is directed to long-term and capital-intensive business investments in their 'front-office'. This change of focus is due to the desire to improve effectiveness, transform entire business processes and gain and sustain competitive advantage. (More information about these topics can be found in various articles of Michael Porter)
IT is a very flexible technology that can be used to facilitate organizational engineering and outcomes and to support inter-organizational business processes (Cooper (1994), Eason (2001) and Mooney et al. (1989)). It has become a critical asset and is fundamental in building infrastructures that enable improvement. According to Lucas (1993), "*information technology gives managers options they have not had in the past*". Technology is a tool that can be used to help an organization to bring its products to the market. It should be used as a means to an end, but not as the end itself.

Many benefits are obtained from the use of IT. These benefits are known as IT business values, which are defined as the contribution of IT to firm performance (Mooney et al., 1989). In the organizational literature, benefits such as the following ones are being mentioned (Lucas (1975 and 1993) and (Mooney et al. (1989)):

- Improvements in management and decision-making.
- Companies have the benefit of small scale and large scale simultaneously and large organizations can become more flexible.
- IT can be used to reduce and manage complexity and make radical changes in business processes.
- IT has major transformation effect on coordination as grouping tasks, functions or people together no longer require physical proximity.
- New organizational design variables are made possible through IT.
- IT can improve the efficiency of operational processes through automation or enhance their effectiveness and reliability by linking them.
- Management processes are enhanced by improved availability and communication of information

The importance of IT can be evaluated by analyzing how investments in IT increase the business's value. Tallon et al. (2000) developed a conceptual model that links IT goals, management practices and realized IT value in order to derive the impact of IT on firm performance (Figure 1). In table 1 on the next page, some examples of ways in which IT impacts the different business activities within the value chain are presented. Tallon et al. derived these examples from the information system studies that they have reviewed.

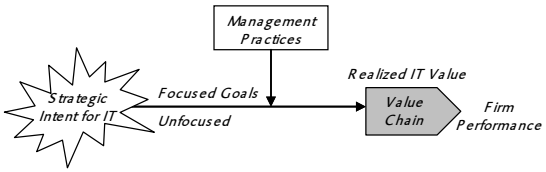

Figure 1. *Conceptual Model of IT Business Value*
Source: Paper of Tallon, Kraemer and Gurbaxani (2000).

The findings they got from their study show that the strategic intend for IT in corporations are not homogeneous, meaning that each corporation uses IT in a different way to support different strategic objectives. The level of perceived payoffs of IT is also directly related to corporate goals for IT. Another important finding was that specific management practices (strategic alignment and IT evaluation) are strongly related to perceived payoffs from IT investments. Effective integration of front- and back-office systems is also crucial to organizational effectiveness (Beynon-Davies, 2004). To obtain this integration, close attention must be paid to the organization's ICT infrastructure. Currently, many IT investments are in IT infrastructures. Due to this, Renkema (2000) states that assessing the business value of IT has become more critical and more complex. *"As infrastructure touches upon the interests of many departments, business units and even*

individuals, investment decisions are inextricably bound up with issues of stakeholder cooperation, commitment and the possibility to capture business synergy". He continues stating that *"business value assessment of IT infrastructure is considered to be a highly organizational and communicative process, in which 'hard' financial appraisals and strategic evaluations interact with 'softer' issues of management ownership, conflicts of interest, power and politics"*.

Table 1. *Dimensions of IT Business Value: A Review of the Research Literature*

Process Planning and Support
IT improves planning and decision making by improving organizational communication and coordination and by enhancing organizational flexibility.
Supplier Relations (inbound Logistics)
Use IT to coordinate supplier linkages and reduce search costs. IT can improve communication (EDI), quality control (TQM) and delivery techniques (EDI/JIT), leading to competitive advantage.
Production & Operations
Use IT to deliver enhanced manufacturing techniques through computer-aided design. Improvements in the production process can lead to economies of scale in the delivery of products and services. Incorporating IT into the end product and the use of advanced manufacturing processes can enable a greater range of products and services.
Product & Services Enhancement
IT can be used in the development of new products and services. IT can enable products and services to be uniquely differentiated in a variety of ways.
Sales & Marketing Support
The development of new products and services can enable an organization to identify and serve new market segments. IT can be used to track market trends and responses to marketing programs.
Customer Relations (Outbound Logistics)
IT can be used to establish, sustain, and improve customer relationships. Improving customer relations can result in improved market share.

Source: Tallon, Kraemer and Gurbaxani (2000)

2.2 Developing information systems

2.2.1 The decision-making process

Before any investment in IT is made, organizations have to go through a thorough decision-making process to select the best IT option to implement. The selected technology

and its functions and operations should be aligned with the overall corporate strategy. Therefore, the decision-making process prior to investment is very important. According to Boonstra (2003), decisions with respect to information systems (IS) are often fundamental decisions that shape a firm. Understanding the way IS decisions are made helps managers to improve the quality of IS decisions.

Factors affecting decision-making processes are summarized as follows (Boonstra, 2003):

- Limited ability of people to process information
- Disagreement among stakeholders
- Change, uncertainty and indistinct objectives
- Psychological barriers of individuals and groups to adapt information and act in a rational way
- Tendency towards incrementalism and arbitrariness in decision-making.

When making decisions about investing in information technology, it is important for managers to be able to measure the value these investments will deliver to the organization. In order to do this, value metrics should be made and used. Appropriate use of these value metrics could make the difference between investing in projects that are worthwhile and investing in projects that do not deliver value for money, given the limited available resources of the organization (Renkema, 2000).

2.2.2 The development process

Every system development and/or implementation project should follow a structured procedure to be successfully implemented. In the book *Systems Analysis and Design with UML Version 2.0* (Dennis et al., 2005) the system development life cycle (SDLC) model is used to structure the whole process of planning till implementation. In following this model, project-teams can get full understanding of how information systems supports business needs. They can design the system appropriately, built it and deliver it to the users. The SDLC consists of four fundamental phases which are the planning, analysis, design and implementation phase.
The *planning phase* is considered to be a fundamental process for understanding why an information system should be built and for determining which steps the team will have to take in order to build the system. In this phase the business value of the system is determined, a system request is created and a feasibility analysis is done. Furthermore, the project manager creates a project plan and staffs the project team.
In the *analysis phase*, questions such as who will use the system, what the system will do and *when* and *where* it will be used are answered. An analysis of the as-is system and the to-be system should be made and a concept should be developed for a new system. It is in this phase that all the stakeholders should be identified, together with their needs with respect to the system to be developed. Finally, a system proposal is presented to the sponsors.
During the *design phase*, decisions on how the system should operate are taken. Hardware, software, network infrastructure, user interfaces, forms and reports, specific programs, databases and files that will be needed, all are carefully evaluated and specified to the programming team for implementation.
The final phase, the *implementation phase*, is when the system is actually built. According to the authors of this book, this is the phase that usually gets most of the attention, because it used to be the longest and most expensive part of the development process.

To effectively execute the development process from the analysis phase up to the final phase, a common vocabulary of object/oriented terms and diagramming techniques have been developed that is rich enough to model any system development project. This common vocabulary is called the UML (Unified Modeling Language). This object-oriented system of notation that is accepted by the Object Management Group (OMG) as the standard for modeling object oriented programs. The current version of UML, Version 2.0, defines a set of fourteen types of diagrams or diagramming techniques used to model a system. This UML version distinguishes two types of diagrams: structure and behavioral. Structure diagrams provide a way for representing the data and static relationships that are in an information system, while behavioral diagrams support the system analyst in modeling the functional requirements of an evolving information system. Figure 2 summarizes the UML Version 2.0 techniques, their definitions and

illustrates which phase(s) of the development process each diagram is useful for.

Diagram Name	Description[1]	Primary Phase
Structure diagrams		
Class	Shows a collection of static model elements such as classes and types, their contents, and their relationships.	Analysis, Design
Object	Depicts objects and their relationships at a point in time, typically a special case of either a class diagram or a communication diagram.	Analysis, Design
Package	Shows how model elements are organized into packages as well as the dependencies between packages.	Analysis, Design, Implementation
Deployment	Shows the execution architecture of systems. This includes nodes, either hardware or software execution environments, as well as the middleware connecting them.	Physical Design, Implementation
Component	Depicts the components that compose an application, system, or enterprise. The components, their interrelationships, interactions, and their public interfaces are depicted	Physical Design, Implementation
Composite Structure	Depicts the internal structure of a classifier (such as a class, component, or use case), including the interaction points of the classifier to other parts of the system.	Analysis, Design
Behavioral Diagrams		
Activity	Depicts high-level business processes, including data flow, or to model the logic of complex logic within a system.	Analysis, Design
Sequence	Models the sequential logic, in effect the time ordering of messages between classifiers.	Analysis, Design
Communication	Shows instances of classes, their interrelationships, and the message flow between them. Communication diagrams typically focus on the structural organization of objects that send and receive messages. Formerly called a Collaboration Diagram.	Analysis, Design
Interaction Overview	A variant of an activity diagram which overviews the control flow within a system or business process. Each node/activity within the diagram can represent another interaction diagram.	Analysis, Design
Timing	Depicts the change in state or condition of a classifier instance or role over time. Typically used to show the change in state of an object over time in response to external events.	Analysis, Design
State Machine	Describes the states an object or interaction may be in, as well as the transitions between states.	
Behavioral State Machine	Examine the behaviour of one class.	Analysis, Design
Protocol State Machine	Illustrate the dependencies among the different interfaces of a class.	Analysis, Design
Use-Case	Shows use cases, actors, and their interrelationships.	Analysis

Figure 2. *UML 2.0 Diagram Summary. Source: Dennis et al.(2005)*

[1] http://www.agilemodeling.com/essays/umlDiagrams.htm

Not all these techniques have to be used in system development projects. The choice which technique(s) to use in a project depends on the project themselves, the project-teams and the project sponsors.
Schaap (2001) claims that the then existing modeling tools for business processes were *"not well suited for an assessment of business processes from a management and organizational viewpoint"*. He, therefore, introduced a new tool which he called the Actor Activity Diagramming (AAD). Schaap describes AAD as "a tool to model business processes in terms of activities, actors and transitions". He explains that AADs have a number of characteristics that keep modeling simple and that its most important characteristics are limited number of symbols, restricted modeling of conditions, the possibility to define activities and actors as relevant to the situation, and finally an explicit modeling of transitions. AAD deals with the observable characteristics of business processes: people are working on a product or service, people are passing a product or service they worked on to a fellow worker or a customer, or people are interacting with a computer. In Actor Activity Diagramming the actors play a central role. These are the employees who perform the activities. AAD is a powerful tool for depicting in details all steps taken in a specific process. Appendix 1 shows the AAD syntax, which describes the graphical elements of an AAD. These elements represent steps in business processes.

2.2.3 Actors in the development process

One element that is mentioned in previous sections that should get special attention is the stakeholder. Much emphasis is put on the importance of human issues in IT related projects (Lorenzi and Riley, 2000; Freeman, 1984; Mitroff, 1983; Mcloughlin, 1999; Boonstra, 2003; Boonstra and de Vries, 2005; Boonstra, 2006). A stakeholder theory was developed by Freeman (1984) to identify and model those relevant groups that are considered as the stakeholders of the organization. Stakeholders are defined by Mitroff (1983) as *"all those parties who either affect or who are affected by an organization's actions, behaviours and policies"*. On the other hand, instead of talking about stakeholders, Mcloughlin (1999) discusses the *"relevant social groups"* and defines them as *"those who share a particular set of understanding and meanings concerning the development of a given technology"*. None of these two definitions mention a specific group or individual that could be considered as a stakeholder. However, Mcloughlin's definition contains a certain criterion that has to be present for an individual or group of individuals to be considered as part of that *"relevant social group"*. As such, stakeholders could be departments, employees, units or autonomous organizations who decide to cooperate to achieve certain common goal. The stakeholder theory permeates firms to address the needs and wishes of all those relevant parties.

When significant changes are to be made in organizations, the attitudes of each stakeholder should be understood and taken into consideration when making decisions (Boonstra, 2006). Ignoring stakeholders could result in project or system implementation failure. Among stakeholders there could be some that have the most power and, of course, those with most interest in the project (results). These stakeholders represent the most significant actors. They are the ones that make sure that the implemented system deals with the problems they are confronted with. *"Stakeholder interests are formulated through a number of expectations, i.e. beliefs and desires concerning how the IS will serve the group's interests"* (Boonstra, 2006 and Lyytinen and Hirschheim, 1987).

In his study, Boonstra identifies the most significant stakeholders by analyzing their awareness of the proposed system. While identifying stakeholders it is also important to look at their culture. Organization theorists suggest that culture affects people's attitude towards the system to be implemented. Culture is the shared ideas, values and beliefs that members of a group or organization develop.

According to Boonstra (2003), people *"will welcome a system that fits their culture and resist or ignore one that conflicts with it"*. He further says that *"successful innovation depends on those promoting it achieving consensus amongst the relevant social groups, which stabilizes the form of an acceptable system"*. He analyzes issues related to user acceptance of an Electronic Prescription System (EPS). He bases his analysis on the Technology Acceptance Model (TAM), which was developed by Fred Davies and Richard Bagozzi. TAM is an information systems theory that models how users come to accept and use a technology. It suggests that when a new technology is presented to the users, a number of factors influence their decision to use it, how and when they will use it. These factors are defined as the perceived usefulness and the perceived ease-of-use and are related to user's attitude to the system (Boonstra, 2003) Perceived usefulness is defined as *"the degree to which a person believes that using a particular system would enhance his or her job performance"* and perceived ease-of-use is defined as *"the degree to which a person believes that using a particular system would be free from effort"* (Davies, 1989). Boonstra categorizes reasons for people to use or not use the EPS according to five different factors, namely system factors, process factors, cultural factors, financial factors and environmental factors. Other important issues that should be considered are preconditions that could be used to encourage external stakeholders (for example customers) to use a system. Beynon-Davies (2004) mentions a total of six preconditions, which include:

- *Awareness*. Stakeholders must be aware of the benefits to use the mechanism.
- *Interest*. Stakeholders must be interested in using the mechanism for their purposes.
- *Access*. Stakeholders must have easy access to the mechanism.
- *Skills*. Stakeholders must have the skills necessary to use to mechanism effectively.
- *Use*. Stakeholders must actively use the mechanism on a regular basis.
- *Impact*. Use of the mechanism must have certain impact on stakeholders which will encourage the use of it.

2.3 Arising difficulties of implementing IT

2.3.1 Risk and performance measurement

The continuous increase in IT spending makes organizations increasingly technology-dependent with the consequence that they become highly vulnerable to the risks of IT failure (Bandyopadhyay et al., 1999). Therefore, it is very important for managers to have the needed capacity to manage IT risks. The four major components of risks management that Bandyopadhyay et al. derived from the literatures they reviewed are risk identification, risk analysis, risk-reducing measures, and risk monitoring. They use these components for constructing a framework for integrated risk management in IT. They emphasize that prior to any risk management decision comes risk identification and the first step toward risk identification is to define the IT environment which consists of the application, organizational- and the inter-organizational level. Markus (2000) recognizes the importance of the technical issues, but emphasizes the other two levels of the IT environment in her article. She argues that *"the knowledge and skills of users and their social interactions while using computer-based information systems are as important to an understanding of risk as is the technical system itself"*. Markus defines IT-related risk *as "the likelihood that an organization will experience a significant negative effect (for example technical, financial, human, operational, or business loss) in the course of acquiring, deploying, and using (meaning maintaining, enhancing, etcetera) information technology either internally or externally*".

She identifies ten categories of IT-related risks, namely:

1. Financial risk (technology costs more than expected, yields fewer financial benefits);
2. Technical risk (technology used is immature, poorly understood, unreliable, obsolete);
3. Project risk (project is late, there is turnover of key personnel);
4. Political risk (the project/system/technology is subject to political infighting or resistance);
5. Contingency risk (accidents, disasters, viruses);
6. Non-use, underused, misuse risk (the intended users do not use the technology, they do not use it sufficiently or in a manner that would lead to the intended benefits, inappropriate use);
7. Internal abuse (malicious or felonious destruction, theft, abuse, etcetera, by company insiders)
8. External risk (hacking, theft of assets, willful destruction, etcetera, by company outsiders)
9. Competitive risk (negative reactions by customers, competitors, suppliers, etcetera, to the company's IT initiatives);
10. Reputation risk (negative reactions by the public at large, the media, the government, etcetera, to a company's IT initiatives).

Alter and Sherer (2004) classify 228 risk factors that they found in the IS risk literature based on the elements of the work system framework. These risk factors are divided into different categories and are related to system or project participants, information, technology, work practices, products and services produced by the organization, customers, the environment, the infrastructure and strategy. The authors believe that *"risk is fundamentally about uncertainty in work performance and the resulting outcomes"*. Further, they suggest that the basis for evaluating success lies in the goals and expectations that do exist prior to, for example, the beginning of the project. They use the elements of the work system framework to organize the risks associated with IS and their negative effects. The risks factors applied to the work systems are believed to apply also to information systems and projects as well. The work system life cycle (WSLC), which is almost the same as the system development life cycle discussed in the previous section, has been combined with the work system framework in the article to generate a more granular view of risk and risk factors across a work system's history, as the authors say. Appendix 2 shows the different phases in the WSLC.

2.3.2 Barriers to IT implementation and IT failures

Boonstra and de Vries (2005) analyzed inter-organizational systems (IOS) and they define these systems as *"systems that enable companies to share information and conduct business electronically across organizational boundaries as ICT based systems"*. According to them, many of these systems are adopted in various industries, among them the healthcare industry. Boonstra and de Vries identify four groups of, as they call them, *inhabitors and barriers* to the successful implementation of IOS. These consist of:

1. technology-related; lack of standards, incompatibility of software and hardware, security problems, encryption, etcetera
2. ability-, awareness- or knowledge-related; for example legal barriers, lack of awareness of the opportunities of the system and lack of knowledge on how to apply available technologies.
3. interest-related; idea of users that the system does not bring enough advantages.
4. power-related barriers; situations in which potential users are not able to make others use the system.

The authors emphasize the interest and power of relevant parties as the most influencing barriers. They argue that taken these two factors for granted, misunderstanding or ignoring them could lead to system failure, trouble with external parties or other undesirable effects. They present a model that can be used to describe and to assess positions of stakeholders. Applying the model should help in overcoming these barriers to the use and successful implementation of IOS.

