Electronic Patient Records in the Dutch hospitals

a decade of changes

EPR in the Dutch hospitals - a decade of changes.

A study about EPR system's success factors in the Dutch hospitals.

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Abstract

Objective: To review relevant topics about hospital Electronic Patient Record (EPR) systems in the Netherlands in the last decade. To measure how different orientations contribute to EPR system's success and update a conceptual model proposed in 2002 by Spil and Michel-Verkerke.

Methods: A literature study is done to provide the researcher with the body of knowledge enabling the identification of success factors and relevant topics. A second search was done into scientific literature, trade literature and interviews provided by the University of Twente to discover EPR system's success factors. These success factors were grouped by orientation and placed in a concept matrix after which they were labelled with acknowledged system quality attributes. Highest scoring orientations and attributes are used to update a model characterizing a successful EPR system.

Results: The following orientations were revealed contributing to EPR systems' success: administration, care workflow, information management, integrated care, internal cooperation, strategy and medical technology. Accompanying system quality attributes in their respective orientations like: efficiency, interoperability, accessibility, relevance, timeliness and customizability, will provide an EPR system with the necessary attributes to be successful.

Conclusion: Successful EPR systems support their users filtering, sorting and selecting relevant information aligned to the care process making information more accessible. They alleviate the administrative burden. EPR systems should comply to standards and should be interoperable supporting internal cooperation and integrated care. A successful EPR system should be aligned to the hospital's strategy making the care process auditable and information traceable. Information from medical technology should be timely and accessed remotely. These orientations have been placed into a model depicting the focus for a successful EPR system and the main system quality aspects supporting these orientations. A first step enabling more successful EPR systems in the Netherlands would be agreeing on one default 'information architecture' per specialists. This would be a first step in the direction of making Dutch EPR systems more interoperable.

Keywords: EPR systems, health-care, success factors, system quality attributes.

Samenvatting (Dutch)

Doelstelling: Het onderzoeken van relevante onderwerpen van de afgelopen 10 jaar omtrent Electonisch Patient Dossiers (EPD) in de Nederlandse ziekenhuizen. Deze onderwerpen in kaart brengen en specifieke systeemeigenschappen die EPD's succesvol maken hier uit halen, gebruikmakend van een voorgesteld conceptueel model uit 2002 gemaakt door Spil en Michel-Verkerke.

Methoden: Er is begonnen met een verkennend literatuuronderzoek om de onderzoeker te voorzien van de benodigde basiskennis om relevante onderwerpen in kaart te kunnen brengen. Dit verkennend literatuuronderzoek bracht de belangrijkste problemen in kaart. Op basis van een tweede zoektocht in wetenschappelijke literatuur, vakbladen en interviews van de IS&CM-vakgroep binnen de Universiteit Twente als mede vier eigen diepte-interviews, zijn succesfactoren in kaart gebracht. Deze factoren zijn 'vertaald' in erkende systeem kwaliteitseigenschappen en in een concept matrix geplaatst. De succesfactoren zijn ook gegroepeerd waarna ze in een model zijn afgebeeld. Hiermee kan het model uit 2002 worden hernieuwd en de karakteristieken van een succesvol EPD kunnen weergeven worden.

Resultaten: In de gevonden succesfactoren is de volgende indeling in verschillende dimensies aan te brengen: administratie, zorgproces, informatiemanagement, geïntegreerde zorg, interne samenwerking, strategie en medische technologie. Systeem eigenschappen die deze succesfactoren mogelijk maken bestaan onder andere uit: efficiëntie, interoperabiliteit, toegankelijkheid, relevantie, tijdigheid en aanpasbaarheid.

Conclusie: Een succesvol EPD werkt ten behoeve van zijn gebruikers, het filtert en sorteert data en is in staat om de gebruiker te voorzien van voor hem of haar belangrijke informatie op een specifiek moment. Het EPD verlicht de administratieve lasten door zijn beschikbaar- en toegankelijkheid. Succesvolle EPD systemen voldoen aan standaarden en zijn gemaakt om inter-operabel te zijn met andere systemen, om zo zowel geïntegreerde zorg als interne samenwerking te kunnen ondersteunen. Een succesvol EPD werkt ondersteunend voor de strategie van het ziekenhuis en maakt het zorgproces auditbaar en traceerbaar. Het stelt zijn gebruikers snelle en universele toegang tot medische apparatuur ter beschikking. Dit onderzoek heeft een model opgeleverd waar de zeven verschillende dimensies van een EPD worden weergegeven met de bijbehorende systeemkwaliteiten. Een goede eerste stap om Nederlandse EPD systemen meer succesvol te maken zou overeenstemming zijn in de 'informatiearchitectuur' per specialisme over heel Nederland, als een eerste stap om EPR systemen meer inter-operabel te maken.

Preface

Dear reader, you are looking at the result of my research into EPR-systems in the Dutch hospitals. My affinity with the health-care sector, a lot of news about 'het Elektronish Patient Dossier' (the EPR) in the Netherlands, and a guest lecture from Robert A. Stegwee[1] made me curious and interested in 'the matter at hand'. "Why can't this EPR-system not just be implemented in the Netherlands?", I wondered. "Its implementation must be struggling for over 10 years now, and making the news about each other month." After some initial research I learned there is a big difference between 'an EPR-system' and these big nationwide EPR-implementation projects. The nation-wide project being way to political and probably too big to gasp, I decided to start at the core, implementation of EPR-products in one single type health-care facility. Not a lot scientific research is available about actually implemented EPR systems in hospitals, so I widened the search for implemented EPR systems and their success factors in comparable situations.

During the research, I discovered my strengths are not in a structured approach to literature or desk study. I especially would like thank Michel-Verkerke, M.B. (Margreet) for her support applying the scientific method to my work and reviewing my documents I also would like to thank Wombacher, A. (Andreas) and Spil, A.A.M. (Ton)for their time spend reviewing this work. I especially would like thank Michel-Verkerke, M.B. (Margreet) for her support applying the scientific method to my work and reviewing my documents.

Only now that I have finished this research, I know how I should start.

Pier van der Graaf

[1] http://www.utwente.nl/mb/htsr/Staff/stegwee.doc/

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1 Introduction

In the year 2002, Michel-Verkerke. and Spil published a paper characterizing Electronic Patient Record (EPR) systems in three orientations: administration, medical technology and care process (Michel-Verkerke & Spil, 2002). Four criteria for a successful EPR were developed from end-user viewpoint: relevance, all data available, all data available to all relevant caregivers and active systems. The researchers predicted that an EPR initiative found in the intersection of these three orientation can meet all of the four criteria as depicted in the figure bellow (Figure 1 - Orientations with intersections).

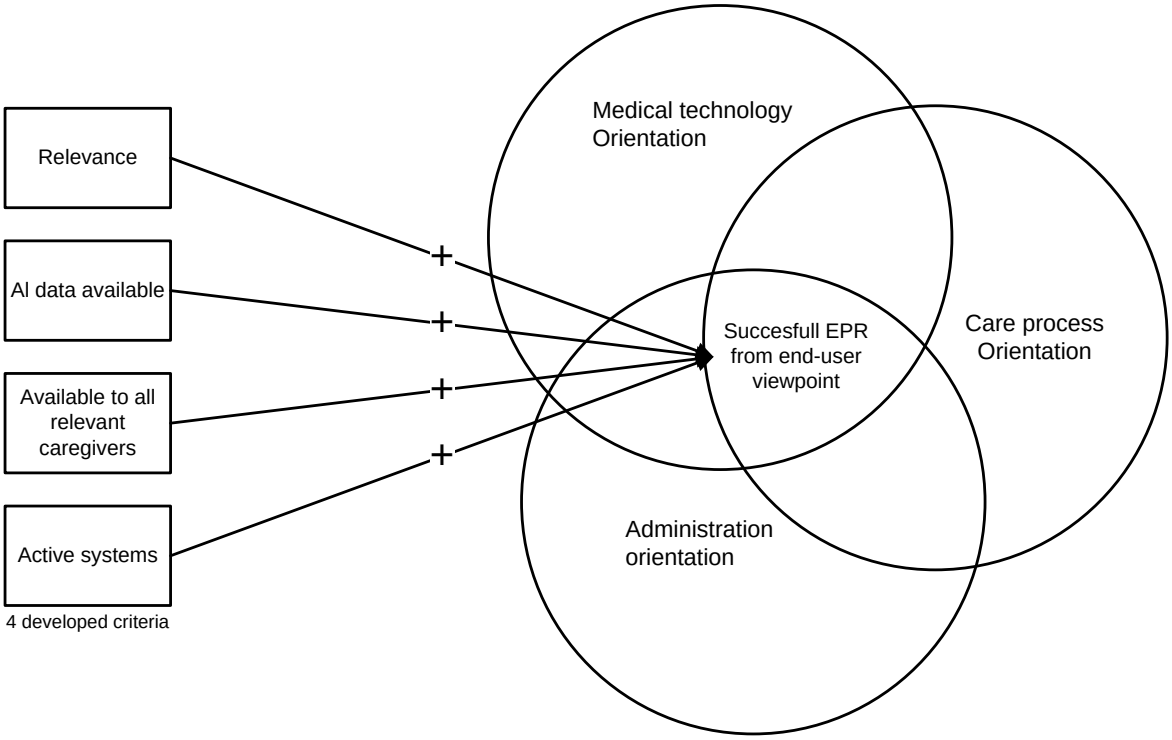


Figure 1 - Orientations with intersections (Michel-Verkerke & Spil, 2002)

The 2002 Michel-Verkerke and Spil model depict four different scenarios, these scenarios will be reviewed and an updated scenarios will be created based on an updated version of this model.