Cooper (1994) describes organizational inertia and the impact of culture as its source. Organizational inertia may prevent structural changes from happening or these may happen but at a very slow pace. Significant organizational changes can foment resistant. This is due to the existing culture within the organization. Cooper defines culture as *"the social or normative glue that holds an organization together and that expresses the values or social ideals and beliefs which organization members come to share"*. He explains that culture is hard to identify and change. Changing people's thinking or behavior is the most difficult thing to achieve. Culture can exert a great power and could, without any doubt, influence the success of a system. This supports what Boonstra and de Vries' (2005) argue with respect to the power of relevant parties.
From literatures, Cooper found that resistant to change arises due to:

- uncertainty concerning jobs, skills etcetera
- lack of felt need
- potential redistribution of power and resources
- lack of organizational validity and
- lack of management support.

Resistance to IT capabilities leads to two forms of inertia 1) implementation failure and 2) IT's adaptation during implementation. Cooper remarks that when cultural resistance is expected, four important questions have to be asked, namely: who's culture should be changed, who should determine what cultural changes to make, whether it is ethical to make such changes and how the changes should be implemented.

Different reasons could be given for the failure of information systems or the implementation of these systems. For example, Lyytinen and Hirschheim (1988) define system failure as *"the inability of an IS to meet a specific stakeholder group's expectations"*. Eason (2001) supports the definition of Lyytinen and Hirschheim and concludes also that *"the bigger and more expensive the project, the more likely it is to fail"*. He further mentions resistance to change as another explanation for system failure. This is also a barrier to system implementation as has been explained earlier. Hirschheim makes a thorough analysis of the concept of users' resistance in the article he wrote with Newman (1988). They define user resistance as *"an adverse reaction to a proposed change which may manifest itself in a visible, overt fashion ….or may be less obvious and covert…"* and conclude that IS professionals consider user resistance as the main reason for IS failures. Furthermore, resistance can occur at various stages of the SDLC. The main causes for users' resistance summarized by Hirschheim and Newman are reluctance to change the status quo, lack of felt need, uncertainty, lack of involvement in change, redistribution of resources, organizational invalidity (mismatch between system design features and characteristics of the existing organization), lack of management support, poor technical quality, training, education, cognitive style of the user and personal characteristics of the designer (too much focused on the technical aspect of the IS and less on the business or organizational aspect of the system). Van Offenbeek (1993) explored the possibilities of controlling the social and organizational aspects developing information systems. Important factors leading to systems' implementation failures can also be derived from this research. The factors relate to among others knowledge of business processes, users and management involvement, project objectives and definition, cooperation, clear project and system specifications, planning and preparation. If these factors are not analyzed with the needed care, the success of a system's implementation is not guaranteed.

Harmon (2003) writes about *silo thinking* and refers to departments or functional groups within a department as 'silos'. According to him, managers tend to focus too much on their own department, on making it as efficient as possible without taking other departments into much consideration. He continues arguing that *"silo thinking tends to lead to departmental or functional optimization"*, which often occurs at the expense of the whole organization. Problems that arise in such situations have to

do with linking systems used in different departments or getting the different departments to co-operate with each other. One way to avoid this phenomenon is by thinking of the organization as a whole and making use of diagrams to get the insight of how things actually work within the organization. The UML diagrams that have been mentioned in the previous section are perfect examples of diagrams that could help managers understand what is going on in their departments and the rest of the organization. This will definitely improve decision-making and help in avoiding failures of implemented systems.
Galbraith (1968) also addresses the problem of organizations divided into different departments, subunits or silos, as Harmon calls them. He argues that *"the greater the degree to which an organization is broken down into specialized subtasks, the more effective is the subtask performance"*. However, *"the greater the degree of subtask specialization, the greater is the problem of subtask integration into effective performance of the entire task"*. This is due to increased amount of interdependence among the subunits, which could lead to a problem of achieving collaboration on joint problems.

The main reason for IT failures discussed by Lucas (1975) is organizational behavior problems. He claims that too much effort and concentration are put on the technical aspects of systems and crucial organizational behavior problems are ignored. Problems he observed from interviews he made are, among others, that users sometimes do not understand the output they receive from the system or they complain about information overload and difficulties obtaining changes in existing systems. Other users actually do not use the information provided by a system. Users' satisfaction is fundamental; if they are dissatisfied they can sabotage the success of a system. Lucas describes three major areas of problem in system design and implementation that if not given appropriate attention can contribute to system failures. These problem areas are technical, organizational and project management. He proposes also that *"new dependencies and power relationships among departments as a result of the development of an information system can create major organizational behavior problems"*. Lucas developed a 'descriptive model of information systems in the context of the organization' which focuses on three crucial classes of variables: user attitudes and perception, the use of systems, and performance. Lucas's model is showed in Appendix 3. This model integrates both human and organizational aspects under a single concept, that of 'organizational behavior' and suggests ways to solve these behavioral problems. It could be helpful in planning and managing information systems. The numbers in the model refer to propositions he made and tested during his research. From his research, he found enough evidence to support his propositions. He argues that besides technical problems, organizational behavior variables have to be considered if the desire is to design and operate a successful system. As far as these variables or a majority of them are continue to be ignored, information systems will continue to fail.

Lorenzi and Riley (2000) emphasize the importance of these human issues and address some 'contemporary' reasons for system failures. They name issues such as communication, culture, underestimation of complexity, scope creep, organizational, technology, training and leadership as relevant causes for failures and state from personal observation that the two most important ones are certainly communications deficiencies and failure to develop user ownership (leadership).
Lyytinen (1988) presents the concept of 'expectation failure' of information systems as another important concept. This concept defines information systems' failure as a *"gap between stakeholders' expectations expressed in some ideal or standard and the actual performance"*. To him, main reasons for IS failures are connected to what the stakeholders perceive as 'pitfalls'. His research found that the most highly ranked reasons for IS failures were: decision-making, organizational, technical and operational, unanticipated reasons and work-based reasons. More specifically, respondents mentioned issues such as inexact development goals and specifications, inadequate understanding of system contingencies and inadequate

understanding of users' work as possible reasons for failures.

2.4 Conclusion

Much is learned from the reviewed literatures. More and more organizations are becoming aware of the role IT plays in enabling and facilitating their processes. Millions are being invested into IT. What is important to managers is that implementing IT brings many benefits to the organization. However, this is not always the case. It is important to balance these benefits with the arising problems. Many reasons for failures of systems and/or IT related projects are mentioned in the literature. One of the most frequent mentioned ones is the lack of knowledge about the users and their needs. Managers and IT clerks usually take users for granted and assume that they will adapt to and use the implemented system. However, users are powerful sources of failures. Users' resistance to change is a well known topic of discussion in organizational literatures. When users do not feel the need for a new system or if they feel that the system does not provide answers to their needs, they simply refuse to use it. Organizations should be seen as wholes. Communication, especially personal communication, is here a fundamental issue and has to be promoted. Departmental cooperation and information sharing could be stimulated. By doing so, the concept of silo thinking and the rise of sub-cultures within organizations can be avoided.

Implementing IT is not so simple, there are many issues that should be taken into account and choices have to be made to manage risk. Managers having the capacity to manage risks, identifying stakeholders in advance and involving them in the whole development process, could help in effective execution of IT development projects. Furthermore, models have been developed that can guide the planning, design and implementation processes. One of these models is the SDLC model, which can be used to structure the whole process of planning till implementation of a new system. Diagrams can also be used to provide overviews of specific processes and workflows. Another fundamental issue to consider is the effective integration of the new system with existing systems within and across functional departments. Alignment with the overall corporate goals and strategies for IT is also an interesting point. Finally, the perceived payoffs of the system have to be calculated and evaluated in every step of the SDLC. As said, these payoffs are perceived, meaning that they are totally dependent on the needs and demands of users and the organization itself. Since organizational issues can be strong barriers to IT implementation, these have to be carefully evaluated. The Lucas's descriptive model of ISs in the context of the organization can be used to identify and deal with these organization issues. If all these issues are carefully analyzed and accurately put in practice, there is a great probability that information systems will help in improving the processes within an organization.

Chapter 3: IT developments in healthcare

3.1 IT's influence on healthcare processes

3.1.1 IT Developments in healthcare

Healthcare sectors are facing many changes these last decades. Changes in legislation (for example state subsidies) are being introduced to ensure that healthcare organizations aim for process efficiency and effectiveness. These changes are the results of high market pressures such as advances in ICT, growing demand for care, better education of personnel, more demanding customers and increasing cost justification needs (Suomi et al., 2001). There is also an ever growing need to cut costs and increase effectiveness in healthcare sectors all around the world (Cramp and Carson, 2001). One way to meet these needs is by implementing health information technology (HIT), this according to Robert Golden[2], Chief Technology Officer of LanVision Systems, Inc. The role of ICT has been increasing at a fast rate. While doing research in the Nordic countries of Europe, Suomi and colleagues (2001) identified two main trends in the different healthcare sectors; these were privatization and computerization of the healthcare industry.

Peterson et al. (1999) analyzed the potential of IT infrastructures and applications for healthcare, particularly in the Dutch healthcare networks. They identified several issues of influence in the organization of healthcare services in the Netherlands. These issues relate to political, economic, social-demographic issues and issues of the technological progress. They argue that the Dutch healthcare system shows several barriers that prevent efficient and effective control of hospital organizations. One of the most important barriers was the budgeting system that the government used for hospitals. This system relied on production parameters such as admissions, nursing days, out-patients, etcetera to related input and output. These legislative ways of exercising control influenced the information systems of hospital, according to the authors. They therefore state that the changes in healthcare demanded a more specific system of product-definition.

The Ministry of Health, Welfare and Sport (2006) explains that the Netherlands is confronting the problem of an aging population, which puts a pressure on the Dutch healthcare system. This is the reason why in 2006 a number of changes have been introduced. Ministry of Health, Welfare and Sport describe the changes as follows:

> *"These changes, which are designed to prepare the system for the future and to make the healthcare more effective, efficient and customer-focused, necessitate a better distribution of responsibility among the key players. The patient/client occupies a central role in the current healthcare system in the Netherlands, with more opportunities but also more responsibility. It is up to the patient/client to bring about improvements to the quality. A well-informed patient can single out the provider that offers the best care for his condition. This will spur healthcare providers (doctors, hospital boards, etc.) to raise their performance. Medical insurers will bear more responsibility for matching the demands of the consumer with the offerings of the providers. It is the government's job to oversee quality, accessibility and affordability.*
> *The Dutch healthcare system takes the form of an insurance system which is run by private providers*

[2] His article on be obtained on http://www.infotivity.com/lanvis.htm.

with a public remit. This set-up also applies to the ICT policy and role allocation in the healthcare sector. The government, in this case the Ministry of Health, Welfare & Sport, wants to promote the use of ICT in healthcare with the ultimate aim of improving affordability, accessibility and quality. It will do so by creating a climate which is conducive to optimal and secure use of ICT. The healthcare providers bear primary responsibility for the quality of the care and the use of ICT systems."

Research conducted by the Dutch pharmaceutical association, revealed that on estimate 90,000 patients are admitted to hospital every year as a result of medication errors that could have been avoided (Ministry of Health, Welfare and Sport, 2006). This costs around 300 million euros a year and accounts for approximately 2,5% of hospitalization nationwide. Leavitt (2007) argues that the use of health information technology (HIT) could bring several benefits to both individuals and healthcare systems as a whole. These benefits are said to relate to higher quality of care, reduction in medical errors, fewer duplicate treatments and tests, decrease in paperwork, lower healthcare costs, constant access to health information and expansion of access to affordable care, which could be achieved by, for example, implementing an order management system. Furthermore, the use of HIT allows better management of medical information and secure exchange between healthcare consumers and providers. Other benefits relate to public health, for example early detection of infectious disease outbreaks around the country and improved tracking of chronic disease management.

The role ICT played in healthcare began to increase in the middle of the 1990's and became more than merely supportive. During those years the supply of ICT tools increased compared to the beginning of the 1990's (Suomi and Tähkäpää, 2002). By that time, a new technology was introduced, that of the electronic patient record system. Different terms are being used in literatures to refer to the electronic records used in healthcare: Computerized Patient Record (CPR), Electronic Medical Record (EMR), Electronic Health Record (EHR), and Personal Health Record (PHR), to mention a few. Analytics of the Health Information Management Systems Society (HIMSS) define EMR as:

"An application environment composed of the clinical data repository, clinical decision support, controlled medical vocabulary, order entry, computerized provider order entry, pharmacy, and clinical documentation applications. This environment supports the patient s electronic medical record across inpatient and outpatient environments, and is used by healthcare practitioners to document, monitor, and manage health care delivery within a care delivery organization (CDO). The data in the EMR is the legal record of what happened to the patient during their encounter at the CDO and is owned by the CDO" (Garets et al., 2005).

They emphasize that the EMR and the EHR are not the same, although these terms are used interchangeably. EHR is defined as *"a subset of each care delivery organization's EMR"*. It represents *"the ability to easily share medical information among stakeholders and to have a patient's information follow him or her through the various modalities of care engaged by that individual"*. According to Garets and colleagues (2005), EHR can only be established when the EMR of the different CDOs have evolved in such a way that they can create and support the exchange of information between stakeholders. According to Bal and de Bont (2005), meanwhile, almost all hospitals in the Netherlands are busy developing and further expanding an EHR.

To be able to establish effective EHRs, it is necessary to establish clinical information transaction standards which can be easily adopted by the existing EMR application architectures. The Ministry of Health, Welfare and Sport (2006) supports this and states that *"information exchange between healthcare professionals requires message standards at various levels"*. 450 different voluntary and

mandated HIT standards have been identified by the National Alliance for Health Information Technology (NAHIT) (Ward et al., 2006). These standards relate to messaging-data interchange, coding, vocabulary and terminology and content of information. One of the better known clinical standards for HIT nowadays is the HL7 standard developed by Health Level Seven Organization (HL7)3. This standard has been implemented in different countries around the world like the United States of America, United Kingdom, Canada, Australia, Japan, The Netherlands, Finland, Germany and more. The next section provides a brief description of this standard.

3.1.2 The HL7 communication standard

Different computer systems are being used in hospitals. All these systems should be able to effectively communicate or interact with each other. Nevertheless, this is not the case in most hospitals. HL7 developed a standard for the exchange, management and integration of clinical data that was expected to support the interconnectivity between systems used in healthcare organizations. This standard is known as the HL7 standard. When developing this standard, the focus was on creating a common data architecture for the interoperability of healthcare documents. HL7 is singular as it focuses on the interface requirements of the entire health care organization, while most other efforts focus on the requirements of a particular department4. The HL7 standard relates primarily to the content of the EMR, representing the longitudinal care history of the patient (Ward et al., 2006). The standard has gained that much acceptation that, over the past decades, the second version of HL7 (HL7 V2) has been implemented in over twenty countries, particularly for messaging within hospitals. It became the worlds leading standard for the electronic interchange of healthcare information. However, HL7 V2 has some limitations. It is not easily implemented and the messages in this version have a large number of optional fields (Beeler, 1998).

Some years ago, professionals of HL7 realized that there was a strong need for a methodology that truly supports interoperability of healthcare systems (Hinchley, 2005). In January 1997, they began developing the third version of HL7. HL7 V3 is based on object-oriented modeling techniques to capture the critical data and semantics associated with a healthcare activity and uses key elements of UML. The difference between version 2 and version 3 is that the latest one supports not only processes within hospitals, but also between healthcare organizations (Ringholm)5. With respect to documents, Ringholm explained that the third version supports the transfer of persistent sets of data between health delivering organizations.

Figure 3 shows the process that occurs while a HL7 V3 message is being created. The process starts with a storyboard which is a short realistic description of a real-world process for which a message may be needed. It is used to show the set of interactions associated with a real-life healthcare situation. In terms of UML modeling, the storyboard concept is known as a 'use case'. Each set of HL7 interactions, trigger events and application roles describe the scope of a particular use case. The application role represents an actor. HL7 defines application roles in terms of the behavior of the application that is sending or receiving an HL7 V3 message (sender or receiver). Trigger events are those events that cause messages to be sent; they are explicit sets of conditions that initiate the transfer of information between system components.

[3] HL7 is an all-volunteer, not-for-profit organization involved in development of international healthcare standards. It is one of several American National Standards Institute (ANSI) -accredited Standards Developing Organizations (SDOs) operating in the healthcare arena.

[4] www.hl7.org

[5] June 5th 2007 was the first day of a 2-days HL7 course given by Mr. Ringholm at the UMCG. The presentation given in this course can be found on www.ringholm.de/download/umcg.pdf

Beeler (1998) divides the HL7 message creating process in four specific models, which are showed in Figure 4. This figure tells the same story as figure 3, but it shows how the elements of UML are put in practice in the HL7 V3 Message Development Framework.

HL7 in the Netherlands

The HL7 organization has affiliates in many countries around the world, also in the Netherlands. HL7 the Netherlands (HL7 NL) is one of the first official International Affiliates of the International Standards Development Organization HL7 Inc6. It was founded in 1992 and has grown to over 130 members, including almost all general and university hospitals, most major vendors, and several general interest parties.
Since its introduction in the Netherlands, the HL7 standard has grown in such a way that it has become the one and only commonly accepted and applied standard for connectivity between systems and applications within institutions. Nearly all Dutch general hospitals operationally use the HL7 standard for links between health information systems (HISs) and departmental systems. NICTIZ, which is the national institute for ICT in healthcare of the Netherlands, has chosen HL7 version 3 as the preferred standard for new developments. The last few years HL7 NL has been working parallel on both versions 2 and version 3. At the same time, in 1996 already, the institute has acknowledged that the manner of development of version 2 offered insufficient guarantees for maintenance, expansion and uniformity. The Netherlands has decided to standardize on 'HL7 version 3' messages because this is an international standard with the potential to develop with one standard from a national e-medication record to a national Electronic Health Record. The specifications have been worked out in dialogue with HL7 the Netherlands and are being incorporated in the international HL7 standard. Although the second version of HL7 is still being used at the UMCG, they are working very hard, preparing for introducing the third version in the near future.

As described above, there are different developments occurring with respect to IT in healthcare. Despite all these developments, organizations still encounter some problems when adopting or planning for adoption of ICT in their processes. The next section elaborates on these problems.