Almost more than a decade after the 2002 research, the healthcare sector hasn't successfully exploited IT systems in general, or EPR systems yet. (Black et al., 2011) No lack of national and local EPR initiatives, but the real benefits are from digitally creating patient records and connecting these records to other systems haven't been fully realized. Hospitals struggle to keep a positive balance and innovating or experimenting with the hospital's business model is a though

challenge. With IT changing the world around us, the last ten years should have brought new opportunities for EPR systems to improve healthcare.

Aim of this research is to update the model from 2002. To create an overview of critical success factors for a hospital EPR systems in the Netherlands, in order to improve the success of these EPR systems.

Studying the Dutch situation could be relevant to many other countries because the current Dutch situation has proven to be outstandingly positioned (Powerhouse, 2009). The Dutch progress is essential from another point of view, the Dutch situation provides patients information tools to support active choice among consumers, essential for the strategic role of the health consumer. It combines competition for funding and provisioning within a regulated framework (Powerhouse, 2009).

This study will focus on the adoption of EPR systems in the Dutch hospitals, what have been relevant topics for the last ten years, which 'system qualities' are successful, which are not. Using both desk study and interviews, research will be done in the field of medical information technology. The research questions driving this study will be discussed in chapter 3, Research Questions. The research methods will be further expanded upon in chapter 4, Research methods.

When talking about EPR systems, there are different layers to identify, also depicted in Figure 2 - Different layers of EPR systems in the Netherlands:

- nationwide EPR system
- regional EPR systems
- hospital-level EPR systems
- physician/department-level EPR systems
- pharmacies' EMR sytem
- general practitioner's EPR systems
- mental health services' EPR systems
- municipal health services' EPR systems.

'Figure 2 - Different layers of EPR systems in the Netherlands displays the different layers of medical record keeping systems. From the smallest departments in a hospital to a nationwide Dutch EPR (LSP, Landelijk Schakel Punt), currently they are not always compatible and not always able to share information (where relevant and authorized). Beside the systems depicted in figure 2, there are also sector EPR system, for example, one system for people with a diabetic condition throughout the Netherlands. Connecting these different EPR systems is out of scope of this research, this research will focus on the hospital level EPR system.

This research will focus on the **bold** part of the model, the main hospital EPR- and the smaller department's EPR systems.

A lot of these hospital EPR systems have been implemented on top of the different department's EPR systems or as an addition to the hospital information system (HIS) These hospital-level EPR systems are introduced mainly to be able to share data between the different departments and systems. For example, they provide direct access for gastroenterologist into lab results, or provide the oncologist direct access to scans from the radiology department. Different information systems, but also medical equipment's can be connected and accessed from every system connected to the hospital's EPR system.

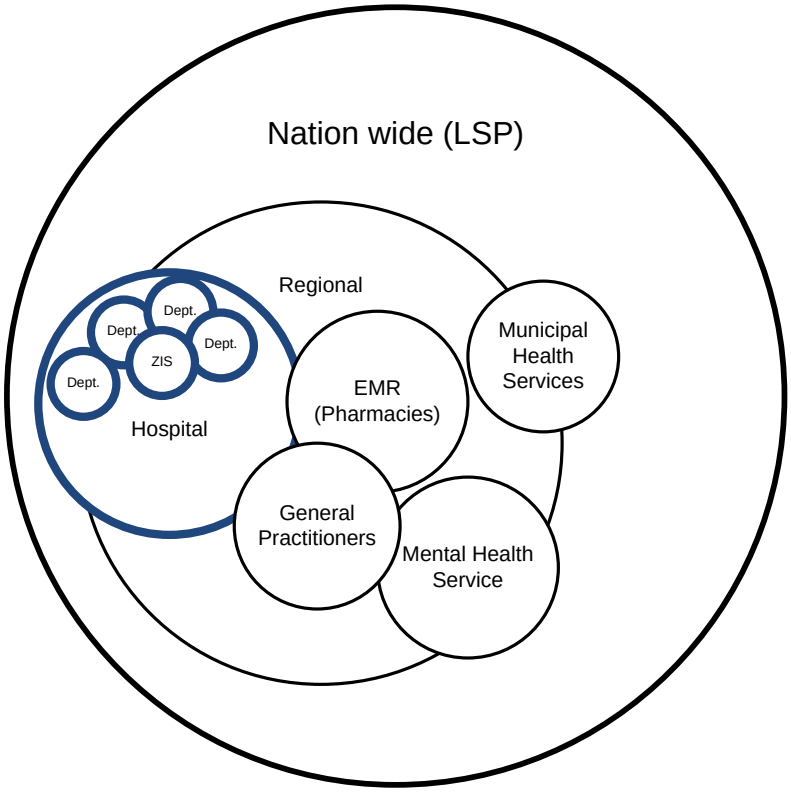


Figure 2 - Different layers of EPR systems in the Netherlands

One way to cope with a complex reality, and to be able to base claims about that reality is to create a model of this complex world. Using a model you can focus on the relevant variables and compare occurrences of the investigated subject on, for you, relevant details. For this research, the model created by Michel-Verkerke and Spil, Figure 1 - Orientations with intersections (Michel-Verkerke & Spil, 2002) will be studied.

Michel-Verkerke and Spil's research conclude that a successful implementation of an EPR system will be in the intersecting area in Figure1. The researchers took lessons from the interaction between technologies and processes described by Walley and Davies (Walley & Davies, 2002). Combining this model with a case-study research and interviews in all three orientations of the model, four criteria were developed from end-user viewpoint. The hypotheses: "Only an EPR initiative in the intersection of the model can meet all four criteria (relevance, all data available, all data available to all relevant caregivers and active systems)." was tested for these success factors with an initiative closest to the intersection. The researchers concluded that without co-operation of all three orientations, there will be no complete EPR and therefore no successful EPR.

Different views on IT have passed IT executives the last two decades (J. Luftman, 2005). Companies went from thinking about IT like 'we must use IT' to 'how can we use IT to enhance our business' point of view. However, implemented systems do not automatically change with these new points of view, and more important, system-designers, system-implementers and system's end-users do not suddenly know how to effectively use these EPR systems. Business and IT systems have to be aligned in order for an IT system to be successful. This alignment can be found within the intersection in the centre of the model. The end user's workflow and the IT system have to be to make optimal use from the system, and the IT system has to be tailored to, or flexible enough, to support the user's workflow (Jerry Luftman, 2003).

It is difficult to keep IT systems' priorities and business strategies aligned. It is even tougher to keep business and IT aligned as business strategies and technology evolve (Jerry Luftman, 2003). Alignment of business and IT can be measured in different levels using a Maturity model.

Such a maturity model could be made for EPR systems to determine its maturity and maybe therefore its strengths and focus. Tom Handler & Barry Hieb presented such a model in which different generations of EPR-systems have been classified (Handler & Hieb, 2007). These generations merely provide an overview and aid discussions about the matter at hand. More about this generations in Chapter 2.4Different generations of EPR systems.

2 Literature study

Before actual research into EPR critical success factors was conducted, a comprehensive survey of literature was undertaken. A systematic review of the current body of knowledge was conducted. Using guidelines put forward by Watson (Watson, 2002), like backwards- and forwards search, creating content matrices to structure literature. This initial exploratory literature study helped to design the interview-structure, as well as provide the researcher the background knowledge necessary to conduct further research into success factors, guide the interviews, and pursue relevant facts. The literature research revealed problems with EPR-systems in use today. To contribute to a the solution for these problems a set of research questions is created, and can be found in Chapter 3 Research Questions.

After the primary data had been gathered from literature, additional literature was consulted to which findings could be compared or to investigate on further studies referenced by the researchers.

2.1 Exploratory literature study

During the initial exploratory research, several online databases were queried in order to cover the top journals in the field. PiCarta, Scopus, Springerlink, Elsevier.com, IEEE explorer, ScienceDirect, and the Web of Science were initially queried with search terms, and combination of terms which were used include (but are not strictly limited to): Clinical, 'information system', healthcare, acceptance, success, satisfaction, 'electronic medical record system (EMRS)', 'critical success factor (CSF)', 'electronic patient record', 'electronic health record'

After a search string was launched, titles were scanned using the inclusion and exclusion criteria, where words like 'on a dairy farm' indicate articles are not relevant for this research. After this initial scan, abstracts were read, again using the inclusion and exclusion criteria.

The detailed search-method can be found in Appendix A.