[6] http://www.hl7.nl/ventura/engine.php?Cmd=see&P_site=407&P_self=10&PMax=1&PSkip=0

3.1.3 Adoption of IT in healthcare

When Christensen and Remler (2007) analyzed the adoption of ICT in clinical care, they found that the adoption of ICT in the sector was quite limited. Bal and de Bont (2005) state that in developing and implementing ICT, too little attention is paid to the consequences ICT has on daily work routines of care providers. As many authors, they agree that the use of ICT in healthcare sector can result in significant efficiency gains, but there are still barriers to the adoption of it. The authors mention key reasons for the slow adoption of ICT in healthcare. These are among others:

1. Network effects and network externalities[7]: Network effects relate to whether or not the technology interacts with the technology of other products or consumers. Technology compatibility or interoperability is of fundamental importance when planning for implementing a new technology. Without this interoperability, physicians, pharmacies and hospitals are unable to share patient information necessary for efficiently delivering care. Furthermore, according to the authors, the number of existing users defines the value of networks which is the reason why network externalities also play an important role in ICT adoption.
2. Switching costs: Three major sources of switching costs must be addressed before adoption of a new

[7] Network externalities are the effects on a user of a product or service of others using the same or compatible products or services. Positive network externalities exist if the benefits are an increasing function of the number of other users. Negative network externalities exist if the benefits are a decreasing function of the number of other users. http://economics.about.com/cs/economicsglossary/g/network_ex.htm

ICT can take place. *"First, there is the cost of adopting new durable hardware such as mainframe computers and operating systems to store information and the costs of complementary products such as system management software to manage the information and database itself. Secondly there is the cost of information storage in databases and the cost of moving information from one database to another, including the cost of additional data storage (e.g. old medical records that need to be store for legal reasons). Third, there is the cost of the training involved in using the new ICT".*

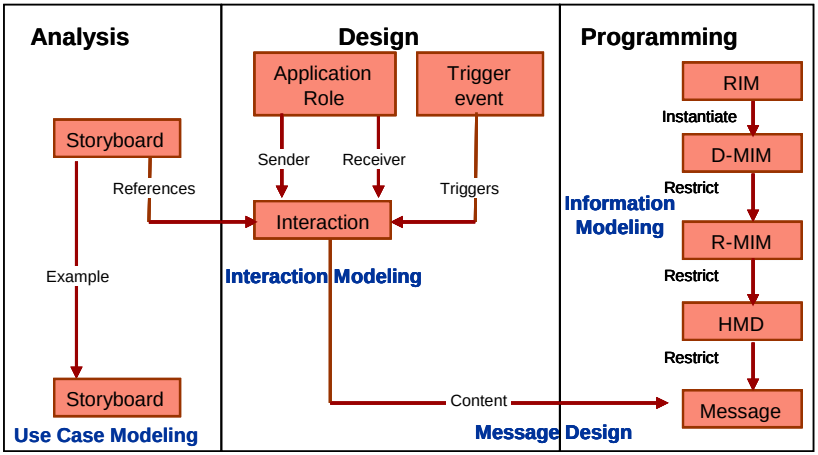

***Figure 3**. The process for development of HL7 V3 messages. Source: Hinchley (2005).*

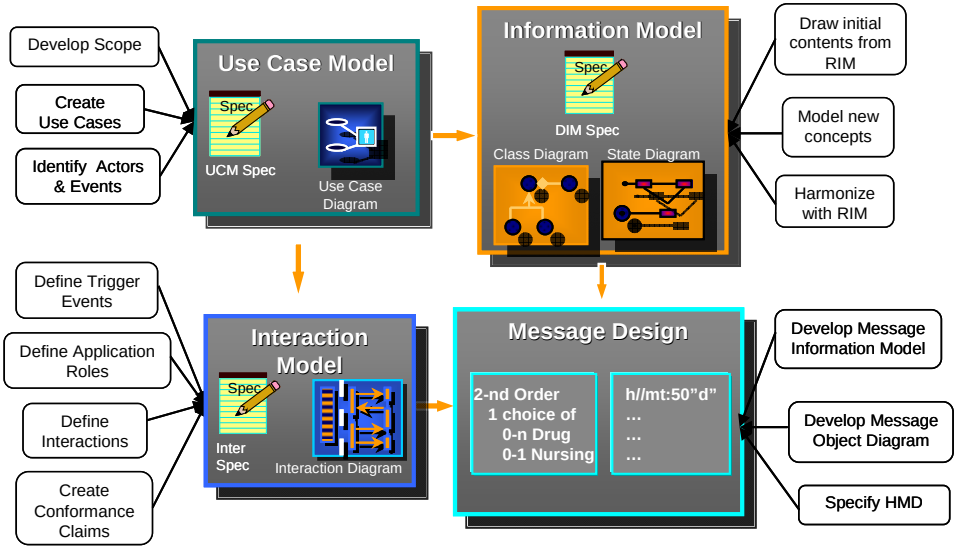

Figure 4. *Diagram of the primary models, development steps and documented deliverables specified by the HL7 Version 3 Message Development Framework (MDF). Source: Presentation Klein, 2000*[8].

Cramp and Carson (2001) mention some challenges that also the Dutch healthcare sector faces which surely influence the adoption of IT. These challenges relate to increasingly aging population, acute shortage of trained manpower and ever-increasing patient or client expectations.

Another barrier to adoption of ICT in healthcare relates to adding older records to EMRs (Laerum et al., 2003). The authors explain that to attain wide accessibility, efficiency, patient safety and cost savings expected from the EMR system, older paper medical records ideally should be incorporated into the patient's record. The digital scanning process involved in the conversion of these physical records to EMR is an expensive, time-consuming process, which must be done according to the standards to ensure exact capture of the content.

3.1.4 Measuring quality of implemented systems and processes

It is very important for organizations to be able to manage quality of implemented systems and systems already in house to see if they are (still) efficient and positively contribute to the company's outcomes. This could be done

[8] http://www.eng.tau.ac.il/~gannot/MI/tutor.ppt

by analyzing the system's performance and the outcomes it generates. Ward et al. (2006) states that *"outcomes management can be achieved once the electronic clinical information system has been in place two to three years and business processes have been streamlined and improved"*. Total Quality Management (TQM) and Excellence Model are two known models used for managing quality. TQM is defined as:

"….. a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback"[9].

It can be applied to any type of organization imaginable, including schools, highway maintenance, hotel management, and churches9. It is based on quality management from the customer's point of view and its processes are divided into four sequential categories: plan, do, check, and act. These categories refer to those of the PDCA cycle of Shewhart. The PDCA cycle is drawn in the next figure, figure 5. In the planning phase of the PDCA cycle, people define the problem to be addressed, collect relevant data, and ascertain the problem's root cause. In the doing phase, people develop and implement a solution, and decide upon a measurement to assess its effectiveness. In the checking phase, people confirm the results through before-and-after data comparison. Finally, in the acting phase, people document their results, inform others about process changes, and make recommendations for the problem to be addressed in the PDCA cycle in figure 5.

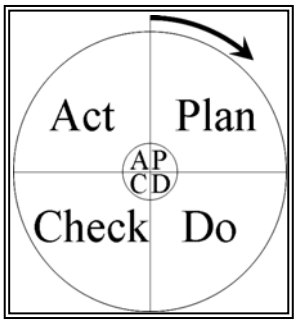

Figure 5. *Shewhart cycle*

The Excellence Model was developed by the European Foundation for Quality Management (EFQM). It is based on nine criteria divided into two main groups: enablers and results. The 'Enabler' criteria cover what an organization does, while the 'Results' criteria cover what an organization achieves[10]. Figure 6 shows the concepts of the Excellence Model. The scope of the model could perfectly be narrowed down. Instead of looking at an entire organization, the focus could be placed on a department or group of interrelated departments. Although, all the presented concepts could be used for improving the quality of processes and delivered products and/or services of the specific department(s), four of these concepts attracted the attention of the researcher. These four concepts have been circled in figure 6. The concepts relate to topics previously discussed such as stakeholders' involvement and information sharing within and across departments. Following the description of Bhatt[10], shared values and a culture of trust and empowerment, would encourage stakeholders involvement in the processes. Furthermore, process excellence is based on balancing and satisfying stakeholders' needs and understanding inter-related activities. Stakeholders' perceptions about these activities are of fundamental importance here. Last but not least, the relationships between the stakeholders have to mutually beneficial and built on trust, sharing of knowledge and integration.

[9] http://searchcio.techtarget.com/sDefinition/0,,sid19_gci799434,00.html

[10] http://www.eknowledgecenter.com/articles/1010/1010.htm

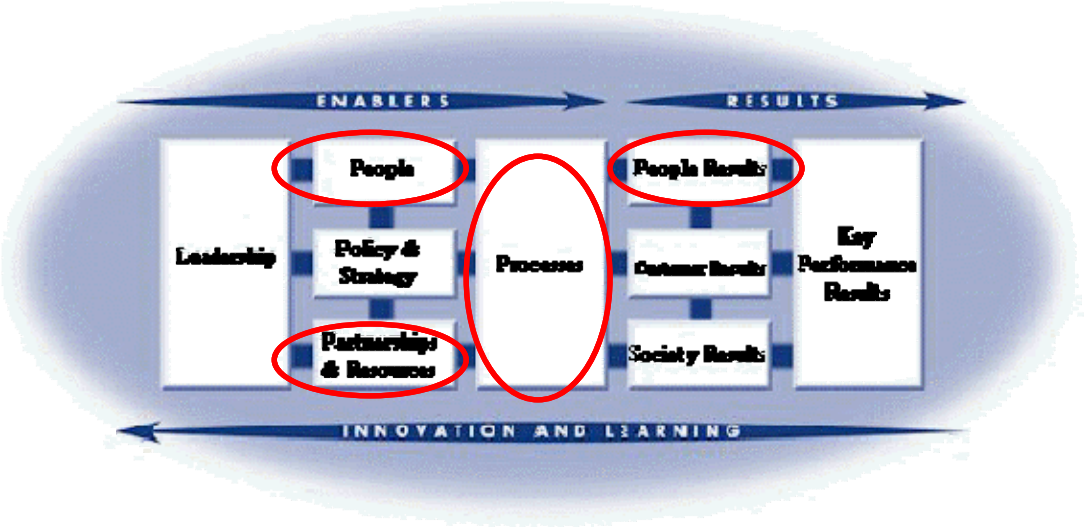

Figure 6. The EFQM Excellence Model

3.1.5 Conclusion

Advances in ICT can assist in transforming the way in which healthcare is delivered. Information technology plays an important role and provides help to make sure that health-related information and services are available anytime and anywhere. By implementing IT, healthcare practitioners are able to access patient information

wherever it is located, information is shared and it is possible to do more accurate researches. Delivering high-quality, safe and efficient hospital care to patients demands well integrated series of exchanges among stakeholders. However, it is the network participant that needs to recognize, adopt, implement and exploit the potential opportunities provided by IT (Peterson et al., 1999).In current chapter as in the previous one, many aspects have to be taken into account when developing a system. These can be divided into three main categories, to mentioned organizational aspects, technical aspects and project management aspects. All these can be put together to create a conceptual model of relevant theories obtained from literature review. The main aspects of the conceptual model and their individual concepts are shown in figure 7. The model can be used to cover all relevant issues when changes are to be made in an organization and/or an information system is to be implemented. The different aspects of this conceptual model will be used for analysis of the conducted case study. More detailed information of this conceptual model will be given in chapter 6.

It has been suggested that implementing an order management system, could yield several benefits to both individuals and healthcare systems as a whole. The arising question is now: How could the implementation

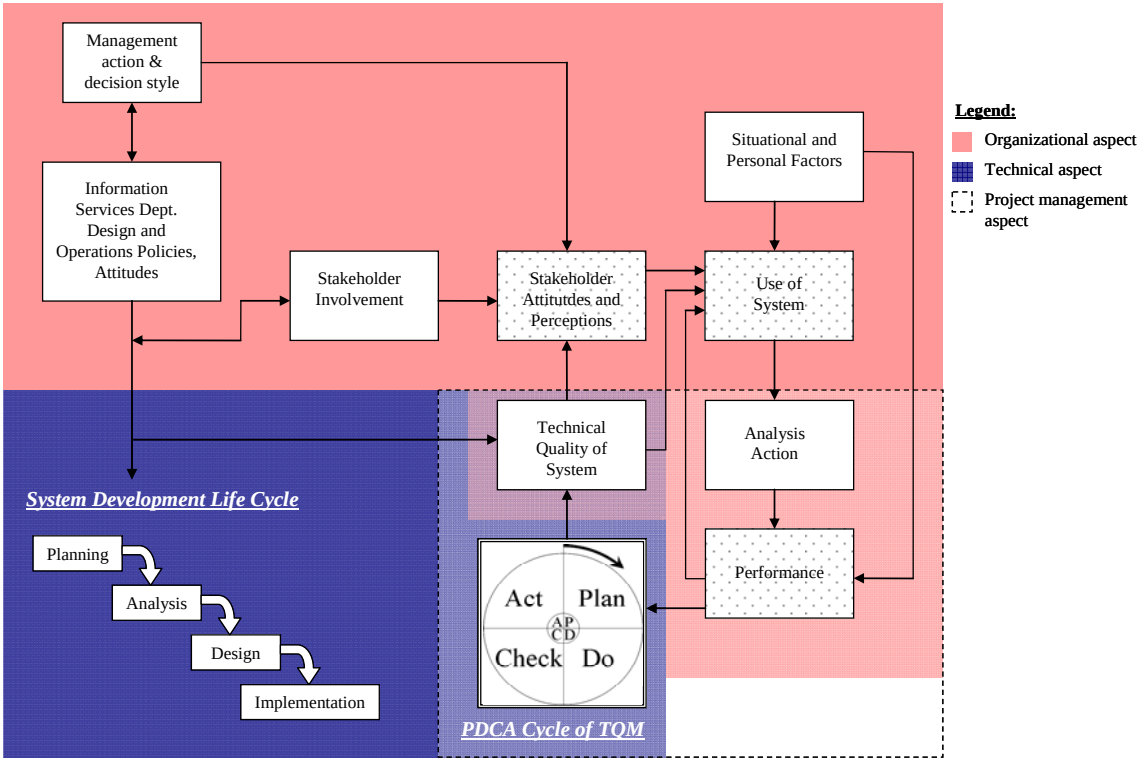

Figure 7: Conceptual model of relevant aspect for the development of a system

of an order management system solve problems healthcare providers encounter when doing their daily job? Before answering this question it is more important to know what kind of problems these people are confronted with during the daily work processes. A case study has been conducted in the emergency facility and the Radiology department of the UMCG to understand the problems that exist within and between these units and to get an overview of the processes and the role IT played in improving these processes. The case study is described in details in the next section.

3.2 The Case Study

3.2.1 The UMCG

A research was conducted in the University Medical Center of Groningen. The UMCG is one of eight university medical centers (UMCs) in the Netherlands and the main centre for health-care education and training in the North of the Netherlands11. UMCG is therefore the final point of referral for many patients coming from the Northern provinces. Patients go to the UMCG for basic care as well as highly specialist top clinical and top reference care12. The UMCG has 1339 beds and more than 9000 employees. Yearly, about 31.000 patients are admitted in the hospital, nearly 32.000 patients arrive at its emergency department and more or less 3.400 medical students are being trained. UMCG has four core functions, namely patient care, education and training, and scientific research. It provides also different training programs and courses to students and both internal and external doctors and specialists. Employees of the hospital conduct researches for new techniques and treatments, new medicines and new forms of care with the objective to make a contribution to qualitative care.
The institution is divided into several facilities and departments among others the CSO and the Radiology department. These are the two areas of concern for current research and are describe in following sections.

[11] http://www.umcg.nl/azg/store/pdf/WelcomUMCG.pdf

[12] Dejardin et al. (2005) use the definition of the French public health authorities to define reference sites. These authorities defined a reference site as "one or several care centres able to manage serious pathologies with bad prognosis and rare pathologies. Moreover, this care centre must propose specialised therapies making use of particular techniques. Actually, such care sites, mainly represented by University hospitals and regional comprehensive cancer centres, were exclusively pooled in regional capitals." http://www.nature.com.server.proxy-ub.rug.nl/bjc/journal /v92/n10/pdf/6602571a.pdf

3.2.2 The emergency facility and the Radiology department at the UMCG

The CSO

Emergency care is one of the most complex, rapidly growing areas of ambulatory care (Zilm et al., 2007). In the Netherlands there are a total of 110 hospitals from which 95% dispose of an emergency care facility or department (NVSHV13, 2005). In 1998, the existing minister of healthcare declared that ten of these hospitals would get the function of trauma center and would dispose of all the needed specialists to admit trauma patients. The UMCG was one of these ten hospitals. Trauma patients that arrive at the UMCG are admitted at the emergency department (ED) of the UMCG which is called the Centrale SpoedOpvang (CSO). This is the primary care facility providing initial treatment to patients suffering of different kind of illnesses and/or injuries.
Emergency departments are increasingly being used for non-emergency care because of overburdened healthcare systems when compared to earlier years. For example, those people with minor injuries or illnesses that cannot go to their doctor's office late at night are forced to go to the ED to get immediate treatment. The total amount of patients entering EDs in the Netherlands is estimated at 1,8 million annually. Patients arriving at CSO are either referred by general practitioners (GPs), by ambulance, from other facilities or medical institutions or independently. They frequently arrive with unstable conditions, and so must be treated quickly. Upon arrival in the ED, patients are typically triaged by a specialized EC nurse with training in emergency medicine to help determine the nature and severity of their illness. Triage is a dynamic decision process

[13] NVSHV stands for Nederlandse Vereniging Spoedeisende Hulp Verpleegkundigen, which is the association of emergency care nurses.

that prioritizes a patient's need for care at his/her entry in the ED NVSHV (2005).
The triage occurs according to the Manchester Triage System (MTS)14. Patients are seen in order of medical urgency, not in order of arrival. Individuals with serious illnesses are then seen by a physician more rapidly than those with less severe symptoms or injuries. After initial assessment and treatment, patients are either admitted to the hospital, stabilized and transferred to another hospital for various reasons, or discharged. A complete picture of the CSO's work processes are given in the next section.

Time efficiency is of crucial importance at the ED. In order to reduce waiting times for transfer of equipment within or between departments, CSO has its own diagnostic equipments. There are two X-ray rooms, and other radiology facilities. The emergency facility characterizes itself by a multidisciplinary collaboration of workers and co-workers. The staff in CSO not only includes medical specialists, residents and specialized EC nurses with specialized training in emergency medicine, but there are also in-house emergency medical technicians, radiology technicians, co-assistants, and other supporting staff who work as a team to treat emergency patients and provide support to anxious family members. The receptionist is the one who makes the initial triage and decides the urgency level of the patient. This person does have knowledge of the variety of illnesses and injuries that patients can arrive with and is able to decide on an urgency code. There are also Nurse Practitioners working at the CSO. The difference between a specialized EC nurse and a Nurse Practitioner (NP) in the ECU is that an NP is a nurse with a master of Advanced Nursing that is authorized to assess and treat a special category of patients (minor traumatology) semi-autonomously. They operate either as an alternative to the patient being seen by a doctor, or in the absence of a doctor in a department where a continuous medical presence is not maintained (Read et al., 1992). Another group at the CSO consists of Co-assistants. These are medical students doing their training period in the unit. The flow of medical students that enter the CSO for a few months than leave to continue their studies is quite substantial. Furthermore, there is the medical specialist, who is an entitled doctor and the resident (AIO in Dutch). EDs in the Netherlands are confronting different social developments (NVSHV, 2005). There is shortage in GP care for which many patients decide to go directly to an ED for primary care. Furthermore, the amount of medical specialists in hospitals is decreasing, while the demand for care and amount of patients increase. Patients are also more demanding and government expectancies with respect to processes and patient information turns higher and higher. In order to cope with some of these changes, CSO decided to incorporate technological advances into their processes. Since April 2006, the CSO is using a patient registry and order management technology called E.care ED. With E.care ED all patient information is recorded in a database and all transactions occurring in the emergency facility can be monitored instantaneously on a wide screen in the emergency care room. It is expected that, by implementing the E.care ED system, both the interactive communication as the system communication between the two units and coordination of processes within the CSO will be improved. The system should provide business value for process planning and support and supplier relations mentioned in table 1 of Tallon et al. (2000). Here, the Radiology department functions as the supplier of X-rays. Further values that are expected to be realized with the use of the system relate to the products and services provided by the CSO, which can be enhanced and employee-patient relation that can be improved through patient satisfaction (customer relation). Up till now, the system has not been fully implemented.