2.1.1 Inclusion and exclusion criteria

While scanning papers for relevance, explicit criteria discussed in this section have been used to include or exclude certain publications.

The inclusion criteria are:

IC1: Research relevant to hospital EPR systems.

IC2: EPR or EPR-like information systems are researched

IC3: The research is about success or acceptance of information systems.

The exclusion criteria are:

EC1: The study only describes a suggestion for an EPR-like system.

EC2: The paper itself is a survey, in this case, the relevant papers themselves were consulted using backwards search.

EC3: The research is a very specific research into one single focussed EPR system.

2.2 Defining the EPR system

In the 80s, hospitals started to invest in Information Technology. The systems were limited to generic administrative tasks, accounting, and a list with names and addresses of their patients. In 1999, a survey on automation in Dutch hospitals revealed a quarter of them using some kind of EPR (Harmsen, 1998). Some hospitals incorporate some EPR functionality in their hospital information system 'HIS', some hospitals evolved their electronic medical records 'EMR' to an EPR like system, using it as main source for storing and retrieving patient records, and some even just call it 'EPR', what could make talking about EPR systems confusing. Whatever the name, over 98% of doctors in the Netherlands make us of EMR systems (Barjis, 2010).

The English National Health Service (NHS) defines the EPR as: "An electronic record of periodic health care of a single individual, provided mainly by one institution. " With an added note that the EPR typically contains healthcare related data by acute care hospitals or specialist units (NHS, 1998). This is a widespread definition, but still often inconsistent in many places. When defining EHR, the ISO organization added the note that the primary definition, the most basic, generic EHR is given for completeness and to acknowledge that there are still currently many variants of EHR in health information systems, which do not comply with their main EHR (or ICEHR) definition (ISO, 2005).

There are a lot of acronyms for EPR-like systems, an overview of different acronyms in use can be found in Appendix IV List of EPR acronyms.

For this research, the term Electronic Patient Record (EPR) will be used because it is a very commonly accepted term. It is best described by the ISO's definition of an EHR for integrated care (ISO, 2005).

> *A repository of information regarding the health status of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorised users. It has a standardised or commonly agreed logical information model which is independent of EHR systems. Its primary purpose is the support of continuing, efficient and quality integrated health care and it contains information which is retrospective, concurrent, and prospective.*

2.3 The EPR-system's environment

An EPR-system is not used as an isolated system. The connectedness to other systems is where value can be found (Handler & Hieb, 2007). It requires interaction with other applications within the care delivery organization (CDO). According to Gartner's guidance model (Handler & Hieb, 2007), four categories of systems can be identified:

- extra enterprise systems
- context systems
- cooperating systems
- subscriber systems.

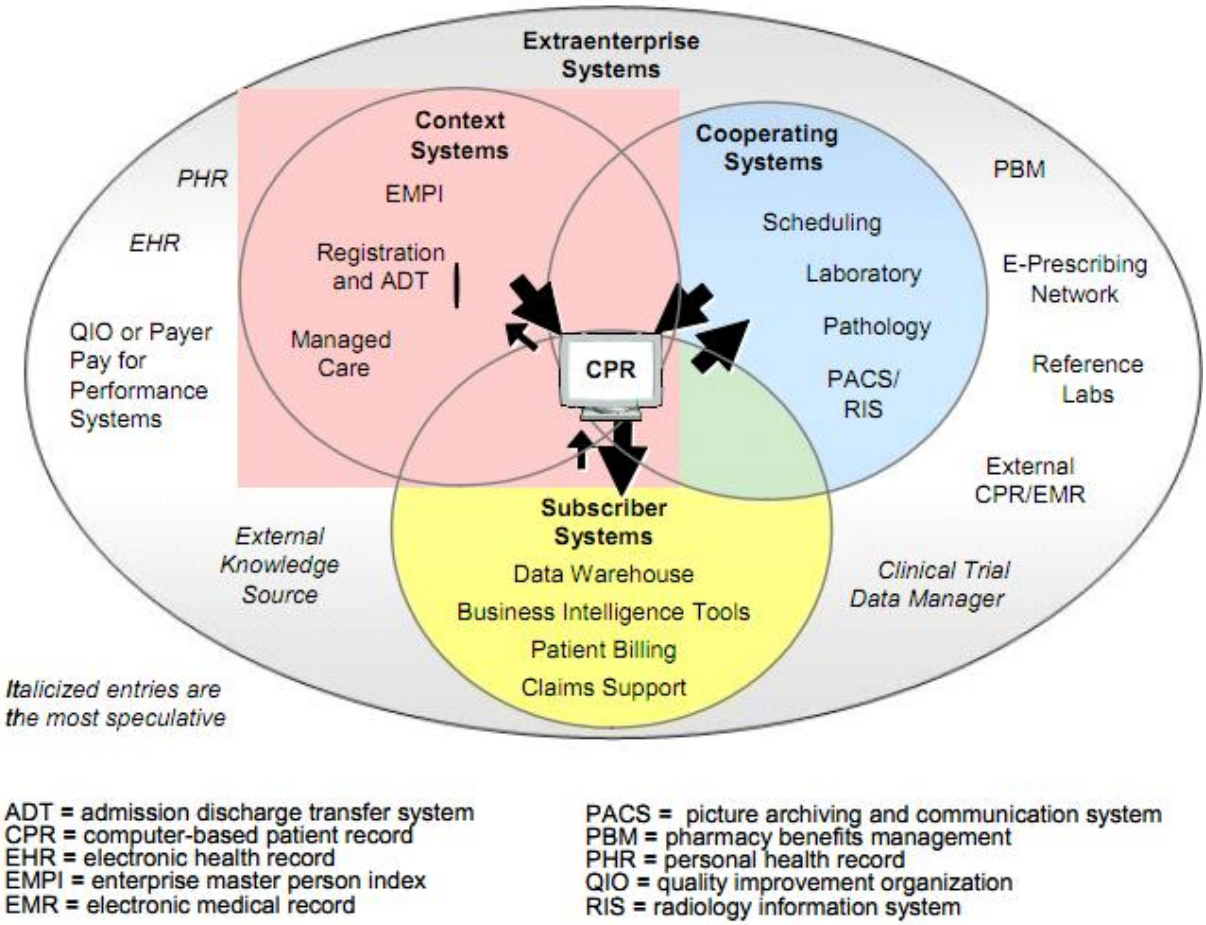


Figure 3 - The CPR environment: an Example (Gartner 2007)

The CPR (Gartner's word for EPR) system can be found in the intersection of these four different types of systems, providing communication between those different types of systems. The CPR could be viewed as the centre of communication for the hospital's information systems, enabling different departments to cooperate, decision making backed by knowledge management and business intelligence.

The CPR's focus is on facilitating communication of medial and patient data amongst the hospital's implemented information systems. For example sharing the patient's history documented in the 'electronic nursing record' (ENR) with clinical decision support systems (CDS) providing real-time guarding and monitoring of variables like the patient's temperature or bloodsugar levels. While the CPR also uses this data from the ENR to compile the list of most relevant patient data, communicated to a physician, providing a basis while determining the patient's treatment.

At its most sophisticated or most infused level, the EHR becomes a hub of all activity, something that permeates every element of the workflow and of work life (Ash & Bates, 2005).

The Dutch expert centre for healthcare informatics, NICTIZ, created a 'Reference domain model' in order to be able to talk about information objects in hospitals (van der Stigchel et al., 2011). The Domain Reference Model for hospitals or Domain Model in short, offers a reference model for individual hospitals which forms a basis for their own situation and which can then be expanded and adapted. This model aims to first map the environment of the hospital, map the business activities, then the information objects and finally the hospital's information systems. In Figure 4 - Example reference domain model application, a hospital's information system environment is mapped. It shows us, the hospital's EPR, in this example called EZIS, is used in a great number of the hospital's business activities.

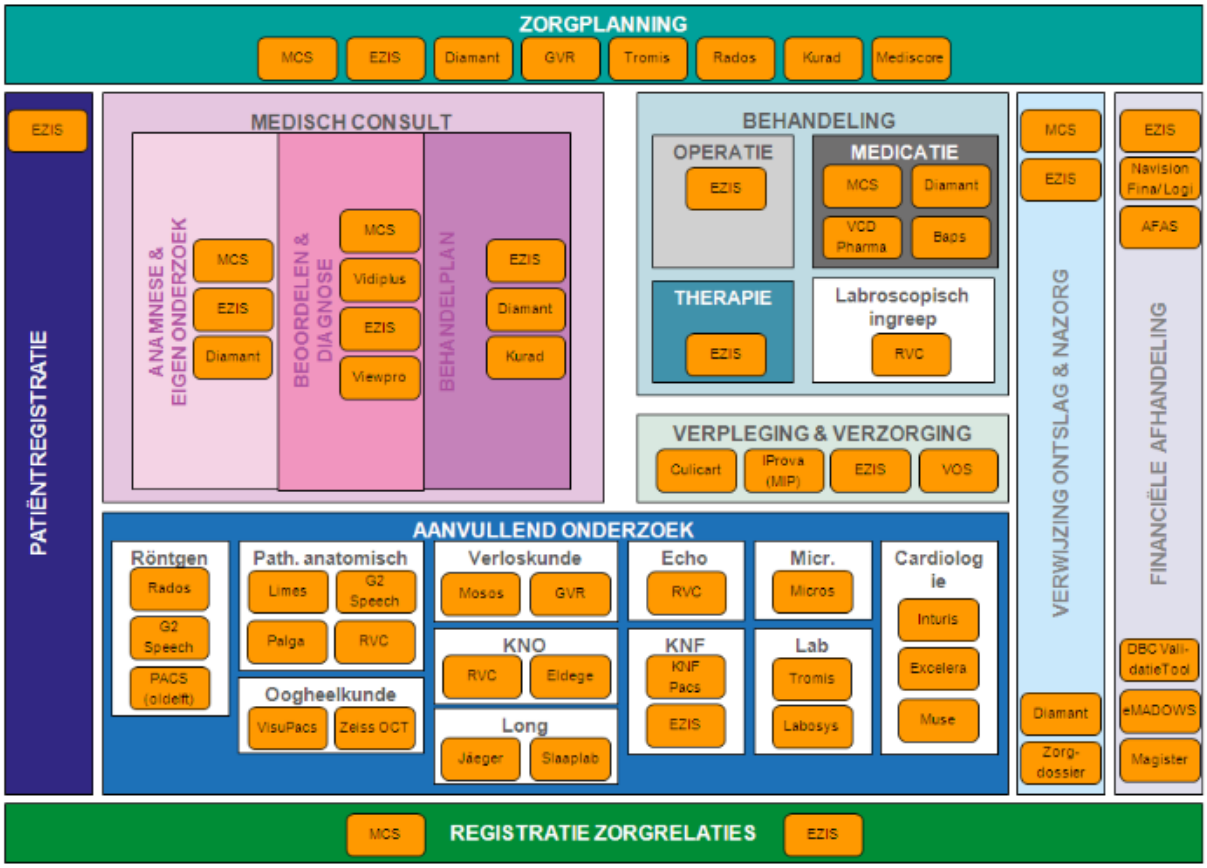


Figure 4 - Example reference domain model application (van der Stigchel, et al., 2011)

2.3.1 Focussed EPR systems

Where some EPR systems are implemented hospital wide and provide the link between all the different business activities (as shown in Figure 4 - Example reference domain model application) some EPR systems are set up with one specific focus (Schilfgaarde, 2006). The 'National Electronic Diabetes Record' is such a system, catered towards a specific goal, facilitating the different healthcare providers involved in the treatment of a diabetic with a shared view on each other's data and for the patients themselves to be able to view their own record and add their findings on 'an electronic diabetic healthcare card'.

Another example of a focused EPR system is the 'Electronic Patient Record for stroke patients' as described by van der Meijden et al (van der Meijden, Tange, Boiten, Troost, & Hasman, 1999). Daily practice at the neurology ward of the Maastricht University Hospital will be supported by this EPR, integrating both medical and nursing record, providing decision support and a connection to the HIS.

2.3.2 Communication

During the study of the EPR's environment, the communication functionality of the EPR system was found to be prominent, thus more research was required in order

to understand this function of an EPR system. A summary about the EPR's communication aspect can be found in Appendix V Communication.

A highly 'loose' architecture with many 'application silos' or 'islands of automation' is comparable to the islands in the manufacturing sector. It is the result of poorly designed and non-integrated IT-strategy. And when those isolated systems, one system for each department, become embedded, they will lock in bad operations practice and the system will fail to reach its full operational potential (Walley & Davies, 2002).

Organizations must come to an agreement on a structured language. This will enable the creation of patient databases, eliminate manual chart auditing, and improve coding. This improvement in data management will cut costs by enhancing efficiency, and more accurate coding will increase revenue (Erstad, 2003).

Communication in healthcare can be between physicians within a department, between physicians, between organizations, etc. These different levels of communication, lead to different implemented standards. In the growing evolving field of healthcare informatics, lack of standards is no problem, the great many different standards are. Within the Netherlands different communication standards are in use. Instead of integration of systems or direct interaction, there are multiple layers of interaction to be distinguished *(Michiel Sprenger, 2010)*. Standard languages for those different layers have been developed to make the connected systems interoperable. Some examples are:

- ICD9 (World Health Organization, 2012)
- OpenEHR (Foundation, 2012)
- SNOMED CT (Aschman, 2003)
- CEN 13606(Services, 2005).
- mapping languages like XML

Further development and adoption of computer-based terminology and communication standards, such as SNOMED, will promote the large-scale dissemination of EHR systems, so that the full range of their benefits may be realized by the largest possible community (Chiang et al., 2008).

2.4 Different generations of EPR systems

When success of EPR systems has to be compared, a fair comparison needs to be made. Since EPR systems and IT in general are constantly evaluating, it is important to be able to classify the different EPR systems before comparing them. Certain lacking features in a previous generation could mean the complete failure

of that generation, where those features could be default in all available systems in a next generation.

Since the first 'electronic patient data collecting systems' began to show up around 1990, EPR systems have evolved and became the core enabler of evidence-based the medicine practice (Handler & Hieb, 2007). Research institute Gartner defined five generations of EPR systems, all of which cover core functionality needed to define an EPR system.

Generation 1 - the Collector

This generation enables site-specific, encounter-based access to clinical data. The EPR system is not yet very connected to other systems, it strictly displays data. It is used as a results-reporting tool, and offers multiple users access to clinical data.

Generation 2 - the Documentor.

This generation provides the users with documentation along-side the patient's records. It gives clinicians the possibility to add (store/write) and edit data in the patient's record. And provide support to message GP's.

Generation 3 - the Helper.

This is currently the most common generation of developed EPR systems. It monitors the data in order to aid the users supporting their processes. The EPR offers support for the care-process supporting activities like order-management, nursing care plans and clinical paths. There is not much 'intelligence' applied to the data. Just some basic rules and protocols are entered into the system.

Generation 4 - the Colleague.

This generation aids the user in predicting and predicating the workflow of the user. So much data is stored and intelligence is applied that a knowledge-base is generated. Combining data from multiple sources from within the CDO (clinical knowledge, business knowledge, patient information), the EPR system can make actual suggestions to improve the patient's wellbeing.

Generation 5 - the Mentor.

Gartner's most sophisticated generation documented. This generation of EPR-systems is able to guide the users in caring for the patients.

Generation 1: Collects and displays information
Generation 2: Makes information interactive
Generation 3: Applies basic rules to information in the system
Generation 4: Changes the work-flow for the end-user based on information in the system
Generation 5: Guides doctors during the care process.

2.5 EPR systems in the Dutch Hospitals

Spil et al (T.A.M. Spil et al., 2010) found that the Dutch hospitals are working towards the 3rd generation of EPR systems. Although hospitals are actively pursuing to get to the 3rd generation of functionality, there is a lack of capability, ill-targeted end user involvement creates a mismatch between the implementation goals and results. End-user-satisfaction seems to be an important criteria to measure the success of an EPR system.

Figure 5 - A complete list of Dutch hospitals and their brand of EPRfeatures a most complete list of the Dutch hospitals and their EPR providers (Zorgvisie, 2009). It shows us the highly disperse landscape of EPR-systems and EPR providers. About seven or eight hospitals use a hospital-wide EPR. For the remainder of the total of 100 hospitals, have some EPR implemented, but there are always a few departments or partnerships that do not participate (Bart Kiers, 2009)

Figure 5 - A complete list of Dutch hospitals and their brand of EPR (Zorgvisie, 2009)

2.6 Theory on success

To be able to say something about EPR's success factors, a basic understanding about success of IT-systems is necessary.

2.6.1 Success from hospital point of view

To measure success from a hospital point of view, success not only needs to be measured from single end-user's point of view, but success from the Hospital level's point of view needs to be explained.

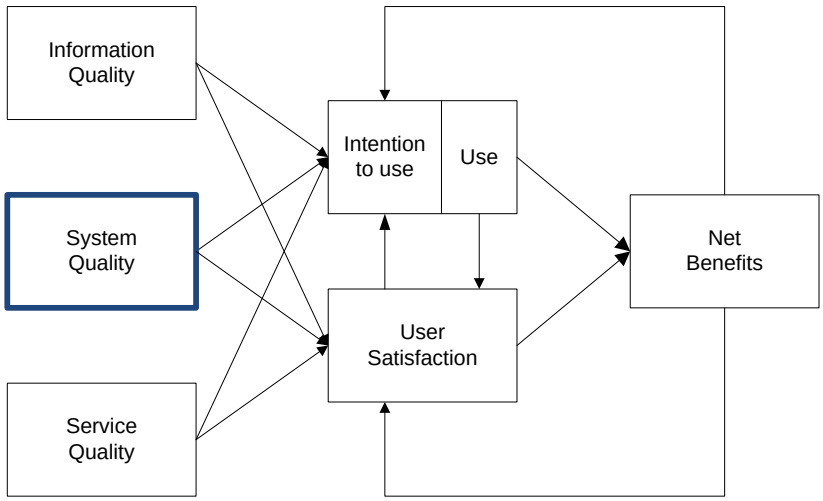
The user receives the benefit he expects from using the system, the system will be used and deemed to be successful. Combining this finding with the more general WordNet definition[2] of the word 'success':

'Success is an event that accomplishes its intended purpose.'