Radiology

[14] The Manchester Triage System (MTS) has been developed in 1997 by ED nurses and doctors from Manchester. It's a flow-based system, where patients' claims are central instead of medical diagnosis.

The other department at the UMCG of interest for this study is the Radiology department. Radiology is the study of images of the human body15. It is the medical specialty directing medical imaging technologies to diagnose and sometimes treat diseases. As the other departments, radiology also forms part of the patient care function of UMCG. Annually, a total of more or less than 160.000 diagnostic researches are done and about 125.000 reports produced. The goals of the department are aligned with the overall goals and can be summarized as:
doing high quality diagnostic research and treatment using medical imaging technologies
contribute to the education of radiologists, RPAs and residents (and doctors) of other disciplines.
contribute to scientific research on the radiology field in cooperation with other disciplines
contribute to the faculty education on radiology field.
The Radiology department is divided into three teams. Each team is specialized in a certain area, to mention oncology diagnostic (cancer diagnostic) and pediatric radiology (of infants, children and adolescents), diagnostics of the thorax (chest), heart and veins and the diagnostic of variations in the head-neck area. The department disposes of several research rooms besides the ones on the department itself. There is one CT and two bucky-rooms, a mobile X-ray and echo device at the CSO. These are managed by RPAs of Team 1. The department makes use of a digital archive and own network. All patient X-rays are stored in this digital archive, which can be found on the internal system of Radiology called X/Care. Then, if necessary, the radiographs are edited, attached to the corresponding patient's information and finally stored in a digital archive in Poliplus where everyone with access can see them. Poliplus is the central system of the UMCG. Every subsystem used in the particular departments, should be integrated to this central system.

[15] http://rad.usuhs.mil/rad/home/whatis.html

3.2.3 The work processes and process dependencies

The work processes at the CSO are divided into five stages (see figure 8). According to CSO's documents, there are only four stages starting from Triage and finishing with Discharge. Since patients have to be admitted before they are triaged it was useful to add the admission stage to the figure as to get the full picture. This is the reason why the 'Admission' is colored red.
In the admission stage, patients are interacting with the receptionist who has to register patients' information in the E.care system (see Appendix 4, AAD 1). The use of E.care ED at CSO helps in coordinating the patients' route and workflows. Here, every patient gets a status bar which depends on theroute they have to follow. The use of colors in this status bar clearly depicts the status of the patient and where the patient is at that specific moment (see Appendix5). The color given to the status of the patient depends on the urgency of the complaint(s) (s)he comes with. The second stage is Triage. CSO uses the MTS as their standard model for patient triage. The model is developed to help specialized EC triage-nurses to be much faster in determining the clinical priority (urgency) of patients. In MTS, urgency is divided into five different categories, namely red for immediate attention, orange for high urgent, yellow for urgent, green for standard and blue for non-urgent. A specialized EC triage-nurse is in charged of checking if all the patient's information has been correctly inserted into the system, assessing the patient's condition and determining the urgency with which that patient has to be treated. Patient information and status are then updated in the E.care ED system (see Appendix 5) and the patient is then informed of the standard procedures of CSO and possible waiting time. Registration times, performances, performers, everything is being registered in E.care ED. By using the technology it is possible to state when a maximum amount of time for a specific process has been exceeded. An overview of the maximum amount of time for each process stage is also mentioned in Appendix 4. As the patient moves through the CSO work processes, the color of his/her status changes in the system.

Besides the five main processes at CSO, there are also supporting processes done by other departments and/or facilities such as Laboratory and Radiology. When additional test is needed to determine a patient's condition, requests are made to these supporting departments/facilities. When an X-ray is needed, patient's information and other information with respect to the needed X-ray, the patient and radiograph(s) and the requester himself are filled into a digital request form in E.care ED. The body part that has to be researched is selected by just clicking on the human body picture on the screen (see figure 9). When done, a print out is made of the request and is given to the receptionist. Then, an RPA takes the request at the receptionist, calls the corresponding patients and carries out the requested research(es). The radiology process is depicted in AAD 4 of Appendix 4. The AADs also show all the actors in the processes described and who is responsible for what process.

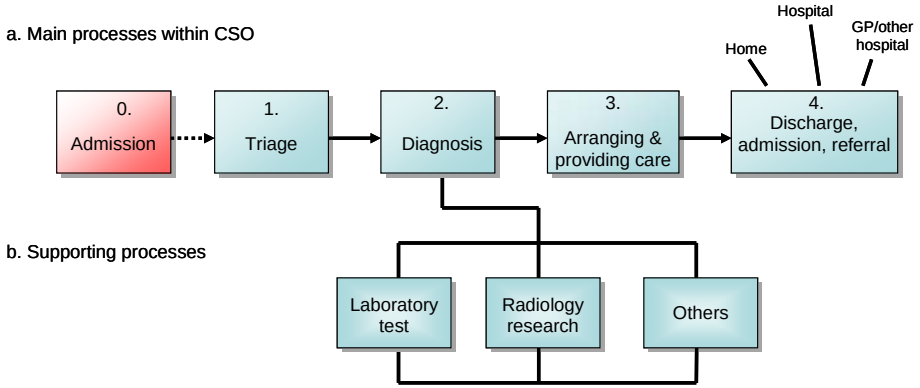

Figure 8. *The work processes at the CSO*

3.2.4 The arising issues between the two departments

Before the implementation of E.care ED, the request process for additional researches was done manually. Paper requests were being sent over and over between departments. Experience has shown that, because of the use of paper requests, many unintended errors occurred and, undesirably, information was changed or was lost during the process. For example, Radiology Practitioner Assistants (RPAs) received an application form without enough information about what occurred to the patient or what kind of research had to be done on the patient. Others also confused directions (left with right) when requesting radiographs. Furthermore, requests used to be misplaced or the handwriting of some requesters was barely legible. One of the reasons for the implementation of the E.care ED package was to eliminate these paper requests. Digitalizing the process would also make it easier and more accurate to make requests online. These would then be sent directly to the corresponding department(s) by linking the departmental systems to each other. Although the employees of the Radiology department were not included into the planning and implementation phases of the E.care ED project, they were hoping that this would help to more or less solve the existing problems, but this was not the case. During the implementation phase, the ICT clercks had been

confronted with some problems regarding linkages between the two systems used in these departments. They were not able to link these two systems to each other and therefore, up till now, requests from CSO have to be printed out and send manually to Radiology.

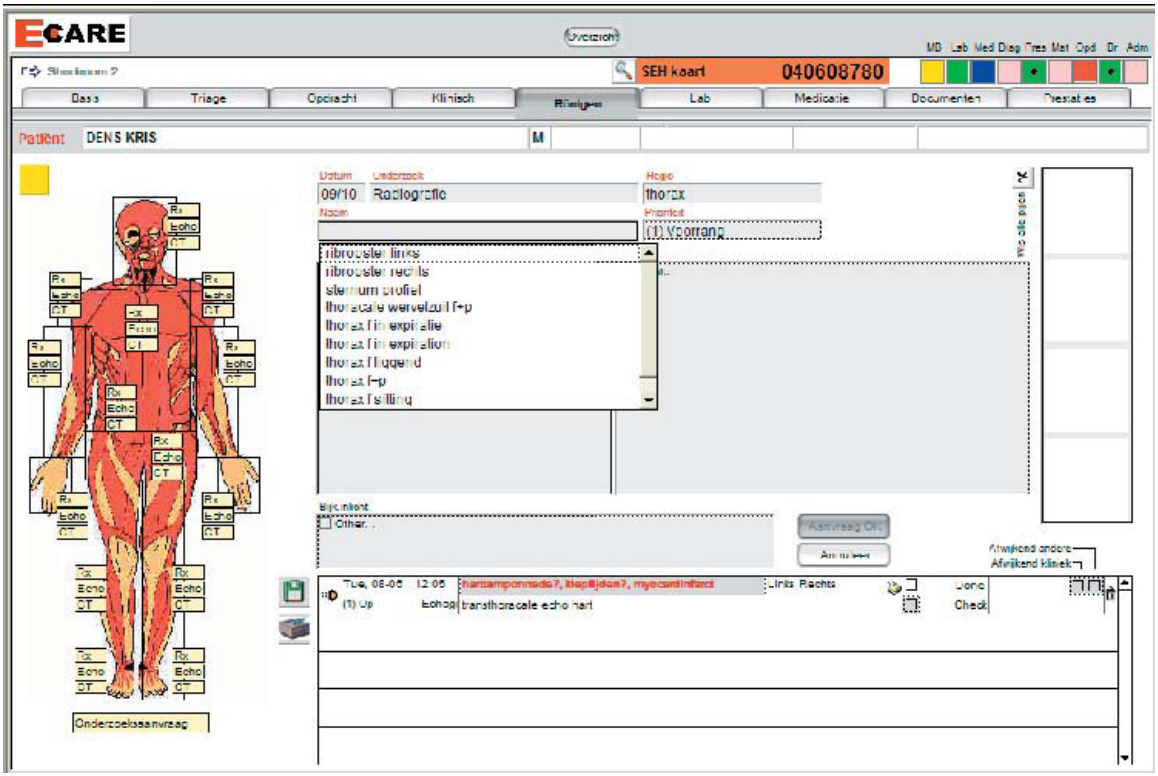

Figure 9. *Request screen for radiology research*

In 2005, Rukanova and Aydin[16] provided the project manager of the E.care ED implementation project with some points of attention to help the project team cope with some of the uncertainties that may lead to risks and problems related to the project execution and project outcome. They missed among others:

- explicit models of processes in the as-is and to-be situation,
- clarity about how the people and technology (E.care ED) will work in a coherent manner and ensure smoothly running processes and
-
-
-
-
- clarity about how the promised benefits of introducing the system are substantiated and what measures will be taken to ensure that the promised benefits before the implementation become actual benefits after the implementation.

At the start of this research, there were also discussions between the people of the CSO and those of the Radiology department with respect to who is allowed or not to make X-ray requests. In September 2005, a proposition has been made by an NP and some colleagues to allow also specialized EC nurses and NPs to make X-ray requests. This proposition was done after conducting a research to find out what the capabilities of the CSO specialized EC nurses are and giving them workshops about how to make X-ray requests and other important issues related to this topic. Although the staff of the Traumatology and the Radiology departments did not agree with this request at first, those who made the proposition, supported by the CSO staff, had been able to more or less talk them into a testing period. This testing period was verbally agreed. Last year on February 1st 2006, the specialized EC nurses at CSO started making X-ray requests of wrist, knee, ankle and other minor injuries. In the period that specialized EC nurses were making X-ray request, RPAs said they have noticed an increase in the amount of X-ray requests and also in the amount of errors found on request forms. They related this increase in errors to the fact that next to doctors, also specialized EC nurses were now making X-ray request. This led to a discussion between the two departments CSO and Radiology. Other complaints from RPAs and Radiologists are that despite the use of an electronic application form, some X-ray request forms are not completely filled or requesters do not report enough details about what has happened to patients. Sometimes patients have to come back to the department to take more photographs because those taken before were not the right ones or the ones that the specialist or resident wanted.

[16] This is an internal document titled Second opinion concerning "Presiteverslag met betrekking tot de implementatie van E.care op de afdeling CSO in het AZG te Groningen" provided by the project leader of the E.care ED project at the time this research was carried out.

3.3 Conclusion

Healthcare organizations and/or institutions in the Netherlands are aiming more then ever for process efficiency and effectiveness. Although many changes are introduced to achieve process improvements, the Dutch healthcare systems still show several barriers that hinder improvement of healthcare processes and efficient control. It has been suggested that the changes in healthcare demanded a more specific system of product-definition. The implementation of health information technologies can surely help to meet this system of product-definition. Healthcare institutions (for example hospitals) consist of different units/departments and each of them uses its own information system. Here, another problem arises, that of effective interaction between those systems. A standard had to be developed to solve this problem. Technologists have already started to work on the development and implementation of a standard called HL7 which is one of the better known and accepted standards nowadays. Its

popularity is funded in the fact that it is based on object-oriented modeling techniques to capture the critical data and semantics associated with a healthcare activity and uses key elements of UML. Despite of the developments of IT in healthcare, adoption of IT in healthcare is still slow. Reasons for the slow adoption relate to network externalities, switching costs, aging population and acute shortage of trained manpower, ever-increasing patient or client expectations, and difficulties to add older records to electronic medical records. For those healthcare institutions that have been able to implement or partially implement IT in their processes, it is important to be also able to measure the quality of the implemented system(s), as to ensure that they are (still) efficient and positively contribute to the company's outcomes.
To get to know how the implementation of IT solve problems people in healthcare encounter when doing their daily job, a case study has been conducted in the emergency facility and the radiology department of the UMCG. There are several issues between these two units that form barriers for achieving the desired efficiency in the process between the two departments. To find out more about the discrepancies between these two departments, a case study has been conducted and the details of this case study are given in chapter 4.

Chapter 4: Research Methodology

4.1 The Problem Statement

The first step in conducting the research was defining the problem statement or research question. The problem statement is a clear and concise statement (or question) that describes the symptoms of the problem to be addressed. This research was centered on a research question related to IT implementation in healthcare. The research question sounded as follow:

"How can information systems (IS) improve the processes between different facilities and/or departments to promote efficiency in healthcare organizations?"

The research question has been divided into several sub-questions which were defined as:

1. What roles does information technology play in organizations?
2. What organizational and human aspects should be taken into consideration when designing and implementing an information system?
3. What may be the difficulties hindering the adoption and diffusion of information systems within an organization?
4. What functions does information technology have in healthcare organizations?
5. What are the work dependencies between an emergency care unit and other departments and/or facilities and how are these affected by IT?
6. How can efficiency in healthcare organizations be measured?
7. What are the problems employees confront with regard to X-ray requests?
8. Did the implementation of the E.care ED system bring improvements?
9. How can the problems be solved?

These questions served as the foundation for conducting the case study and for answering the following management questions:

The answers to the above mentioned questions served as small steps in order to provide the final answers to the main question.

4.2 Research methods and design

A qualitative research approach has been chosen for conducting this research. Since the research would deal mainly with the human and organizational aspects, a qualitative research was the best methodology to provide an in-depth understanding of the human behavior and the reasons that govern this behavior. Furthermore, the research question was a 'how' question about a set of events over which the researcher had no control. According to Yin (2003), the best approach to this type of research questions is a case study approach and this was the reason for conducting the case study. The unit of analysis was the electronic order process of X-ray request from CSO to Radiology department. The methods used in this research were literature analysis and field research. More detailed information about these is given in subsequent sub-sections.

4.2.1 Literature review

Prior studies had been reviewed in order to show what has been written about 1) the role of IT in organizations, 2) the aspects that should be taken into consideration when designing and implementing IS, 3) the difficulties organizations may encounter which make system integration difficult, 4) roles of information systems in healthcare institutions and 5) the existing work dependencies between ECU and other departments and/or

facilities. The obtained information provides answers to the research sub-questions.
The theories and methods obtained from the literature review are put in practice in the field research. Analysis of the factors that affected decision-making with respect to the implementation of IT same as an analysis of the business values of the implemented IT is done. The AAD modeling tool presented Schaap (2001) has also been used in previous chapter as a first step in the case analysis. Besides these, the research tried to identify the barriers to the full implementation of E.care ED system and other barriers to effective communications between the two units. At the end, the identified barriers are compared to those already mentioned in the literature to see if there is any similarity.

4.2.2 The field research

The field research consists of several phases. First, there has been an observation period, which consisted of walking a few hours along with RPAs and a nurse practitioner from CSO to see how the processes in CSO and Radiology flow. This observation period was useful for gathering initial understanding of the situation, identifying stakeholders and for collecting enough materials to draw the AADs referred to in chapter 3. These AADs had been reviewed with one of the research sponsors, who is an employee of the CSO unit. Furthermore, informal conversations with the sponsors and some RPAs during the observations helped in gathering enough information for developing a questionnaire.

The questionnaire research was the second phase of the field research and aimed at revealing errors encountered after the implementation of the system. The questionnaire was based on a list of questions that were aimed for RPAs to fill in. The questions had been discussed with two RPAs and additional information necessary for developing the questionnaire was also obtained from these RPAs. Before releasing the questionnaires, research sponsors had reviewed it and provided their feedback. A brief presentation had also been held for each of the radiology teams during their periodical progress discussion meeting. Here, an initial abstract had been provided to the team members and the questionnaire had been presented and explained to them. Moreover, the purpose of the research was communicated followed by what would be expected from them during the research period. The purpose of the questionnaire was to collect data about:

- the amount of errors that were encountered on X-ray request forms during a specified period and to compare these to the total amount of X-rays that had been done in that period,
- who were responsible for these errors (a specialized EC nurse, Nurse Practitioner, co-assistant, medical specialist or resident),
- the use of the E.care ED system for making X-ray requests and
- what kind of errors were being made.

It was expected that RPAs, who were confronted with errors on request forms during their daily work, would fill one of these questionnaires (see Appendix 5 for a copy of the questionnaire) each time an error was found. The questionnaire research was conducted during a period of 4 weeks, starting from the 16th of April 2007 till the 15th of May 2007. All the questions on the questionnaires were written in Dutch for the ease of the respondents. The questionnaire contained general questions such as the name and job-function of the requester and date, and other more specific questions like the way the request was done (by hand or printed) (Q1)[17], the type of research requested (Q2), which part of the body had to be submitted to X-ray (Q3), what kind of errors were made on the form (Q4) and if the patient had to come back for additional research(es) (Q4b). There was also room for additional remarks (Q5). Analysis of the questionnaire responses was done with a statistical application, SPSS version 14.0. This analysis would, particularly, give an overview of the errors that occurred more frequently, who were the ones responsible

[17] "Q" stands for "question".

for these errors and more. The information is used to further analyze the situation between the two units and to help searching for possible solutions.
Additional statistical information and other relevant internal documents from processes within and between CSO and Radiology were also collected. The observation period and the answers to the questionnaires revealed basic answers to sub-question six mentioned in section 4.1.