The reason for an organization to start a project like an EPR-implementation project, is for the organization to achieve its organizational goals. The intended purpose of an EPR-implementation project initiated by a hospital should support the hospital's overall purpose. Therefore, hospital's mission and vision statements are scanned and analyzed to discover what the Dutch hospitals attempt to accomplish (Appendix III Goals overview).

2.6.2 Success of IT systems

In DeLone and McLean's updated IS success model (Delone & McLean, 2003), success is measured by "use, user satisfaction, individual impact" and "organizational impact". A causal model will explain relationships between dimensions of success. In DeLone and McLean's model, three major dimensions of quality; "information quality", "systems quality", and "service quality", affect use of the system and user's satisfaction about the system.



[2] http://wordnetweb.princeton.edu/perl/webwn?s=success

Figure 6 - Updated IS Success Model (Delone & McLean, 2003)

The feedback loops from positive "net benefits" to "user satisfaction" and "(intention to) Use" in combination with the causal effect between "User Satisfaction" and "Intention to use" (and thus Use, due to the fact that these are closely interrelated), tells us that when a system is in use, and it is beneficial, people will keep using it. When **System-, Service- and Information Quality** are adequate, and employees of the hospital **use** the system, the system provides **net benefits** for these users, the users will be **satisfied** and will have even more **intention to**, and thus **use** the system, the system is considered a success. This research will focus on the **bold, 'system quality',** aspect of the model, as EPR systems and their use will be studied.

This claim is also supported by research from Metzger and Teich (Metzger & Teich, 1995), "In many cases, physician use of clinical functions is voluntary and, unless they conclude that the system is a reasonable tool, they simply will not use it.".

According to Garrity and Sanders, there are four dimensions of User Satisfaction (Garrity & Sanders, 1998):

- Task support satisfaction, a measure of the fit between the user's job or task and the computer-based system.
    - Decision making satisfaction, a measure of how well a system supports decision and problem solving activities of the user.
- Quality of work-life satisfaction, a measure of how a computer system affects an individual's quality of work-life and job satisfaction.
- Interface satisfaction, a measure of human-machine interface in terms of presentation, format and information processing efficiency.

Saarinen and Sääksjärvi demonstrate that success of information systems depends on both success of the product and success of the process (Saarinen & Sääksjärvi, 1992). Figure 7 - Main dimensions of IS success, shows us that success of the IS product also depend on the development process (investment costs and efficient use of resources). IT also shows that product success is not only dependant on the quality of the actual end product, but also n the impact of the IS on the organization (benefits of the investment). This research will focus on the, **bold, Quality of the IS product**, thus how this quality will impact the work-process of the end-users and therefore the success of the system.

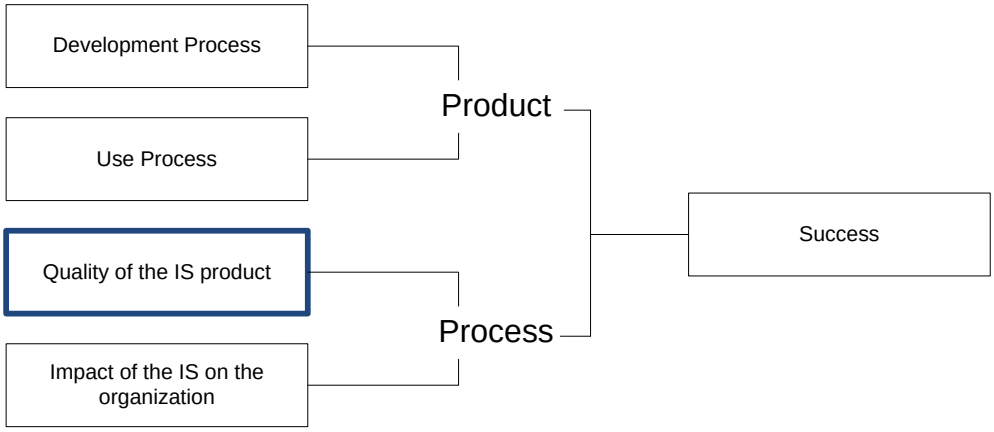


Figure 7 - Main dimensions of IS success (Saarinen & Sääksjärvi, 1992)

Ludwick and Doucette studied adoption of medical records in primary care, and learned that the quality of the implementation process is as important as the quality of the system being implemented (Ludwick & Doucette, 2009). Health system usability, computer skills and the system's fit within the organizational culture and processes are significant factors in implementation success. Their literature study showed that systems' graphical user interface design quality, feature functionality, project management, procurement and users' previous experience affect implementation outcomes. They explored the concept of socio-technical factors, or 'fit factors' complicating health information systems deployment. This socio-technical perspective considers how technical features interact with social features of a health care work environment. Furthermore, the research showed that implementers of IT systems can insulate certain concerns and risk factors by mitigating them with strong leaderships, project management techniques using standards and staff training. The better these risks (Figure 8 - Insulating and risk factors) were mitigated, the less they would compromise the system's implementation success.

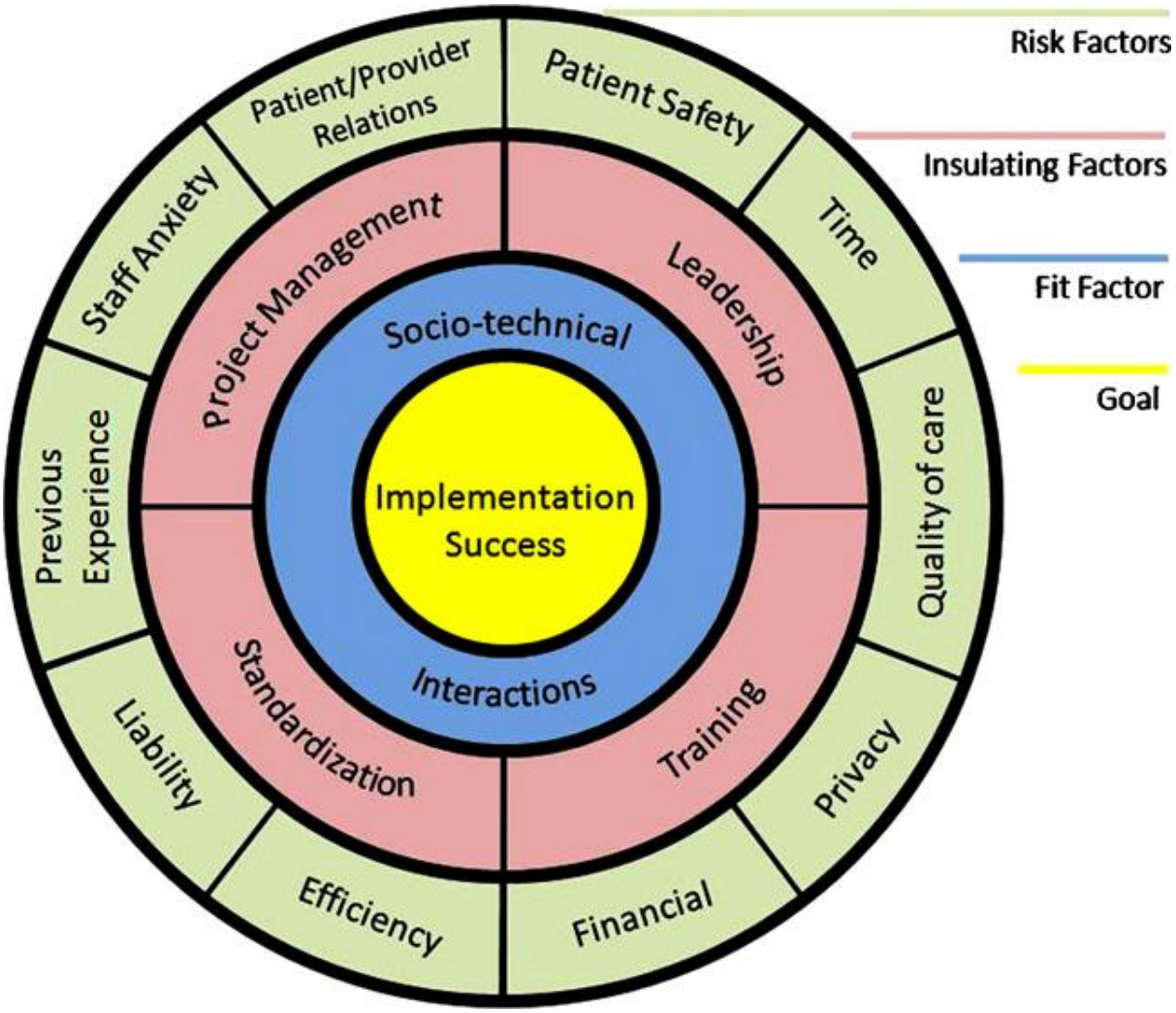


Figure 8 - Insulating and risk factors (Ludwick & Doucette, 2009)

2.6.3 The USE IT model

Although IT should be one of the enablers of change in Healthcare (Pare & Elam, 1999), actually implementing IT systems is a big challenge. The USE IT model focuses on four determinants of user-adoption of IT in healthcare, resistance, relevance, requirements and resources (Schuring & Spil, 2002). The USE IT model is especially designed to explain and predict success or failure of IT (in health-care related projects). It focuses on the product and process on both macro and micro level.

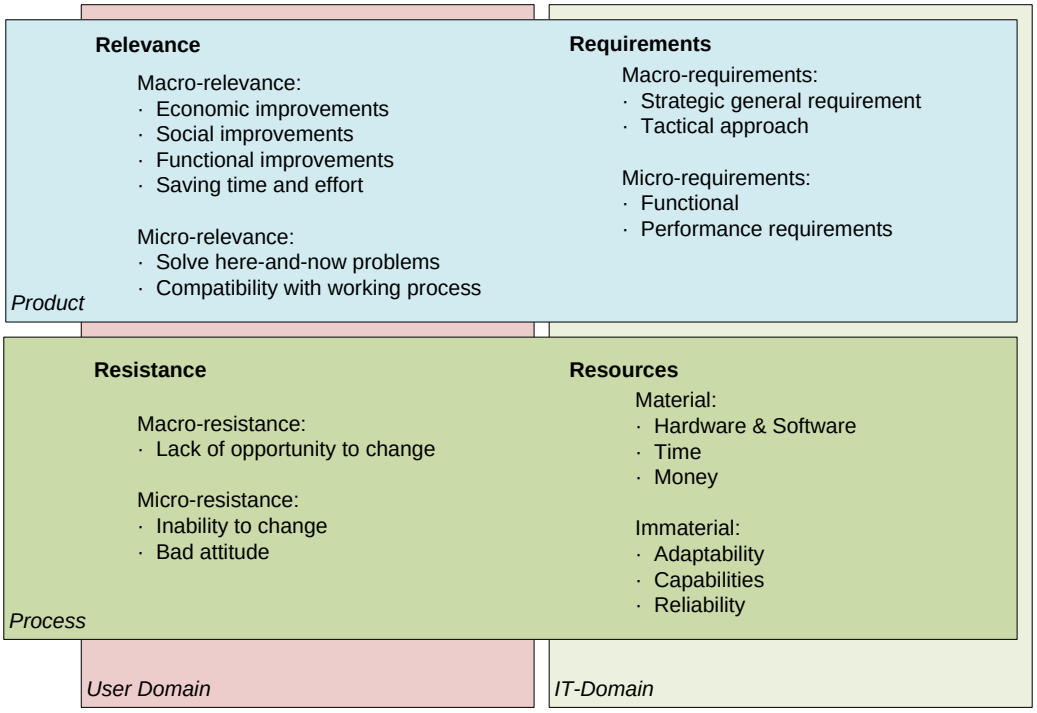


Table 1 - USE IT model (Schuring & Spil, 2002)

This USE IT model has been successfully used researching adoption success of health care information systems in the past. Knowledge and categories from the USE IT model will be applied while researching.

2.6.4 Summary of the theory on information system success

In summary, when a potential user of an information system starts using the system, this user expects the system to give the user some kind of advantage. When the user is satisfied with the kind of advantage the user gains from using the system, he will continue to use the system.

There is a difference between project and product success to be considered when measuring Information System success. Risks compromising the implementation process success can be mitigated by strong leadership, standardization, training and project management. Organizational culture and the impact of the technical features of the health information system on the interaction with social features of health care work environment, complicate health information system's deployment.

Saarinen & Sääksjärvi (Saarinen & Sääksjärvi, 1992) state that the quality of the IS product influences the process, thus workflow of the end-users, which, in turn, influences the success of the information system. DeLone and McLean (Delone & McLean, 2003) explain that System Quality influences the system's intention to use, and use, which provides the user with satisfaction and/or net benefits. Focus of this research will be on these System Quality aspects, the (intention to) actual use of the system, and the influence the EPR system has on the work-flow of the end-user.

As the definition of 'success' leads us to the 'intended purpose' of the 'event', the implementation of an EPR system, the intended purpose of these EPR system implementation projects need to be mapped out as well.

2.7 Summary of the exploratory literature study

To discover that research is needed into EPR systems' success, and to construct a set of relevant research questions (Chapter 3 Research Questions), a literature study has been conducted. This literature research provided context necessary to create a basic body of knowledge about EPR systems, their environment and their features. Research into the field of information system success and adoption will provide insight in how to determine these EPR system's success factors.

The situation of these EPR systems in the Dutch hospitals has been explored, and showed EPR systems providing communication on different levels between users, IT systems, departments, organizations, and between patient and doctor. Different levels, from disease focussed supporting one hospitals department, to a nationwide HUB connecting a great number of different information systems, have been identified.

The USE IT model has been studied to be able to successfully question IT system's users and understand their satisfaction with the EPR system or resistance against it.

The literature research provided this body of knowledge allowing the recognition and perusing of relevant facts about EPR systems and their success factors.

The literature research allows to reflect finding back to the already existing body of knowledge, comparing this research's findings to other published literature, helping to understand what novel results this study yields.

No literature was found about how different EPR system aspects contribute to success of an EPR system. A lot of architectural and proposed functionality is found in literature, while success factors from end-user point of view is not really studied. This research can contribute an overview of system quality aspects and their contribution to a successful EPR system.

3 Research Questions

The Dutch healthcare sector has been struggling to successfully implement and exploit EPR systems for the past decades. No different than any other sector, the healthcare sector, due to rapid change of technology and uncertainty of project's benefits, decisions about how to use IT to empower the organisation are slow and complex (Walley & Davies, 2002). A lot of research has been done aiming to improve the success of EPR implementation projects. So did Michel-Verkerke, M.B. and Spil, T.A.M. (Michel-Verkerke & Spil, 2002). This research produced four success factors and a conceptual model enclosing three categories; administration, medical technology and care process. The research concluded that only when an EPR implementation project can be found in the intersection of the three categories it will meet all of the four success criteria. Since then, a decade has passed, from physicians' remuneration structure, to the general availability of the internet as a low barrier to connect IT systems, a lot has been changed in the field of healthcare information systems.

Since the Dutch healthcare situation seems to be quite uniquely structured, and decisions are made on a lot of different levels, yet the Dutch healthcare is relatively effective (Powerhouse, 2009) the Dutch healthcare situation makes a good research candidate.

EPR systems contain healthcare's core business information, the patient, and what happened to him or her. From the literature (chapter 2.2), EPR systems are at the core of the hospital's IT system. EPR systems play an important role supporting communication between a great variety of entities.

An addition to the current understanding of EPR success can be made when system quality aspects (aspects contributing to success of an EPR system), are discovered. These quality aspects could help update the 2002 model to reflect the current situation of EPR systems in the Dutch hospitals.

3.1 Main research question

The main question this research will try to answer is:

"How can EPR Success Factors within Dutch Hospitals over the past decade be explained; and what topics are most relevant for the next decade?

The aim is to provide an overview of relevant topics and give a state-of-affairs like overview. Mainly a desk-study research method will be used studying both scientific and trade literature. To get a more qualitative and up-to-date overview, several experts will be interviewed and interviews with users of EPR systems will be studied.

3.2 Sub questions

In order to answer the main research question, this question will be split up in a series of sub-questions. Their relation and contribution to the main research question is further explained and pictured in Chapter3.3 Relation between Main an Sub questions.

Sub question A

In order to explain last decade's relevant topics, first they will have to be identified.

"What are last decade's relevant topics about EPR systems?"

This overview will be the foundation on which the 2002-model will be updated. The model should reflect lessons learned from successfully and unsuccessfully implemented EPR systems and other relevant projects. Research done on the subject of EPR systems national and worldwide will be synthesized to form the body of this foundation.

Sub question B

Based on a literature study and interviews, critical success factors will be identified.

"What are currently critical success factors for EPR-systems?"

The overview and insight in the theory of project success will make it possible to compare the orientation, scope and approach of different EPR implementations. Critical success factors can be extracted from the comparison of these projects and topics.

Sub question C

Based on the listed relevant topics and measured contribution to a successful EPR implementation project, the 2002-model will be updated.

"How could the 2002 model be updated in order to explain the success of EPR systems implemented in the Dutch Hospitals?"

To grasp and harness the complex world, a conceptual model will help understanding the situation. In the 2002-research, a few possible future scenarios were constructed with the knowledge gained by creating such a model and applying the model on the researcher's view on EPR systems in the Netherlands (in 2002).

Sub question D

The overview of topics from the last decade, an up-to-date model will enable us to construct future scenarios.

"What are possible future scenarios?"