Findings of the questionnaire were also used during the interviews in the third phase. The interviews were semi-structured interviews made with one or two members of the identified stakeholders' groups. Identified stakeholders were specialized EC nurses, co-assistants and Nurse Practitioners (including receptionists) (one group), medical specialists and residents as another group, RPAs and Radiologists (one group), managers of both CSO and Radiology and members of the ICT department that are or were related to the E.care ED project. Totally, there were five identified groups of stakeholders in this research. As said, the interviews were semi-structured meaning that a list of questions was made beforehand, but if other questions arose during the interview/conversation these had been also included, same as additional information the interviewee gave. Some of the interviewees were chosen based on their job titles and close relation to the researched situation. An e-mail was sent to a total amount of fourteen people of both CSO and Radiology with a brief description of the research and researcher and asking for their willingness to collaborate with an interview. Seven people consisting of one Regieverpleegkundige (who is also part of the management team at the CSO), a Nurse Practitioner, two Radiologists, an internal medical specialist who is also medical coordinator and the by then manager of CSO and the manager of Radiology, responded to the e-mail expressing their willingness to do the interview. There was also an interview with the leader of the E.care ED implementation project. Interviews were scheduled with these people to last about 45 minutes to a maximum of one hour. The questions of the interview related to:

a) communication and collaboration within and between employees of the two units.
b) The problem with errors that were encountered on X-ray request forms and the fact that specialized EC nurses, NPs and co-assistants were making X-ray requests.
c) The decision that, since 1st of April 2007, specialized EC nurses, NPs and co-assistants were not allowed anymore to make X-ray requests and its consequences.
d) The role and implementation of the E.care ED system.

The interviews were also done in Dutch since the interviewees were of Dutch origins and it was assumed that they would speak more easily in their native language. Appendix 6 contains the questions that were asked to the interviewees.

Chapter 5: The Results

5.1 Questionnaire research

5.1.1 Frequencies of total X-rays performed

As the CSO has different sub-units, many specialties receive their patients there. The Radiology department supplies all these sub-units with X-rays. During the period between 16th of April 2007 and 15th of May 2007, a total amount of 2179 X-rays has been made for all these sub-units. These statistics are summarized in table 2. From this table it can be observed that 92,79% (or 2022) of the requested X-rays belong to the SIAP, SLZP, SNEP, SORP, STCP and STRP specialties.
Of these 2179 researches, about 3,26% were related to patient numbers reported on questionnaires. These patient numbers are reported in Appendix 8. The frequency column in this appendix shows how many X-rays have been done per patient in the period of 16th April 2007 till 15th May 2007. Since each questionnaire has been attached to a patient number, the following results will refer to the different patient numbers and not to the amount of X-rays that have been made per patient.
40 questionnaires has been filled by RPAs, but from the registered data collected from the radiology system about X-rays made for the CSO units, only 39 of the indicated patient numbers could be found. Researcher assumes that the missing research for the specific patient number has not been carried out and therefore it has not been registered into the system. The amount of valid questionnaires or erroneous X-ray requests is therefore 39 and these have been used to obtain following results. Good attention has to be paid to following results as there are results based on types of errors and others based on erroneous X-ray requests!

5.1.2 Use of E.care ED for making X-ray requests

Answers to the first question of the questionnaire shows that E.care ED is well used. An answer to the question was missing for 16 of the 39 cases. However, for the other cases that had been answered, 82,61% were digitally filled (see Figure 10).
It is interesting to know which employee group(s) was/were still making handwritten X-ray requests during the research period. Table 3a shows that this question has been answered on only nineteen of the questionnaires, but this should not be a barrier to obtain the information. In table 3b it can be observed that two of the requests that were written by hand pertained to residents. Job title of the requester(s) of the other two requests written by hand is unknown.

5.1.3 Errors on X-ray requests

The 39 questionnaires that were filled by RPAs reported a total amount of 55 errors found on X-ray request forms done by CSO employees. The top 4 types of errors made were (see table 4):

1. Too little information was provided about what has occurred to the patient.
2. The requested X-ray did not belong to patient's lesion or disorder.
3. Wrong body part was indicated, for example left hand instead of right hand.
4. Declared reason was not enough for the amount of images requested.

The amount of erroneous X-ray requests that were made per visiting day is summarized in Figure 11. What can be observed from this figure is that most errors found were made in the first half of the research period, in April. Table 5 supports this finding by reporting a total of 26 errors made in the last half of April compared to 13

Table 2. *Total amount of X-rays made per month for each CSO sub-unit (SU)between April 16th 2007 and May 15th 2007.*

CSO Sub-units	SU* code	Month		Total
		April (2nd half)	May (1st half)	
CSO Chirurgie Abdominal Poli	SABP	30	36	66
CSO Chirurgie Algemeen Poli	SCAP	4	1	5
CSO Chirurgie Hepato-Biliair Poli	SHPP	2	3	5
CSO Interne Algemeen Poli	SIAP	110	131	241
CSO Chirurgie Kinderchirurgie Poli	SKCP	3	4	7
CSO KinderkliniekPoli	SKIP	10	5	15
CSO KNO-Heelkunde Poli	SKNP	2	0	2
CSO Longziekte Poli	SLZP	55	59	114
CSO Mondheelkunde Poli	SMOP	4	3	7
CSO Neuro-Chirurgie Poli	SNCP	3	5	8
CSO Neurologie Poli	SNEP	99	85	184
CSO Chirurgie Oncologie Poli	SONP	4	1	5
CSO Orthopedie Poli	SORP	85	94	179
CSO Chirurgie Plastisch Poli	SPLP	4	4	8
CSO Revalidatie Poli	SREP	1	0	1
CSO Thorax-Cardiologie Poli	STCP	63	60	123
CSO Chirurgie Traumatologie Poli	STRP	626	555	1181
CSO Chirurgie Urologie Poli	SURP	9	12	21
CSO Chirurgie Poli	SVAP	5	2	7
Total		1119	1060	2179

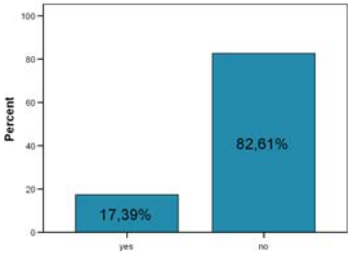

Figure 10. *Is the request form filled by hand?*

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Job title of the requester * Is the request written by hand?	23	59,0%	16	41,0%	39	100,0%

Table 3a. *Case processing summary.*

Table 3b. *Who filled X-ray request forms by hand?*

		Is the request written by hand?			Total
		missing	yes	no	
Job title of the requester	Unknown	3	2	2	7
	Medical Specialist	1	0	0	1
	Resident (AIO)	9	2	13	24
	Co-assistant	1	0	3	4
	Specialized EC Nurse	1	0	0	1
	Co-assistant i.d.w. AIO	1	0	1	2
Total		16	4	19	39

- i.d.w. stands for in deliberation with.
-

Table 4. *Types of errors found on X-ray requests.*

		Responses	
		N	Percent
What type of error have been made?(a)	Too little information about what has occurred to the patient	14	25,5%
	Requested X-ray does not match the lesion/disorder	12	21,8%
	Too many images requested for patient's age (thorax)	4	7,3%
	Declared reason is not enough for # of images requested	5	9,1%
	Wrong body part indicated	8	14,5%
	Unclear what the specialist/resident wants to see on image	1	1,8%
	Insufficient patient research; wrong research selected	4	7,3%
	Different request forms instead of one	2	3,6%
	Wrong research added in radiology system	2	3,6%
	Research requested by specialized EC nurse while there was no indication for urgency	1	1,8%
	Incomplete request form	2	3,6%
Total		55	100,0%

Table 5. *Errors made per month..*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2nd half of April	26	66,7	66,7	66,7
	1st half of May	13	33,3	33,3	100,0
Total		39	100,0	100,0	

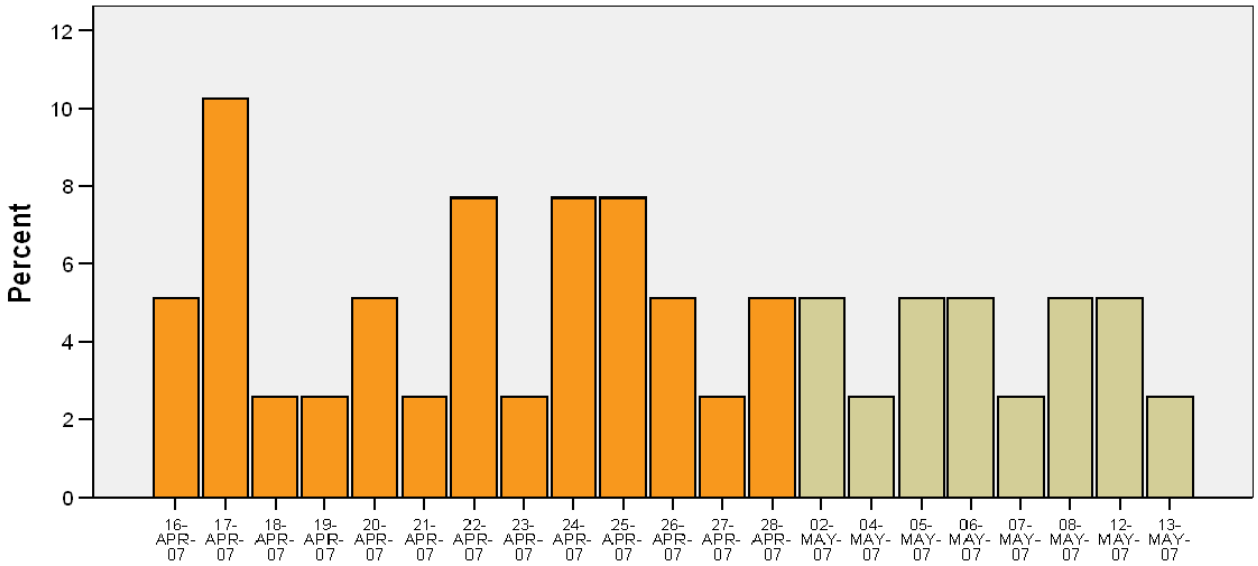

Figure 11. *Errors per day.*

errors found in the month of May. This yields 1,73318 errors per day in April and 0,86719 errors per day in May.
Table 6 shows which employee group made most errors in April and May. The results show that during the last half of April most errors were made by the residents and in the first half of May this was also the case.

From the questionnaire, result data have been obtained about errors made per CSO sub-unit. Errors were found on X-ray requests obtained from six of the nineteen sub-units. In Table 7, it can be observed that most of these errors belonged to X-ray requests made by employees of the SORP and the STRP

specialties. When analyzing more detailed information about the

job title of employees of the specialties, it can be seen that residents were responsible for most of the errors encountered (see table 8). There were also six co-assistants of these same sub-units that were responsible for errors found. Although there were seven requesters whose job titles were unknown, it is remarkably that during a one month period, only one specialized EC nurse could be identified that made an erroneous X-ray request.

For the analysis of patients' body parts that had to be submitted to X-rays, a multiple response analysis had been carried out. A multiple response analysis combines multiple variables that measure the same thing into a

18 From 16th of April till 30th of April: 26/15 days = 1,733

19 From 1st of May till 15th of May: 13/15 days = 0,867

Table 6. Errors per job title per month.

		Month		
		April (2nd half)	May (1st half)	Total
Job title of the requester	Unknown	3	4	7
	Medical Specialist	1	0	1
	Resident (AIO)	16	8	24
	Co-assistant	3	1	4
	Specialized EC Nurse	1	0	1
	Co-assistant i.d.w. AIO	2	0	2
Total		26	13	39

Table 7. Errors per CSO Specialty.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SIAP	3	7,7	7,7	7,7
	SLZP	1	2,6	2,6	10,3
	SORP	9	23,1	23,1	33,3
	STCP	1	2,6	2,6	35,9
	STRP	25	64,1	64,1	100,0
Total		39	100,0	100,0	

Table 8. CSO sub-units and job title of requesters.

		Job title of the requester						Total
		Unknown	Medical Specialist	Resident (AIO)	Co-assistant	Specialized EC Nurse	Co-assistant i.d.w. AIO	
Sub-unit	SIAP	1	1	0	0	1	0	3
	SLZP	0	0	1	0	0	0	1
	SORP	1	0	6	2	0	0	9
	STCP	0	0	1	0	0	0	1
	STRP	5	0	16	2	0	2	25
Total		7	1	24	4	1	2	39

single table20. Multiple-response items are questions that can have more than one value for each case. For questions 3 and 4 of the questionnaire, respondents had the opportunity to write and circle, respectively, more than one

answer. This, in fact, provided answers that required a multiple response analysis.
When entering the data in SPSS, a maximum number of possible answers from respondents have been estimated and variables have been created for the same number. Cases, for which the maximum number of answers has not been reached, were left blank. Then the different variables created for the specific questions were combined into groups to finally carry out the analyses. In the case of the questionnaire, a maximum number of five possible answers were created for the variable 'body part(s) that had to be researched', question 3. Then a multiple response set of variables has been defined with the answers provided by respondents. The human body has been divided into 16 general parts and respondents' answers have been classified into these 16 categories. The 16 categories of human body parts were: head, cheek, thorax, abdomen, arm(s), wrist(s), hand(s), hip, leg(s), knee(s), ankle(s), foot/feet, cervical vertebra, thoracic vertebra, lumbar vertebra and pelvic vertebra (see Appendix 9). For the variable 'what type of error has been made' a multiple response set has also been defined with the same categories as the ones mentioned in table 4. The results are shown in Appendix 10. The cases where the error 'wrong body part indicated' occurred was when the body parts arm, wrist, hand, knee, ankle and foot had to be researched. In the following table, table 9, the multiple response variable 'Type of error found' has been cross-tabulated with the 'job title of requester' variable. Results show that during the research period, co-assistants and residents, particularly, made X-ray requests:

- providing too little information about what has occurred to the patient;
- that did not match the patient's lesion or disorder;
- requesting too many images for the age of the patient;
- for which the declared reason was not enough for the amount of images requested;
- where the indicated body part to be researched was wrong;
- where a wrong research was selected.

Table 9. *Type of errors per job title.*

	Job title of the requester					Total
Type of error found	Medical Specialist	Resident (AIO)	Co-assistant	Specialized EC nurse	Co-assistant i.d.w. AIO	
Too little information about what has occurred to the patient	0	10	1	0	0	11
Requested X-ray does not match the lesion/disorder	1	8	2	0	1	12
Too many images requested for patient's age (thorax)	0	2	0	0	2	4
Declared reason is not enough for # of images requested	0	2	1	0	0	3
Wrong body part indicated	0	4	1	0	0	5
Unclear what the specialist/resident wants to see on image	0	1	0	0	0	1
Insufficient patient research; wrong research selected	0	2	1	0	0	3
Different request forms instead of one	0	0	2	0	0	2
Wrong research added in radiology system	0	2	0	0	0	2
Research requested by specialized EC nurse while there was no indication for urgency	0	0	0	1	0	1
Incomplete request form	0	1	0	0	0	1
Total	1	32	8	1	3	45

Percentages and totals are based on responses.

5.2 Results from interviews

5.2.1 Role of IT in the organization

According to the leader of the E.care ED project, IT is very important for UMCG and much of the processes in the organization rely on the support of IT for effectiveness and efficiency. Currently there are 20 to 25 projects taken place on a yearly basis that has to do with IT improvements and/or implementation. These are both small and big projects. UMCG invests about 2 million euros annually in IT. He said that the E.care ED project could be classified as a medium-sized project for which the projected budget was more or less € 200.000.

5.2.2 System development, implementation and quality measurement

The reason for implementing E.care ED was the need of more control on the processes by obtaining a complete, better picture of the unit and more control on patients' routing information; this according to the project leader, an NP and management of CSO. Management and employees wanted to have more insight into patients' progress and time at the CSO. It was expected that implementing the system would help improve communication of information and task division by, for example, showing who is in charge of what and when. Medical specialists and residents were against the implementation of the system, in the first place, because by implementing it, they would have to enter data into the system when making (X-ray) requests and this would cost them too much time and effort. The ICT director was also against the execution of the implementation project. His argument was that there were too many conflicting issues involved in the implementation of the system. On the other hand, CSO management staff and specialized EC nurses were most happy with the idea since digitalizing work processes would yield a better administration of processes and patients' information. Even the project leader saw the logic of implementing this system and did want to start moving towards implementation of the project. He said that the expected business impact of investing in E.care ED was the creation of fulltime-equivalent (fte) employment as a consequence of process and efficiency improvement. However, it took four years, since the first conversation, before they could really start with the system's implementation process, this as a consequence of political reasoning within the organization itself.

Before the implementation of E.care ED, a risk analysis has been conducted. The only risks he mentioned was that by digitalizing all processes at the CSO, people cannot go back to the old way of working with paper. This would eliminate one way of archiving things (hardcopy files).

Formal project initiation date became October 2004.

When analyzing the situation and planning for the system implementation, the project team relied on storyboards obtained from employees of the CSO. Then, in the planning and design phase, the architecture of E.care ED did not match that of the UMCG, which is why the system had to be customized before implementation. Then, in 2005, the project team had been able to make the first moves into implementation of the system. Stakeholders of the CSO department were fully involved in the implementation process. However, the stakeholders of the Radiology department have not been involved into the developing and implementation phases.

Finally, in April 2006, the system was in place and people could start using it. In the initial phase, key users have been selected and these have been trained properly for system use. The key users were then in charge of training the rest of the crew. Residents receive this training in their basic training package together with the Poliplus course before they start working for the CSO.

Up till now, optimal use of all the features cannot be obtained. As mentioned earlier, there is a link missing between the E.care ED system and that of the radiology department which was supposed to digitalize the entire X-

ray request process. ICT people still cannot find the origin of the problem. This is one reason why the implementation of the E.care ED system could not be fully executed. Another reason mentioned by the project leader was that the system's perceived added value for the other departments of the UMCG was too small. Besides that, the organizational aspect of E.care ED has got too little attention and the breadth and the impact of the system on the rest of the organization have been underestimated. There is also a missing link between E.care ED and Poliplus. Management argues that the emergency care and the pre-clinical care (ambulance) should be better integrated. An ambulance file should be added to the system for pre-hospital registration of patients that are transported by ambulance. This would facilitate the intake of trauma patients when these arrive at the CSO unit. Another issue with the E.care ED system that is related to user interface is that there is no space assigned on the X-ray request form in the system for placing the barcode sticker containing patient's information. The consequence is that the sticker is placed randomly on the form and when RPAs proceed to scanning the sticker they encounter problems for scanning it. The project team has evaluated other solutions/other systems, but none of these offered the same procedures as did E.care ED.