To answer the "what will be relevant topics for the next decade" part of the main research question, future scenarios will be created based on the research done about the last decade and explained by the updated model.

3.3 Relation between Main an Sub questions

When the sub questions are answered, only then a complete answer the main research question can be given. Figure 9 - Research question tree, places the sub questions in a tree, and explains how the combination of those questions enables for answering the main research question.

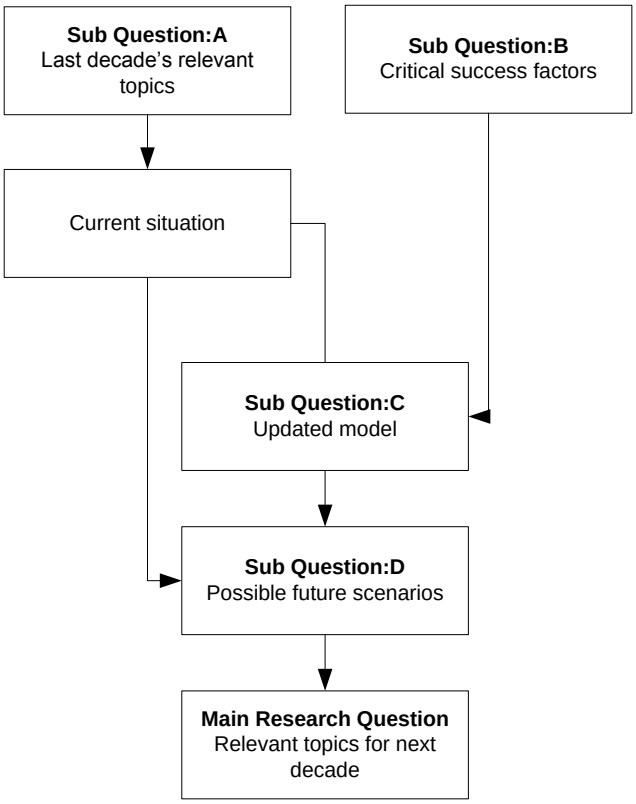


Figure 9 - Research question tree

When last decade's relevant topics about EPR systems are identified (Sub Question: A), and critical the EPR's critical success have been identified (Sub Questeion: B), it is possible to update the 2002-model in order to explain the success of EPR systems in the Dutch hospitals (Sub Question: C). Applying this model to the current situation, future scenarios can be created (Sub Question: D) and the main research question can be answered, explaining what happened last decade, relevant topics can be explained and in combination with success factors and the future scenarios, relevant topics for the next decade can be given.

4 Research methods

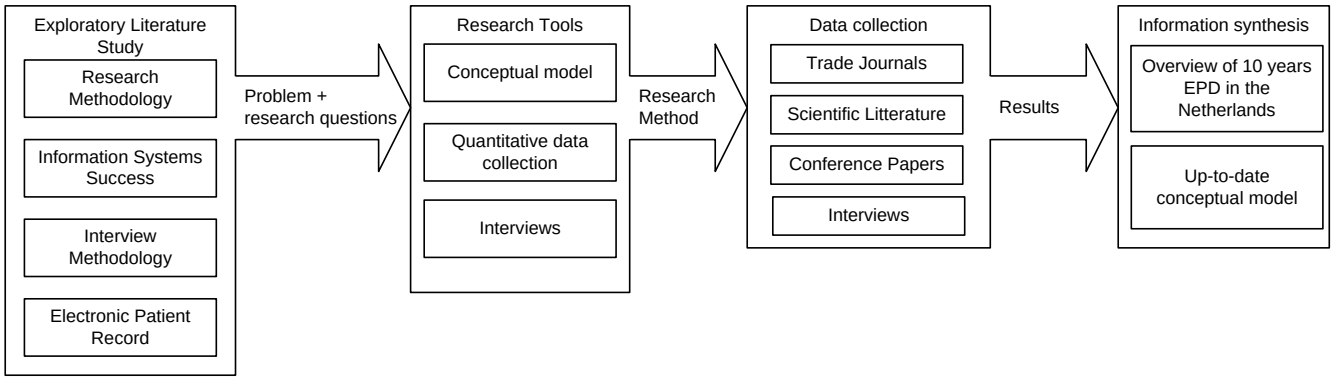


Figure 10 - Research design

Exploratory literature study

The research started with an exploratory literature study. Research was done to get a grasp on the workings of EPR systems, its functions, users and environment. Based on this knowledge of the current state of EPR systems in the Netherlands, relevant 'problems' could be identified and research questions were constructed to provide a solution for these problems.

In order to identify the strategy of 'a hospital' in the Netherlands, a missions and visions scan has been done to analyse the purpose of the Dutch hospitals.

The main research question was separated into different sub-questions. In order to answer these sub-questions more literature research was needed to understand different concepts used in the sub-questions. Concepts like success of information systems, what is exactly 'the Dutch situation' and what is 'system quality'.

Research Tools

Based on that body of knowledge and the research questions, an appropriate research method was selected and the research-steps were designed.

Data collection

These steps included the creation of interviews, and data collection, the search and study of specific literature containing statements about EPR success factors.

Results

Results from this second literature study were summarized and the findings were placed in a concept matrix, updated and sorted as an ongoing process. System

quality attributes were connected to the success factors and based on scores, a new conceptual model was created.

4.1 Data Collection, success factor research

Relevant papers, quotes, articles found during the data collection were placed into a mind-map. The mind-map enables grouping and clustering of results according to theme, concept or dimension. This mind-map is a research-tool and its organic nature and size makes it unable to be represented on an plain A4 paper.

The data used in the 'data collection' part of the research originated from different sources. Beside scientific literature, trade journals, interviews and conference papers have been studied.

Inclusion and exclusion criteria

While searching scientific literature for EPR success factors, explicit criteria discussed in this section have been used to include or exclude certain publications. The inclusion criteria are:

IC1: Dated between 2001 – 2011

IC2: Situational comparable to an EPR system in a Dutch Hospitals

IC3: Case study based research

The exclusion criteria are:

EC1: A focused EPR system

EC2: 'Expected' success factors from (architectural) suggestion how to design an EPR system.

4.2 Trade journal research

In the Netherlands, there are different organizations publishing literature for healthcare specialists. In the Netherlands, the organization called NVMA (Nederlandse vereniging voor Zorgadministratie en Informatie) publishes a well known journal, the NTMA. Up until the 144th issue (June 2011) has been studied to get a grasp on what has changed in the EPR landscape for the last 10 years. Zorgvisie's issues, a Dutch trade journal for (beleid en management in de zorg), have also been studied from 1999 until 01-07-2011's issue. Also, material from special editions and focussed conferences about EPR (or more general e-Health) have been studied.

These journals have been studied and after the inclusion and exclusion criteria have been applied, the findings were put in a concept matrix and can be found in Appendix X Results from trade journals.

4.3 Interview research

Interviews from the University of Twente's Information Systems and Change Management (IS&CM) department have been acquired and studied. These acquired interviews contained interviews with a great range of health-care providers, from physicians to physiotherapists. These interviews have been studied and after the inclusion and exclusion criteria have been applied, the findings were put in a concept matrix and can be found in Appendix XII Results from conducted interviews.

4.4 Interviews

A total of four interviews have been conducted to get an up-to-date view on the state of the Dutch ERP systems and to see different points of view from expert in the field (see Table 2 - Overview of interviews). As mentioned by one of the experts during the interview: "What is discussed on trade-meetings and in trade papers, is between 5 and 10 years ahead on the actual real situation.". These interviews have also added to the accuracy of the status of EPR implementations in especially the Dutch hospitals. All interviews were conducted face-to-face or through video conferencing.

Before each interview, the interviewee was provided with some information on the research's purpose, and the semi-structure of the interview.

To guarantee usable results, the interview model is backed by the USE-IT model (Ton A.M. Spil, Schuring, & Michel-Verkerke, 2004). Chapter **Fout! Verwijzingsbron niet gevonden. Fout! Verwijzingsbron niet gevonden.**, will give a summary of the interviews. The complete interview schematics can be found in Appendix VI The Interview Model. Based on the different orientations provided by the USE IT model, an interview model has been designed covering the different found within the USE IT model. Because of the semi-structured nature of the interview, interesting answers were often pursued further through ad-hoc follow-up questions.

4.4.1 Interview candidates

Four experts have been chosen in four different layers of the Dutch health-care sector.

Participant	Role	Modality
INT 1	Hospital Physician	Face-to-face
INT 2	Consultant Dutch IT healthcare Expert centre	Video-con
INT 3	Project Leader EPR implementation	Face-to-face
INT 4	Hospital CEO	Face-to-face

Table 2 - Overview of interviews

Selecting a candidate from different industry levels provided a global view on the Dutch EPR situation.

4.4.2 Interview model

The USE IT model formed the basis for the interview questions. The different orientations provided a foundation for the different angles of the questions. The interviews started with a short introduction of the research followed by a few question about 'global developments in healthcare and EPR-systems', 'the specific EPR implementation at hand', 'project in question', 'how the project groups were created', what the (measureable) goals of the project were. After these general introductory questions, the dimensions resistance, requirements, relevance and resources were handled.