Despite of all the critics with respect to E.care ED implementation, positive results have been obtained from it, says the NP. The project leader argues that E.care ED contains more or less all the functionalities needed for adequate X-ray request. The NP supports this statement and explains further that employees [of the CSO] can easily see which patients have visited the unit and when, what treatment(s) they have got, etcetera She concluded saying that the system meets the needs of CSO employees.
The project leader is of the opinion that E.care ED should be used exclusively at the CSO and medical specialists and residents should use Poliplus. According to him, the order management system should be the order placer, radiology (X/care) the order filler and E.care ED the order tracker. He said that if X/care is used as the order management system, it would have the same power with respect to total time for process execution as does E.care ED. The CSO manager also supported the opinion of the project leader when asked for his short term view of what will happen to E.care ED. He predicted that specialists and residents will be using Poliplus and specialized EC nurses and NPs will keep using E.care ED in the future. On the long run, E.care ED's functionalities would be added to Poliplus and the E.care ED system would disappear, he said.

5.2.3 Communication and collaboration between and within the units

Both management and employees of CSO agreed that their interactive communication is not the way it is supposed to be. NP illustrated this by giving an example of a decision that have been take recently by the management team and employees of the CSO were the last ones to be communicated about this decision. The manager explained that the reason why the interaction between manager and employees has deteriorated is because he had to manage both political and organizational matters alone. This was taken too much time and effort from him and there were not enough time left for him to interact as should have been with the CSO people. At the time the interview was made changes were being made in the management team. It was expected that these changes would generate better communication and closer interaction between management and CSO employees.
Interaction between management and radiology employees, on the other hand seemed quite well. Once a month, meetings are scheduled for radiology teams and management to sum up and discuss further course of action. However, all interviewees agreed that the interaction between employees of the CSO unit and the Radiology department is not well. CSO's manager explains that both the CSO team and the Radiology team have grown and this might have influenced the communication between the two teams. Change of workforce at the CSO is very frequent. New employees come into the units for a small period of time, especially co-assistants and residents of other departments who work shifts at the CSO. There

are just a few employees that work permanently for the CSO. Furthermore, management thinks it is, perhaps, not clear what both teams expect or demand from each other and that the teams do not know the details of each other's work.

5.2.4 Previous research done by radiology and CSO

In the first instance, Traumatology and Radiology people were against the proposal that has been presented to grant specialized EC nurses the authority to, next to medical specialists and residents, request X-rays. The objectives of this proposal were a more efficient logistic flow of patients at the CSO, optimum quality and safety for both employee and patient. According to the interviewed NP, they were of the opinion that only medicals specialists and residents should make X-ray requests. CSO management argues that Traumatology and Radiology people were afraid that by given the specialized EC nurses this authority, the amount of requested X-rays would increase. One of the interviewed radiologists indicated that the amount of requested X-ray indeed has increased from the moment specialized EC nurses started to make X-ray requests. He based his statement on a research that has been conducted by RPAs. RPAs concluded from their research that the amount of errors has increased and that the errors that were made related to:

- identical requests made for the same patient, by different requesters,
- left and right were often being confused,
- Inadequate justification for the request, for example requester mentions only 'trauma', while the lesion should be elaborated in more details,
- Name of the requester is not mentioned on the request and
- Combination of X-ray request and motivation is not clear, too many researches requested, request is not adequately pointed around the specific lesion.

Research, conducted by an NP of the CSO21 , showed that it were not the specialized EC nurses that made these errors. Contrary to what was being stated; specialized EC nurses were making good requests and in some case even better than medical specialists and residents themselves. The research also showed that the fact that specialized EC nurses were making requests had a positive influence on patients' waiting times, amount of time for treatment and waiting times for X-ray results at the CSO. All these variables showed a slight decrease22. Management of the CSO, however, does not rely for a 100% on these results because, according to the manager, the researched population was small (about 200 patients per measurement) and factors such as increase in patient groups and changes in capacity, space and workforce have not been taken into account when conducting the research. These factors represent bottlenecks that people at the CSO have to deal with. According to the staff of the CSO management team, the amount of errors encountered can be related to the knowledge and capabilities of requesters. There is a research going on in the CSO which is a follow up the earlier one, to see the effects of the changes that had taken place in the last few months.

5.2.5 Triage and X-ray request by non-residents

There are differences of opinion about agreements made between the two units, especially those related to X-ray requests. Both interviewed radiologists were of the opinion that specialized EC nurses, NPs and co-assistants do not have the right to make X-ray requests. According to them, only medical specialists and residents are responsible and do have the right and capability for requesting X-rays. One of them expressed that *"responsibilities cannot be delegated to someone else; only skills"*. In this case, NPs can have the necessary skills for requesting X-ray, but the medical specialist and/or resident is the one that have to bear the 'final responsibility' for the requested researches. If a radiologist accepts and carries out an X-ray requested by a non-resident, he is the one and only responsible for the justification of the use of ionizing radiation. These statements are based on the notion of the Radiological Society of the Netherlands of 1999 (NVvR)23. This and the amount of errors that were being found on X-ray requests

has lead them to take the decision to stop accepting all X-ray requests that were independently being made by non-residents (in this case Co-assistants, Specialized EC nurses and/or NPs) of the CSO. Although the CSO management and the NP thought that the decision was taken too abruptly, radiologists claim that they had been discussing this decision months before the decision was finally made. Interviewed radiologists also claimed that, nowadays, doctors have to carry out too much tasks at the same time. A given example was the case of digital X-ray requests in E.care ED. Too many data have to be filled into the system, especially in the process of requesting X-ray. They argue that too much time is spent in working with the system to fill in all these data; time that could be spent on patient's examination. One of the radiologists expressed that technology not always solves problems, but, sometimes, it might create more problems. *"If digitalizing the X-ray request process is the case, then the doctor would need an administrative assistant to handle the digital documents while he is examining the patient"*. Furthermore, they claimed that triage should be carried out by the person who is assigned by the law as the responsible one, the medical specialist or the resident. *"Patients should be immediately triaged by a doctor or resident"*. Reacting on what has been said before, CSO management stated that triage is carried about by specialized EC nurses all around the country and that concrete agreements should be made locally (within the organization) with all the parties involved. Furthermore, the manager explained that due to the increase in the amount of patients, there is a shortage in available treatment rooms and the amount of available medical specialists and residents on the work floor is also too small.

The following table summarizes the most important issues that emerged from the conducted interviews.

Table 10. *Summary of important issues emerging from the interviews*

E.care ED system
E.care ED was implemented to have more control on the processes. It was expected that the system would help improve communication of information and task division. *(E.care project leader, NP and CSO management)*
By digitalizing all the processes at CSO, there is the risk of eliminating one way of archiving information. *(E.care project leader)*
From analyzing the situation and planning for the system implementation, the project team relied only on storyboards obtained from employees of the CSO unit. *(E.care project leader)*
Stakeholders of the CSO department were involved in the implementation process, but those of the Radiology department were not involved. *(E.care project leader)*
When the system was implemented, key users were selected and trained and these were in charge of training the rest of the crew. Residents that are new at the UMCG receive the training in their basic training package. *(E.care project leader)*
The system's perceived added value for the other departments of the UMCG was too small. *(E.care project leader)*
The organizational aspect of E.care ED has got too little attention and the breadth and the impact of the system on the rest of the organization have been underestimated. *(E.care project leader)*
There is also a missing link between E.care ED and Poliplus. *(E.care project leader)*
The emergency care and the pre-clinical care (ambulance) should be better integrated. *(Radiology management)*
There is no space assigned on the X-ray request form in the system for placing the barcode sticker containing

patient's information. *(Radiologist)*
E.care ED contains more or less all the functionalities needed for adequate X-ray request and meets the needs of CSO employees. *(E.care project leader)*
Employees of the CSO can easily see which patients have visited the unit and when and what treatment(s) they have got. *(NP)*
If X/care is used as the order management system, it would have the same power with respect to total time for process execution as does E.care ED. *(E.care project leader)*
In the future, medical specialists and residents will be using Poliplus and specialized EC nurses and NPs will keep using E.care ED. *(CSO management)*
E.care ED's functionalities would be added to Poliplus and the E.care ED system would disappear. *(CSO management)*
Communication within and between the units
Interaction between CSO management and CSO employees has to be improved. *(CSO management and NP)*
Interaction between CSO employees and Radiology employees is not well. *(CSO management, NP, radiologists, RPAs)*
Both the CSO team and the Radiology team have grown and this might have influenced interactive communication between the two teams. *(CSO management)*
Change of workforce at the CSO is very frequent. *(CSO management)*
It is, perhaps, not clear what both teams expect or demand from each other and they do not know the details of each other's work. *(CSO management)*
Errors on X-ray requests
The amount of requested X-ray has increased from the moment specialized EC nurses started to make X-ray requests. *(Radiologist)*
Research, conducted showed that most errors were made by medical specialists and/or residents and that specialized EC nurses were making good requests. *(NP)*
Research also showed that the fact that specialized EC nurses were making requests had a positive influence on patients' waiting times, amount of time for treatment and waiting times for X-ray results at the CSO. *(NP)*
Triage and X-ray request
Co-assistants, specialized EC nurses and NPs do not have the right to make X-ray requests. Only medical specialists and residents are responsible and do have the right and capability for requesting X-rays. *(Radiologists)*
Nowadays, doctors have to carry out too much tasks at the same time. *(Radiologists)*
Too much time is spent in working with the system to fill in all the data necessary; time that could be spent on patient's examination. *(Radiologists)*
The doctor would need an administrative assistant to handle the digital documents while he is examining the patient. *(Radiologists)*
Triage should be carried out by the person who is assigned by the law as the responsible one, the medical specialist or the resident. *(Radiologists)*

Triage is carried about by specialized EC nurses all around the country. *(CSO management)*
There is a shortage in available treatment rooms. *(CSO management)*
The amount of available specialists and residents on the work floor is too small. *(CSO management)*

5.3 Results discussion

IT implementation

It was expected that at UMCG great investments were made in ICT related projects, as it is a modern and one of the biggest medical centers of the Netherlands. In chapter 2 it was mentioned that organizations invest 40 to 50% of annual capitals in ICT. This is also the case at the UMCG. The annual financial report of 2005 shows that 58,56% of the financed capital bound has been invested in ICT during that year.

An example of implementing an order management technology to support existing processes has been analyzed; this was the implementation of the E.care ED system. E.care ED was supposed to have both a facilitating and enabling role, since it would facilitate the coordination of patient flow and enable direct digital transfer of, among others, X-ray requests. In using the conceptual model of Tallon et al. (figure 1, chapter 2) for deriving the impact of this system on CSO and Radiology, it can be said that the strategic reasoning behind the system implementation was too narrow, focusing too much on the CSO and leaving out of focus the interests and requirements of the members of the radiology department (unfocused goal). The strategic intend for implementing the system was to have more control on processes taken place at the CSO. However, the system was supposed to interact with X/care (focused goal) and therefore it had to be integrated with it. Nevertheless, the implementation of E.care ED failed to realize the enabling link with the X/care system of the Radiology department. Furthermore, CSO management practices during the implementation period needed some improvements, especially with respect to interactive communication with CSO employees. The realized IT value can be estimated based on the IT business value dimensions of Tallon et al. in table 1 and the results from the questionnaire and interviews. It can be said that the implementation of the E.care ED system failed in improving the interaction between employees of the two departments and in digitally connecting the two departments. Reasons for these failures are:

- Too little attention was placed on the organizational and technical aspect of the system.
- System implementation complexity was underestimation.
- Technology-related barrier; inability to integrate the E.care ED and the X/Care system.
- A thorough risk analysis has not been done in the initial phase.
- Silo thinking.

In chapters 2 and 3, thorough discussion has been carried out about all the important aspects of system implementation. All these aspects have been incorporated in one single framework showed in figure 7. However, when the theory is compared with how the E.care ED system has been implemented, what can be said is that the project missed some important elements. First of all, one of the elements that according to Boonstra and Lucas need to get special attention is involvement of all stakeholders. Boonstra states that it is important to understand and to take all relevant stakeholders into account. In this case, not all the relevant stakeholders have been involved in the E.care ED project. If the system was being implemented for, among others, digitalizing and coordinating the X-ray request process, then the people of the Radiology department had an important role in the project since they are the ones that should make the X-rays requested from the CSO. Their involvement would have revealed

important requirements for the system to be implemented. Furthermore, as Dennis et al. suggests, a good system development or implementation project has to follow a certain structured procedure to be successful. In the analysis phase, no diagrams have been used for obtaining overviews of the as-is and to-be situation. The project team relied only on storyboards obtained from employees of the CSO. The use of diagrams would have provided better insight and answers to questions such as who would use the system, what the system would do and when and where it would be used. The AADs that were created during this research (Appendix 4) give a through insight in all the processes that take place from the moment the patient arrive at the CSO till the moment the patient is ready to leave or to be admitted to the hospital. These AADs provide an overview of the relevant actors in the process and of what is done in each of the process phases. This would have been the first step in developing the system if the project team had followed a structured development project. Then, in defining the interaction between the two systems for implementation, deployment, package, component and/or state machine diagrams could have been drawn to depict the architecture of the system and the way they would be connected to each other.
The project leader mentioned that a risk analysis was conducted before the implementation of the system. The only risk they found was that paper archives would be eliminated and after this people could not go back to this way of archiving patient information. However, this risk analysis failed to reveal the current problem with network effects which is caused by problems related to linking the E.care ED system to the X/Care. The project team has focused too much on the E.care ED system and its features and underestimated the complexity of implementing the system.

From the interview results it could be observed that the different actors have different perceptions about the implemented system's performance. For example, the NP mentioned some positive results that were obtained from using the system and expressed their satisfaction with the performance of the system. She claimed that there are improvements in process coordination within the CSO since the system has been implemented. This means that the perceived usefulness of the implemented system, as Boonstra call it, is quite high for the users of the system. On the other hand, radiologists perceive that the ease-of-use of the E.care ED system is a little complicated for medical specialists and residents. One of them explained that it might take them too much time to use the system for requesting X-rays and this could be a reason for the amount of errors found. Boonstra and de Vries identified four groups of barriers to successful implementation of systems and emphasize that the interest and power of relevant parties can be the most influencing barriers. However, the problems with completing the system implementation project in this case study are directly related to technical problem. In this case the users are interested to use the system as could be observed from the findings in figure 10. What can be said is that the technology-related issues are as important as the interest and power of the relevant stakeholders.

Lack of communication

As said, another reason for the arising problems between the two units is 'silo thinking' and the lack of communication within and between the units. Management failed in stimulating a good interaction between the two units. Employees and management of both units agree that the interaction between the units is not that well. One reason mentioned by the CSO management was that both the CSO and the Radiology teams have grown and this could have influenced the communication between the teams. Besides this, there are different workers at the CSO with different authority levels. As Galbraith says, the greater the degree of subtask specialization, the greater is the problem of subtask integration into effective performance of the entire task. Here, it is not clear for everyone who is allowed to do what.

Patients are viewed by different people in different stages of the process. As said the process is a bit complex. Furthermore, workforce at the CSO changes very frequent; new co-assistants, residents and specialists come and go. The consequence of this frequent change in workforce is that there would not be enough time for them to get to know each other and build a relationship based on trust and integration.
In the E.care ED's planning and analysis phase, there was also no interaction between the CSO unit and the Radiology department to find out which system requirements are essential for requesting good X-rays and find the best solution. Management and employees of the CSO has focused too much on improving their own processes without considering if these changes would also fit the processes of the supporting department (silo thinking).

Errors on X-ray requests

Radiology people complain about errors being found and wrong X-rays being requested. The questionnaire research revealed that only 3,26% of the X-ray requests made in the observation period related to requests containing errors. This yields on average 1,733 errors per day in the second half of April 2007 and 0,867 errors per day in the first half of May 2007, which are quite acceptable compared to the way RPAs and Radiologists talk about amount of errors found. Furthermore, the amount of errors found in the first period has decrease by 50% in the second period. Different reason can be formulated for this decrease in amount of errors found. One reason could be based on the results in table 6, which show that the amount of errors made by co-assistants and specialized EC nurses has decreased in the May period. It can be assumed that the message that RPAs and radiologists have stopped accepting X-ray requests made individually by others than medical specialists and residents have reached most of the CSO employees. Another assumption could be that in the May period the total amount of X-rays requested for patients visiting the CSO was less than in the observed period of April24. This could have as a consequence that the amount of errors would also be less.
The errors that most frequently were found resembled those obtained in the research of RPAs of the Radiology department. Previous researches have shown that most specialized EC nurses were requesting better X-rays than medical specialists and residents. Despite of this, no action plan has been developed for handling the errors made by medicals specialists and/or residents. Results obtained from the current questionnaire research show that 66,67% of the requested X-rays containing errors have been requested by or under the responsibility of residents. Only 12,82% of these requests have been requested by non-residents (co-assistants and specialized EC nurses). Results from this questionnaire also show that, though the decision had been made to stop accepting X-ray requests made individually by non-residents, the same errors are still found on X-ray requests25 and most of these errors pertain to residents of the STRP specialty of the CSO (table 8).
In analyzing the Dutch healthcare sector, Cramp and Carson confronted challenges such as acute shortage of trained manpower and ever-increasing patient expectations. As expected, CSO is confronted with these same challenges. There is a shortage of specialists and residents working at the CSO and the amount of patients entering the unit keep increasing. The questionnaire results revealed that the type of error (table 9) that most frequently occurred was that residents provided too little information about what has happened to the patient. Radiologists argued that specialists and residents have too much tasks to carry out nowadays. Since they are expected to request X-rays themselves, they have not that much time to fill detailed data into the system. Furthermore the system is quite new at the CSO. Medical specialists and residents working at the CSO are from many other units or departments and might not be that familiar with the system. These issues can be used to explain the errors found. Another error that was frequently made was that the requested X-ray did not match the patient's lesion or disorder. This can be related to protocols of the radiology

department for X-rays and knowledge of these protocols by CSO employees. Here, the frequent change of workforce plays again an important role. Besides this, in Appendix 10, it can be observed that the reported error 'wrong body part indicated' has a clear relationship with those parts that appear twice on a human, to mention arms, wrists, hands, knee, ankle and foot. Since there is a shortage in residents and/or specialists on the work floor, the work burden on these residents and/or specialists in busy hours could be heavy. Then, it could happen that these residents or specialists request wrong X-rays or send incomplete X-ray requests to the Radiology department. Furthermore, some employees at the CSO confuse the left and right side of the human body on the X-ray request screen in E.care ED and therefore request X-ray for a left hand, foot, etcetera, instead of right.

Quality and efficiency

Quality of X-ray requests has not been improved by the implementation of the E.care ED system. From the research conducted it could be observed that the implemented system had little influence on the errors that are found on X-ray requests. The system partially digitalizes and coordinates the X-ray request process, but the quality of these X-rays depends on the users' attitudes and use of the system, which are two of the components of the conceptual framework showed in figure 7.

It is not clear whether E.care ED has enhanced efficiency of services provided to patients at the CSO. What is clear is that the system has improved coordination of processes at the CSO. As the NP said, CSO employees can easily see which patients have visited the unit, when the patient was there and what treatment they have got. Furthermore, the system provides information of which specialized EC nurse is coupled to which patient and provides also thorough information on the CSO stage in which the patient is at a specific moment. E.care ED makes it also easier to make and retrieve patient and management reports. The use of the system seems to have great value for management and employees of the CSO department. However, up till now, E.care ED has no added value for radiologists and RPAs.

Triage by non-residents

There are discussions within the CSO and the Radiology department about who has the right to triage patients or not. Radiologists complain about the fact that patients are being triaged by specialized EC nurses and argue that only medical specialists and residents have the right to do this. But, according to the Netherlands Institute for Emergency Care Nurses (NVSHV), triage is carried out by specialized EC nurses all around the country. The Wet BIG 26, which contains rules for care provided by health professionals and aim for quality promotion of provided care and the protection of the patient, states that in the process of triage, indisputably, a first - overall - appraisal of the medical condition of the patient takes place to be able to determine the urgency of the treatment. Here, specialized EC nurses engage themselves, in principle, in the expertise field of the doctor. Wet BIG further states that triage cannot be allocated to the expertise field of the specialized EC nurse. However, triage by specialized EC nurses is tolerated because practice demands this, but it is not supported by the law. NVSHV explains that what is and remains underexposed is the fact that at triage, a specialized EC nurse performs this appraisal using nurse methodologies and skills, and therefore remains outside the field of the doctor. According to the NVSHV definition of triage, specialized EC nurses do not assess the medical condition, but the care need of the patient. Furthermore, the institute claims that, for a few years already, specialized EC nurses are being educated and trainings are provided to them on the basis of nurse-based diagnostic methods. These methods are developed according to the taxonomy of the North American Nursing Diagnoses Association (NANDA) which makes it possible for them to identify and signal life-threatening problems based on a pure nurse-based methodology. NVSHV has developed some guidelines for the triage process at the emergency. These guidelines are not legal regulations, but on evidence based notions and

recommendations with which care providers should comply as to deliver good quality based care. Following the processes at CSO in Appendix 4, there is a diagnosing process occurring when the patient is taken to a treatment room in the CSO. In this diagnosing process assessment of the medical condition of the patient is taking place by a co-assistant and if necessary a medical specialist or resident is called. However, according to the Wet BIG, this process falls in the expertise field of a resident or medical specialist and therefore a resident or medical specialist has to be always present at the diagnosing process.

Besides the specialized EC nurse, there is also the NP which fulfills also an important role in among others the emergency department. A research conducted by Chang et al. (1999) shows that there is no significant difference in the quality of care or level of client satisfaction provided by the medical officers and the NPs. An NP performs both nursing and medical tasks. The NP performs tasks that belong to the nursing expertise field autonomously, while those that belong to the expertise of the doctor are performed under supervision of a medical specialist. According to the Wet BIG, the NP is allowed to do the so-called *voorbehouden handelingen* (reserved procedures) which only physicians, residents or specialists (including radiologists) are allowed to perform. Chang et al. define the duties of NPs as:

- taking patient histories,
- performing physical examinations,
- minor wound closure – simple suturing,
- ordering basic laboratory studies, cultures and X-rays and
- generating treatment plans and discharge education.

As is also mentioned, in the USA and the UK, NPs' role often involves triage activities and responsibilities. The authors conclude from their literature review that appropriately prepared emergency NPs can assist in the management of non-urgent cases. A benefit that could be obtained from this is decrease in total waiting times for treatment.

X-ray request by specialized EC nurses, co-assistants and NPs

If additional patient research is needed after the retriage phase, than, radiologists state that it is the resident or medical specialist who has to request this additional research. Before 1st of April 2007, also specialized EC nurses, co-assistants and NPs were requesting X-rays, either at the triage or retriage process without supervision of a resident or medical specialist. Radiologists' decision to stop accepting X-rays requested by these non-residents is supported by the notion of the NVvR of 1999. This notion declares that it is not desired that the NVvR, the civil partnerships/cooperation bonds radiology and the individual radiologists actively promote that radiological operations are performed at the request of the patient himself or of a non-resident as practitioner of the individual healthcare. The Wet BIG, on the other hand, mentions some reserved proceedings. One of these reserved proceedings is the use of radio-active stuffs and ionizing radiation. Nowhere is being mentioned that requesting X-ray is also part of these reserved proceedings. Therefore, X-ray requests can be done by specialized EC nurses and co-assistants. However, since specialized EC nurses and co-assistants do not have the knowledge enough about medical and radiation issues and the patient's well-being should be guarded, it is not recommended that they request X-rays without the supervision of a resident or specialist. NP's, on the other hand, are considered in practice competent for making X-ray requests from the confidence that they enjoy the doctors, their training, their work experience and their knowledge and skills (Kenbeek and Rademakers, 2006). As said previously, requesting X-rays is also one of the tasks an NP is allowed to perform. A research has been conducted to compare NPs with residents for their ability to request and interpret correctly a limited range of X-rays of patients attending a minor injuries unit (Freij et al., 1996). Results from this research shows that there were no significant differences in the ability of an NP and a resident to request and interpret appropriate X-rays. They concluded that appropriately

trained NPs are at least as good as SHOs in recognizing the need for an X-ray and as competent in their interpretation. Specialized EC nurses and co-assistants can be authorized by a resident or specialist to request X-rays, but then the resident/specialist has to reasonably assume that this person is sufficiently capable to properly execute the assignment. Another criteria for a specialized EC nurse or co-assistant to request X-rays is that (s)he should not go outside the limits of the authority that (s)he has been granted by the resident or specialist. The obtained assignment for X-ray request should also be clear. The rough-and-ready rule according to the Wet BIG is: not capable means not authorized. When a specialized EC nurse or co-assistant gets the authorization of a resident or specialist to request a X-ray, then (s)he is committed to mention the name of the responsible resident/specialist on the request form. By doing this, this resident/specialist is made responsible for the requested research.
The Dutch legislation do not allow shifts of tasks, but due to the shortage in the amount of residents this shift of task is being tolerated and task that traditionally were performed by doctors have now been taken over by other care workers (Houweling et al., 2003)

Chapter 6: From case back to theory

Theories obtained from the initial literature review served as fundament for analyzing the situation at and between the emergency and the radiology department of the University Medical Center of Groningen. However, what could be learned from the case study and what new theoretical insights could be derived from it? The chapter constitute a critical evaluation of theories used based on results obtained from the case study. The importance of the conceptual model of relevant aspects for developing information systems (figure 7), which has been developed in this research, will be explained and used as the guideline for conducting the evaluation. Results from this chapter can contribute to organizational and technology literatures exploring organizational changes and IT implementation.

Different reason for failure of IT projects have been mentioned. One of the statements that were been made by Eason (2001) was that "*the bigger and more expensive the project, the more likely it is to fail*". However, the case study has shown that small implementation projects that do not get the adequate attention do have a great chance of ending up as failures. E.care ED project, as classified by the project leader, is a small project. Although the implementation of the E.care ED has not been qualified as a failure, the answers of CSO management with respect to the future existence of the system could lead to the assumption that this system will not be in place anymore in the near future and by then the implementation project could be classified as a failure. Besides this, project team failed in realizing all the necessary links required for the optimal function of the system. Furthermore, no adequate structure has been used in planning, designing and implementing the system and from the start of the project a very important stakeholder has not been involved into the system implementation project. What can be derived from this is that Eason's theory can be adjusted and, instead of that, it could be argued that:

- the more complex the project, the more likely it is to fail; the less the cooperation between
- stakeholders, the more likely a project is to fail;
- the more unable the project team is in identifying relevant stakeholders, the more likely a project is to fail;
- the less structure in the IT project, the more likely the project is to fail.

The Excellence Model of EFQM provided four important elements on which quality of an implemented system can be measured. These elements related to people, process, resources and people results. The first element, *people*, can be divided into three sub-elements to mention management, project team and stakeholders. As can be observed from the conceptual model developed in this research, these sub-elements are closely related to each other. Management and the Information Service Department or project team are the first two sub-elements in the conceptual model. Management actions and decisions, especially in cases of information systems' implementation are crucial to the success of processes involving ISs. Therefore, it is essential for a manager to be able to understand the business problem that requires IT changes or implementation and to effectively communicate this to the IT specialist/ the project team. Unfortunately, this is not [always] the case as managers focus too much on the business side of problems, while IT people focus too much on the technical issues. Consequence of this could be an implemented system that works well in technical terms, but does not satisfy management needs or the implementation of a system that satisfy management needs, but cannot be integrated with other systems within the organization. This last situation has been observed in the conducted case study where the implemented E.care ED system does satisfy CSO management and employee needs, but cannot be linked

with the system used in the Radiology department. Although organizational theory recognizes this lack of effective communication between management and IT specialists, people not always follow the advices given in literature. One advice researcher would give would be the use of a middleman (or group of people), someone who has deep understanding of the business processes and some knowledge/insight of IT issues. In this case, for example, an ERP consultant who has both business and ICT background or organization specialized in giving advise about these business and ICT cases would be could have provided the needed insights for this project. Another professional that could perform as the middleman and would also be accepted by all parties in the process, is a resident with great knowledge of all the processes taking place at the CSO and enough knowledge of business development based on the use of technology. Management would talk to this person about the problems that require immediate attention and this person, on his/her turn, would talk to IT specialist(s) or the project team to evaluate possible solutions. (S)He will do so, until a consensus have been achieved between management and project team about the best solution to the existing problem. After that, project team would initiate the process from planning for till implementation of the IS.

When searching for 'System Development Life Cycle' (SDCL) concept on the Internet, about 7 million hits appear on the screen. Besides this, there are almost 2 million scientific articles and/or books discussing this concept. Knowing this, it could be assumed that this is a well known model used to structure planning till implementation processes of new systems and that especially those big organizations, with IT department, would use this or similar models to structure the IT projects. When analyzing this case, it is clear that not all IT projects follow structured procedures as would be expected. There are, still, IT project teams that rely more or less only on stories of people to base an entire project on. The SDLC model suggests a structured way of planning, designing and implementing a system. It is not necessary for project teams to follow strictly the procedures delineated by the SDLC model. For example, small scale, simple projects would require simpler processes and/or procedures when implementing a system. However, this model helps project teams in designing a through implementation process taking into account all the relevant steps and issues for a successful project, especially when the project is big and complex.

Just a few authors have addressed the issue of stakeholder identification and involvement. Authors agree that the involvement of relevant stakeholders is essential for an efficient and effective system implementation project (Lorenzi and Riley, 2000; Freeman, 1984; Mitroff, 1983; Mcloughlin, 1999; Boonstra, 2003; Boonstra and de Vries, 2005; Boonstra, 2006). From the theory and the case study, researcher has learned that relevant stakeholders are not only the users of the system to be implemented, but all those parties who either affect or are affected [directly or indirectly] by the implementation of the system (Mitroff, 1983). Due to this, instead of talking about 'users', as is done in Lucas's (1975) model, researcher talks about 'stakeholders' in the developed conceptual model. There is also an interesting article written by Vos and Achterkamp (2004) discussing how stakeholders should be identified. According to them, stakeholders can be identified based on their role. They divide them into actively and passively involved stakeholders. Dennis et al. (2005) explain that stakeholders should be identified in the analysis phase of the SDLC model. Complementary to the explanation of Dennis et al., researcher would argue that stakeholders' involvement is not only essential in the analysis phase, but also in the design and implementation phase of the SDLC process. Unfortunately, Dennis et al. do not discuss how these relevant stakeholders should be involved in the system implementation project. It could be imagine that, depending on their role, they would have much influence when designing user interfaces and when testing the system in the implementation phase. Researcher bases her argument on the instrument of Vos and Achterkamp (2004).

The concept of departmental or silo thinking is not new. It has been addressed many times by among others Galbraith in 1968 and Harmon in 2003. Despite of this, departmental objectives within organizations continue to be divided which lead to cultural differences and departmental enhancements without taking into account the effects these enhancements or innovations would have on the performance or output of other departments. This silo thinking issue was the main source of problems between the departments observed in the case study. Here is where the model of Tallon, Kraemer and Gurbaxani (figure 1) plays an important role. The most important actor in this model is management. Same as in the conceptual model developed in this research, management practices determine for a great part the success of an IT implementation project. Focusing not only on their departmental goals but also on the effects the project would have on related departments and/or processes (unfocused goals) would end up in better strategic decisions and finally realization of IT value. The case study showed a clear lack of focus on the attitudes, values and perceptions of related departments, in this case the supporting department.

The developed conceptual model in figure 7 brings together theories for different authors which are considered to be the most critical theories needed for an efficient and effective implementation of information systems in organizations. As in Lucas's model, the model starts with management, as it is the management team that has to make decisions about whether or not to start processes for implementing a system when the situation calls for it. Management discusses with the project team and together they decide which possible solutions are there. Project team starts with the planning and design phase where relevant stakeholders have to be identified and involved in the process. Stakeholders' involvement is crucial for the analysis of the situation and identification of bottlenecks. Management actions and involvement of stakeholders affect stakeholders' attitudes and perception towards the system to be implemented, which on his turn would affect the future use of the system. Other situational and personal factors such as ability to use the system, availability of materials and interest can also influence system use. After implementation of the system, it would be necessary to monitor/analyze the system's performance for if changes have to be made. This could be done systematically using the PDCA cycle for structure. Improving the technical quality, which is done by the project team, would then influence stakeholders' attitudes and/or perception and system use.

Chapter 7: Conclusions

7.1 General conclusions

Two important roles could be defined for information technology in organizations. These are 1) the role of facilitator and 2) the role of enabler. During the last decades IT's role has been changing from being a facilitator to become an enabler in the development of processes (Huizingh, 2002, Eason, 2001 and Beynon-Davies, 2004). IT plays a key role in organizational development, since it helps processes to take place and also enables people to do things they were not able to do before. These same roles can be identified in healthcare departments. When well implemented, IT facilitates process coordination and can enable direct, digital connection between departments.

In designing and implementing IT not only human and organizational aspects are important but also the technical and project management aspects. Human and organizational aspects represent the major part of the conceptual model of relevant aspects for system development and consist of:

- management action and decision style,
- policies and attitudes of members of the project team,
- involving all the stakeholders in all development and implementation stages,
- attitudes of the users and their use of the system,
- situational and personal factors that can influence system use,
- regular analysis of system use,
- analysis of system performance and technical quality of the system.

Here, situational and personal factors could negatively influence system use. Results from the case study show that human issues such as stakeholder's felt need and system's impact on the users which could encourage the interest to use the system, can be more difficult to deal with than technical issues of a system. Other issues of influence are user's awareness of the benefits using the system and users' skills. Problems arise when not all the relevant stakeholders are involved in the project. Not involving all relevant stakeholders can lead to missing functionalities in the system that are important for optimal job performance of those stakeholders that were not involved. Stakeholders' attitudes and perceptions are also of fundamental importance for successful implementation of a system. Lack of interaction between stakeholders of different departments can lead to inefficiencies in processes taking place between these departments, as was the case in current research.

An important project management aspect is structure and the use of diagramming techniques to model a system to be developed. In the analyzed case, the use of diagrams proved to be fundamental for the planning and design of a system. The project team did not use any diagrams to model the as-is situation and the to-be system. Consequence was that, while implementing the system, project team has been confronted with a major (unexpected) problem of linking the implemented system with the system of the supporting department. Therefore, in developing and implementing as well as in improving a system, the use of object-oriented modeling techniques must be considered a standard procedure. Actor Activity Diagrams (AADs) have been used in current research to model the business processes emerging within and between an emergency department and one of its supporting departments in terms of activities, actors and transitions. Such AADs provide an overview in the existing processes within and between departments and can be used as the starting point for developing structural and

behavioral diagrams for the designing and implementation phases.
When a system is implemented, there are different factors that can hinder the adoption and/or diffusion of the information system. These factors represent barriers to effective implementation of information system and relate to technology-related barriers, such as incompatibility of software and hardware and inability to integrate the implemented system with already in-house systems. Ability-, awareness- or knowledge-related issues such as lack of knowledge on how to apply available technologies or lack of awareness of the opportunities of the system, can also form barriers to effective implementation. Furthermore, there are interest-related and power-related barriers; stakeholders that do not interact well with each other and/or are not interested to be part of changes made, can further obstruct implementation of a system or effective flow of processes. Here, identification of key stakeholders is important and interaction between these stakeholders has to be promoted. Important for managers to know is that the actions and perceptions of these powerful stakeholders are of fundamental importance for the successful adoption and diffusion of changes made, since these stakeholders can influence other users' attitudes, perceptions and use of the system. Besides this, current research shows that identification of key stakeholders is not only important for system development projects, but also in situations where organizations experience problems within and/or between departments which could be directly or indirectly related to silo thinking. These latter barriers are related to human and organizational aspects of projects development and are usually more difficult to handle when encountered, since human beliefs and behavior is very difficult to change.

Emergency care units and departments such as radiology are directly linked to each other. Radiology departments provide the emergency care unit with additional researches needed to diagnose a patient's physical condition. Although the results from this research cannot be generalized, because they are based on a case study in two departments of just one hospital, they sure proved that processes at an emergency care unit are quite complex. Assessment, diagnosing and monitoring of patients' situation occur most of the time in different stages of the process and by different people from different expertise fields (specialized EC nurse, co-assistants, Nurse Practitioners, residents and/or medical specialists). Furthermore, employees have little to no control on patients' inflow and the types of disorders and/or lesions each patient arrive with. Therefore it is essential that the emergency care unit has good collaborations with supporting departments for efficient patients' routing. Here, results from the research case show that the use of an order management system to digitalize the processes at the emergency care unit facilitates task coordination and gives a better overview of patients' routing and other relevant information. Results also show that not following a structured process when developing and implementing IT can lead to unexpected problems. It is important for project teams to know that benefits can be obtained if the information system development process is properly carried out. The conceptual framework developed in this research contains all the important aspects that have to be taken into account for a successful implementation of an information system. These aspects relate to human and organizational issues as well as technical and project management issues. All these issues are important, however, human and organizational issues seem to be crucial and, therefore, cover the greatest area of the conceptual framework. The case study served as an example to illustrate that implementing information systems alone, does not solve all problems. The case study also showed that underestimating system complexity by conducting an ordinary risk analysis could easily lead to unexpected technology-related barriers hindering the completion of the implementation process.

Efficiency of implemented systems within healthcare organizations can be measured based on the realization of the strategic intend for the implemented IT. This strategic intend is translated into focused and unfocused goals and

guided through management practices. At the end of the implementation process an evaluation can be made to measure whether the project has achieved the intended strategic goals and brought value to the organization.

7.2 Case specific conclusions

The identified problems between these departments can be divided into two groups, to mention technology-related problems and human and organizational problems.
The technology-related problems resulted in failure to link the systems to each other and fully digitalizing the process, what has not eliminated the paperwork. This failure was due to unstructured system implementation process; no adequate risk analysis was conducted and no modeling diagrams were used to get detailed overview of processes taking place within and between these departments. The AADs developed in current research (Appendix 4) provide a clear overview of the processes taking place at and between the CSO and Radiology, which is what the E.care ED project team needed from the start of the project. These AADs provide better insights into who are the actors, how each actor is related to each other and to patients, in which phases of the process each actor takes actions and what system functionalities are necessary for these actors to perform their tasks at what time and in which system. The AADs also show how the relevant systems are or are not connected to each other.
One of the causes for the human and organization related problems is that the Radiology people were not involved in the development and implementation project. These people were also part of the relevant stakeholders group. Involving them would have revealed more useful information about system requirements for adequate X-ray request and probably change their attitudes and perception towards the E.care ED system. Another cause is that the team underestimated the complexity of the implementation project. This is directly related to the risk analysis mentioned above. Finally, silo thinking is also a barrier to effective implementation of information system and this is concept that is definitely present at the CSO.

The realized IT value of the E.care ED system can be estimated based on what has been or has not been achieved with the implementation of the E.care ED system and the results of the questionnaire and interviews. E.care ED system failed in improving the interaction between employees of the two departments. Furthermore, it has not been able to link the E.care ED system with X/care and Poliplus, which is also a failure to realize IT value. Since the paper work has not been eliminated, and there is no link between the systems, the processes' flow is still not optimally efficient. Further research is needed to find out whether these systems can be linked to each other. On the other hand, the implementation of E.care ED has improved coordination of processes within the CSO and employees of the CSO are satisfied with its performance. A conclusion cannot be drawn for whether the system has enhanced services offered to patients. To draw such a conclusion further research is needed in which total treatment times, waiting times and patients' satisfaction are measured.

Errors encountered on X-ray request forms from the CSO were the primary cause of the problems between the CSO and the Radiology department. The conducted questionnaire research mainly revealed who made these errors and what kinds of errors were being made. The majority (61,54%) of the manually filled requests came from residents. Besides this, 66,67% of the requests containing errors have been requested by residents or under supervision of a resident. Only one (2,56%) was requested by a medical specialist and 12,82% by co-assistants and a specialized nurse. Most of the residents belonged to the STRP specialty. The three most frequently found errors were that 1) residents provided too little information about what has happened to the patient, 2) the requested X-ray did not belong to the patient's disorder an 3) that a wrong body part was indicated. Again, all three errors were mainly made by residents.
From these questionnaire results it is clear that the errors found have little to do with the technical aspect of the

E.care ED system, but more with issues of human and organizational aspects of the system. Interview results show that stakeholders' differ in their perceptions about the usefulness and ease of use of the implemented system. CSO employees are very satisfied with E.care ED, but radiologists see no added value and are of the opinion that system use requires too much time from residents and medical specialist. Interaction between the stakeholders is not well and residents are not using the system as was expected; too little information is provided about the patient. All these issues relate to the human and organizational aspects (contact involvement, user attitudes and perceptions and use of system) of the implemented system.

There were also many discussions within the two departments regarding who should triage patients and who is allowed to request X-rays. By making use of nurse-based protocols for assessing patient's need for care, triage can be done by a specialized EC triage-nurse. The Wet BIG mentions some reserved proceedings (in Dutch voorbehouden handelingen). One of these reserved proceedings is the use of radio-active stuffs and ionizing radiation. Nowhere is being mentioned that requesting X-ray is also part of these reserved proceedings. Therefore, X-ray requests can be done by specialized EC nurses and co-assistants. However, since specialized EC nurses and co-assistants do not have the knowledge enough about medical and radiation issues and the patient's well-being should be guarded, it is not recommended that they request X-rays without the supervision of a resident or specialist. Important to know is that at the patient's physical diagnosing phase, a resident or specialist must be present to assess the patient's medical condition, decide about the necessary treatment and, if needed, request or give the assignment to request additional (X-ray) researches.

The law does recognize the NP as a professional that is allowed to perform both nursing and medical tasks. Medical tasks are performed under supervision of a medical specialist. The NP is allowed to do the reserved procedures which only physicians, residents or specialists are allowed to perform and, therefore, to both triage patients and request X-rays. What can be concluded is that as long as there is no support by the law for specialized EC nurses to make X-ray requests, they are not allowed to do this independently and neither do co-assistants. Requesting X-ray can be done by these non-residents under the conditions that 1. the resident or specialist has to reasonably assume that the non-resident is sufficiently capable to properly perform the assignment, 2. the name of the responsible resident or specialist must be mentioned on the X-ray request form and 3. the non-resident has to follow the specific order that (s)he has been given and do not go outside the authority that (s)he has been granted. NPs, on the other hand, are allowed to among others triage and request X-rays and furthermore perform other medical tasks under the supervision of a specialist.

Chapter 8: Final Discussion and Recommendations

8.1 Discussing the entire research

Benefits of the research

There are several other methods that could have been chosen to do this research with. However, two of the best and better known methods for doing a qualitative research are observational field research, and unstructured interviews. Observational methods have been developed with the objective of 'observing people in their natural setting - as they go about their everyday lives'. Since the researcher had very poor knowledge of the processes that occur in an emergency department and a radiology department, walking with employees of both departments, observing what they do and taking to them for a few hours helped in getting an overview of the processes and the situation. The use of questionnaires for analysis of the errors encountered on X-ray request forms was the best way to register how many errors were done during a specific period of time and what kind of errors were encountered most. Finally, to get more detailed information about people perceptions and ways of thinking, unstructured interviews with some members of the stakeholder groups have revealed additional information, which could not be obtained by only observing them. The reason for choosing unstructured interviews instead of structured interviews was that, although structured interviews permit more focused information gathering, these could overlook aspects of the group that an unstructured interview could reveal. Researcher was also able to get to know the interviewed persons a little bit, to see their expressions which sometimes say more that just words. These unstructured interviews allowed interviewees to better express their feelings and thoughts compared to when they are asked to fill in a list of predefined questions. Doing a field research or a case study allowed the researcher to put theory in practice and analyze specific problems of one organization and look for solutions that could help both that specific organization and other organizations in the future.

Limitations of the research

There were so many things occurring at the CSO and the Radiology department at the same time, that it was impossible to capture all these in just a few hours. Due to time constrains it was not possible to spend too much time observing. Besides that the research was conducted by just one person, this also restricted the observation phase a little bit. Furthermore, employees at the CSO used to be very busy. The physical complaints patients arrive with and the amount of patients arriving there at a time are so unpredictable that sometimes the employees are so busy and as the researcher you do not want to disturb the process by standing in the way or asking questions. Another limitation relates to the amount of people that participated in the study. This had also to do with the limited time available and the willingness of some stakeholders to cooperate. Not every stakeholder could be interviewed as to get a greater group of respondents. Furthermore, an email has been sent to several residents and specialists to ask if they would like to cooperate with an interview of maximum one hour, but none of these residents or specialists answered this email. Therefore, the researched missed the opinion of this stakeholders group about the implemented system and the problems with errors on X-ray request forms. Interviewing one or two residents would have revealed the exact cause(s) of the errors that are being made.

Another issue was that the questionnaire research for identifying errors on X-ray request forms was conducted in the period when Radiology decided that they would not accept X-ray requests made by specialized EC nurse, NPs or co-assistants. This limited the comparison of the situation

before and the one after April 1st 2007. As said before, conclusions drawn from this research cannot be generalized. However, this study can be used as a guide for future researches. The following sections go into more detail about the possibilities for future researches.

8.2 General recommendations

This research consisted of a case study on the partly IT-supported coordination and communication between two units of a university medical center. Results obtained can be used as an example of how things could go between an emergency unit and supporting departments.

Though information technology is said to play an important role in facilitating and enabling processes in healthcare institutions and benefits such as higher quality of care, reduction in medical errors, decrease in paperwork and lower healthcare costs can be obtained from its use, few empirical researches have been conducted to find out if these benefits are really obtained in practice. Changes are being introduced in the Dutch healthcare sector and the government is promoting the use of ICT in healthcare with the objective to improve affordability, accessibility and quality of the delivered services in healthcare. Different healthcare institutions in the Netherlands are making steps towards optimizing their processes by using IT, but it is not clear whether this has brought benefits to either those institutions themselves or the whole Dutch healthcare network.

Further research is also needed to find out if the describe organizational problems and issues also occur at other types of hospitals, to say smaller hospitals, private hospitals, and so on. It is also interesting to know whether these problems only occur between ECUs and supporting departments or if these are also found between other departments within a hospital.

UMCG is not the only hospital in the Netherlands that has implemented the E.care ED system in its emergency care unit. Other hospitals such as the 'Onze Lieve Vrouwe Gasthuis' (OLVG) in Amsterdam and the UMC St Radboud in Nijmegen, were also planning to implement the system, but no information is available about whether the system has been successfully implemented and linkages with other existing systems have been positively made. Research could be done in these hospitals to find out if they have managed to implement the systems successfully, whether they have encountered problems with linking the system with already in-house systems and if so, how they have solved the problem, if it has been solved.

8.3 Case specific recommendations

Investing in users' motivation and knowledge of implemented systems can improve appropriate use of the system. Interaction with especially residents to find out what their needs are and what difficulties they have that could cause the errors described in the questionnaire results, is essential. A research could be conducted to get to know the factors that lead residents to make the errors. This research can be broaden to obtain information about the degree of satisfaction of the CSO workforce with respect to the system itself and patients satisfaction with services delivered and if the level of satisfaction can be directly related to the use of the E.care ED system. The business value of the E.care ED system can also be evaluated for both the relevant units and the organization as a whole. Quality of the E.care ED system and processes at the CSO can be measured based on a quantitative research to see if this system and processes are efficient and provide value to the organization. The conceptual model developed in this research can help in measuring quality of the system.

Interactive communication should be improved within the CSO and between the CSO and the Radiology department.

Management of the CSO and the Radiology department could achieve this by organizing periodical evaluations for employees of both units. Meetings would then be scheduled for example once a month to discuss what has been done well and what needs to be improved in the X-ray requesting and delivering process. Doing this, the employees will be stimulated to talk with each other and together they would find the best solutions that fit the needs and interest of both groups. Employees of the CSO would also know exactly what radiologists and RPAs regard as a correctly filled X-ray request and how they expect CSO's employees to fill in these request forms. X-ray requests protocols have to be made and/or reviewed locally (between the two units) with respect to who does what tasks and how these tasks should be carried out. Members of both units have to agree with the protocols that would be made. These have to be written and signed agreements. The units have to make sure that each and every employee knows these protocols and work according to them.

Since this research has not dealt with the technical aspects of system implementation, further research is needed to evaluate the realized IT value of the E.care ED system. Research is also needed to find out if the E.care ED system and the X/Care system of the Radiology department can be linked to each other. This can be done by one or two students with knowledge of business and technical aspects of system implementation. The use of modeling diagrams should then be a requirement. The AADs developed in this research, which give an overview of the as-is situation at and between the units, would then serve as the starting point for analyzing the existing processes and developing other object-oriented modeling diagrams such as the class, use case, deployment, communication and the interaction overview diagrams. HL7 V3 should also be integrated to this research, as this standard is based on object-oriented methodologies and an analysis based on it could bring possible solutions for linking the systems. Another possibility that could be considered to link the E.care ED system to X/care and Poliplus is the use of middleware software. This research could be linked with the previously mentioned research in other hospitals that have implemented the E.care ED system.
Interviewees suggested that the possibility exists that in the near future the E.care ED system will not be in place anymore. An evaluation could also be made to see if it is useful to try and link the E.care ED system or if management of CSO and the E.care ED project team have to start analyzing other possibilities such as transferring the features of the E.care ED system into Poliplus and stop the use of E.care ED, as the CSO manager suggested or implement the X/care system at the CSO.

Efficient ordering of X-ray requests require some time to fill in the digital request form, time that the medical specialists and residents might not have, due to shortage in the amount available on the work floor. Focusing on the speed of processes of the CSO, in the diagnosing phase, a non-resident (with enough capabilities, say a specialized EC nurse) could directly assist the resident/specialist; while the resident/specialist is doing the physical analysis of the patient, the assistant makes notes and when additional X-ray is needed, this non-resident could request it based on the indications obtained from the specialist/resident. Following the Wet BIG and the notion of the NVvR: 1. the resident or specialist has to reasonably assume that the non-resident is sufficiently capable to properly perform the assignment, 2. the name of the responsible resident or specialist must be mentioned on the X-ray request form and 3. the non-resident has to follow the specific order that (s)he has been given and do not go outside the authority that (s)he has been granted.
Another possibility is working with more NPs on the floor. The NP can perform tasks that fall in the medical field under supervision of a specialist. Here, the NP could perform the physical diagnosis of a patient under supervision and if additional tests are needed, this NP could request these additional tests independently, since requesting X-rays is also one of the regular tasks that an NP does and is supported by the law.

The Skills Center of the Wenckeback Institute at the UMCG provides all kinds of training possibilities for employees of the hospitals to train their skills by simulating actual processes using very advanced information systems and simulation mannequins and other simulation equipments. In a simulation room, where actual processes such as those in an operating room are simulated and a group of people working in an operation room are asked to simulate a process based on given patient information. There are cameras placed in the simulation room through which the group can be monitored by supervisors in another room. The group submitted to the simulation process is tested on their working skills and also on the communication skills with other team members. Afterwards, the supervisors give feedback to these people. This technology could also be used to simulate the processes taking place at and between the CSO and the Radiology department. Doing this, communication/interaction trainings could be developed based on simulation scenarios to enhance the communication between members of these two departments. The E.care ED and the X/care systems could then be added to the simulation process in which the difficulties in using or connecting the systems could be analyzed. The simulation could be done in small groups consisting of members of each group of actors taking action in the normal process. Their special simulation mannequin acts as the patient, who can actually breathe, have a broken leg, suffer of hearth decease, etcetera as a normal patient can do. All these could be defined by the application used in the simulation equipment.
The coordinator of the simulation process at the Skills Center explained that they are already working on this case. He said that simulating such a process requires them to do that in the actual environment of the CSO unit and for that they have a mobile simulation equipment that could be used to carry this out. Furthermore, people from the Radiology department would have to be invited to complete the team and a trauma room at the CSO would be used to conduct this simulation. Provided that most of the X-ray request errors relate to residents, it is of fundamental importance that especially residents assist to these trainings. Motivation for assisting to the simulation processes has to come from management of the departments. There should also be enough available time on the duty-roster of the employees to participate in such training. By conduction these process and communication simulations, the costs of errors and communication problems could also be estimated and, in the best case, simulation could depict to which extent the E.care ED system contributes to the whole process or not.
CSO and Radiology department can work together with the people of the Wenckebach Skills Center to see whether these simulations can be realized. According to the coordinator, simulating the processes within and between CSO and Radiology is feasible and they have been working on team trainings for two years already. However, processes and information of the CSO are nowhere to be found, which complicates things a little bit. The AADs developed in this research could then serve as initial tools to give initial overview of the existing processes. Benefits that could be obtained are that:

1. interaction within and between members of these departments could be improved and
2. the amount of errors would decrease through the development and training of employees' skills.

Last but not least, provided that one of the most frequent errors found related to indication of the wrong body part in the E.care ED system, a Left and Right symbol could be placed on the human body picture in E.care ED screen. An example is showed in Appendix 11. This is a simple solution that could eliminate possible confusions and decrease the amount of errors made.

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List of abbreviations and definitions

AAD	=Actor Activity Diagram
ANSI	=American National Standards Institute
CDO	=Care Delivery Organization
CPOE	=Computerized Physician Order Entry
Co-assistant	=Medical student, not yet a doctor; also referred to as intern.
CPR	=Computerized Patient Record
CSO	=Centrale SpoedOpvang
CT	=Computed Tomography
E.care ED	=E.care Emergency Department
EC	=Emergency Care
ECU	=Emergency Care Unit
EDI	=Electronic Data Interchange
EHR	=Electronic Health Record`
EMR	=Electronic Medical Record Dutch: Electronisch Medisch Dossier (EMD)
EP	=Emergency Physician Dutch: Spoedeisende hulp arts
EPF	=Electronic Patient File Dutch: Electronisch Patiënten Dossier (EPD)
EPS	=Electronic Prescription System
FTE	=Fulltime Equivalent
GP	=General Practitioner Dutch: Huisarts
HIMSS	=Health Information Management Systems Society
HIS	=Health Information System
HIT	=Health Information Technology
HL7	=Health Level Seven
ICT	=Information and Communication Technology
IOS	=Inter-organizational System
IS	=Information System
IT	=Information Technology
JIT	=Just In Time (an inventory strategy)
MDF	=Message Development Framework
MMT	=Mobile Medical Team
NAHIT	=National Alliance for Health Information Technology

NICTIZ	=Nationaal ICT Instituut in de Zorg
NP	=Nurse Practitioner
NVSHV	=Nederlandse Vereniging Spoedeisende Hulp Verpleegkundigen
NVvR	=Nederlandse Vereniging voor Radiologie English: Radiological Society of the Netherlands
OMG	=Object Management Group
PHR	=Personal health Record
Resident	=Dutch: Assistent in opleiding tot medisch specialist (AIO) or arts-assistent
Retriage	=Retriage occurs when the status of a patient changes either to a worse condition or if they improve to a less life-threatening level
RP	=Radiology Practitioner
RPA	=Radiology Practitioner Assistant Dutch: Radiologisch Laborant
SDLC	=System Development Life Cycle
SDOs	=Standards Developing Organizations
Specialized EC nurse	=Specialized Emergency Care nurse
SPSS	=Statistical Package for the Social Sciences. It is a computer program for statistical analysis
TAM	=Technology Acceptance Model
TQM	=Total Quality Management
Triage	=A French word meaning to 'sort' by priority or life-threatening nature of injury. It is a dynamic decision process that prioritizes a patient's need for care
UK	=United Kingdom
UMCG	=University Medical Center of Groningen
UML	=Unified Modeling Language
USA	=United States of America
WSLC	=Work System Life Cycle
X/Care	=The health information system used in Radiology
XML	=Extensible Markup Language

Appendices

Availaible on request.