The interview model aimed to not miss out on any of the dimensions and helped all interviews covering more or less the same topics. This interview model was provided to the interviewees in advance by request.

4.5 Literature synthesis

The first part data collection stage identified source material for processing later on. The body of knowledge provided by the initial exploratory research helped to identify relevant articles. After the selection of articles was made, based on the exclusion and inclusion criteria (chapter 0 Inclusion and exclusion criteria) and stored in the mind-map, the articles were grouped in an evidence table/concept matrix (Watson, 2002).

Grouping relevant topics, and to be able to review Spil and Michel-Verkerke's 2002 conceptual model (Michel-Verkerke & Spil, 2002), success factors mentioned in the articles were initially grouped using the same orientations used in the 2002 research;

- medical technology
- care process
- administrative automation, (renamed to administration).

The interviews were processed in similar manner. After transcribing the interviews, the interviews were scanned for success factors. These factors were grouped by the orientations mentioned.

5 Results

This chapter will feature the results of the data collection (the search for success factors), and the conducted interviews.

To be able to determine the overall goal of EPR systems, a missions and visions scan was done to be able to know in what way an EPR system could influence relevant stakeholders (Chapter 5.1 EPR in the Netherlands). To be able to determine what specific information system attributes add to the success of EPR systems, ISO/EIC 9126 system quality attributes have been used (Chapter 5.2 List of system quality attributes ISO/IEC 9126). Success factors found in scientific literature, gathered during the 'success literature study', have been grouped according to their specific orientation (Chapter 5.3 The Orientations). After which the same have been done for success factors found in trade-journal/meeting articles, and the studied interviews.

Chapter '5.4 Results from the study of scientific literature' summarises results from the scientific literature study.

Chapter '5.5 Results from the study of trade journals' summarises the results from the trade journals study.

Chapter '5.6 Results from the study of interviews provided by IS&CM' summarises the results from the studied interviews.

Chapter '5.7 Results from study of Conducted Interviews' summarises the results from the study of these conducted interviews.

Only after the study of, scientific literature, trade journals and the interviews, it was possible to finalize the grouping of success factors into the different orientations explained in Chapter 5.3 The Orientations. Using the techniques of the concept matrix proposed by Watson (Watson, 2002) and a mind-mapping tool, this organic process was made possible.

5.1 EPR in the Netherlands

Missions and visions from the biggest Dutch hospitals found on the Hospital's websites have been scanned in order to get an idea for a Dutch hospital's strategy. Projects undertaken by the hospital should –in some way- add to this main goal. A successfully implemented EPR system could add directly or indirectly to the hospital's goals. Scanning these goals gill give an indication where and how to look while researching success of EPR systems in the Dutch hospitals. A table with the results of the scan can be found in Appendix III .

Common goals in these mission statements are:

- direct communication lines
- a focus on people, both employees and clients
- catering towards the patient's needs and expectations
- high quality of care.

5.2 List of system quality attributes ISO/IEC 9126

Within systems engineering, quality attributes are non-functional requirements used to evaluate the performance of a system (Jung, Kim, & Chung, 2004). These are sometimes named "ilities" after the suffix many of the words share. The International Organisation for Standardization, ISO, in cooperation with the International Electronical Commission (IEC), are responsible for the ISO/IEC 9126 standards defining system quality attributes using the attributes found in Appendix VIII System quality attributes.

5.3 The orientations

Articles have been scanned for success factors after they complied to the inclusion and exclusion criteria. These 'quotes' or 'statements' found about EPR success have been put into a concept matrix according to a specific orientation they would fit in. Starting with the three orientations from Spill and Michel-Verkerke's work in 2002 (Michel-Verkerke & Spil, 2002), during the research, orientations were added, removed and consolidated.

In the 2002 model, a 'care process' orientation was present. This care process orientation represented the 'healthcare information functionality'-part of the EPR system. Whereas the 'administration' and 'medical technology' orientations represented EPR functionality, evolved from administrational IT systems and the separate medical equipment's information systems. As a result of this research, the old 'care process' orientation has been separated into three orientations; care workflow, integrated care and internal cooperation. Information management could be seen 'support'-orientation, providing access to information about the entire care process.

During the research, the following orientations arised:

- administration
- medical technology
- care workflow
- information management
- strategy
- internal cooperation
- integrated care
- *management information.*
- *patient empowerment.*

Later on, success factors listed in 'patient empowerment' were filed under different topics as they were ultimately about 'administration made easier', or 'care process made more transparent', and this orientation was removed.

Success factors listed in 'management information' were combined with strategy, as they were all about how to manage the hospital, short- (management dashboards, hospital/department performance indicators) or long- (securing relations with other health-care providers) term.

The resulting orientations can be found in the corners of the **surface** of the heptagon in Figure 11 - Orientations in the success model. Figure 11 depicts the

final results of this research, where different orientations have different impact on the success of the EPR system. Different system quality aspects (List of system quality attributes ISO/IEC 9126) have been revealed during this research and their relevance to the different orientations will be distilled from the results revealed in the next chapters.

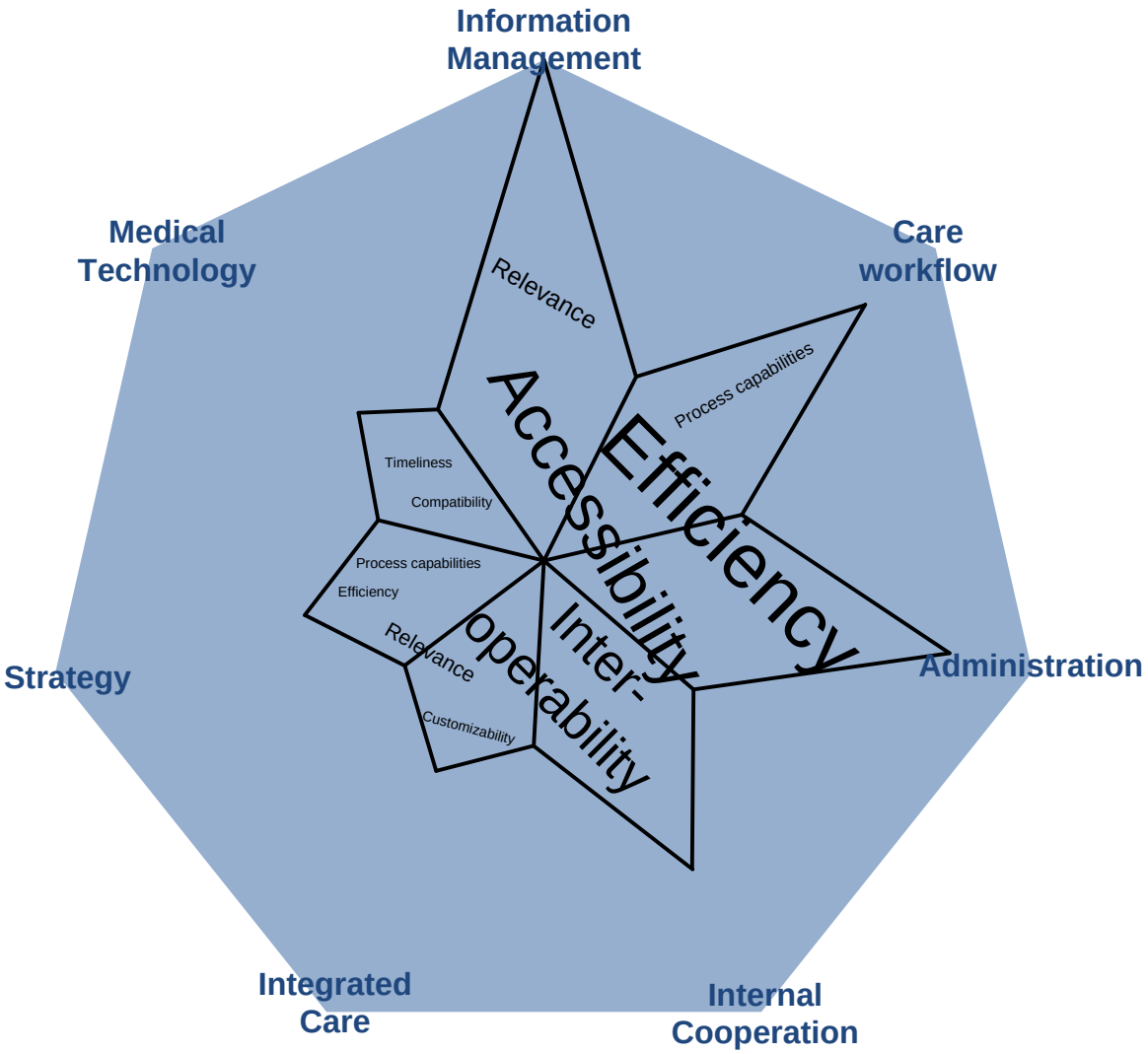


Figure 11 - Orientations in the success model

There are some similarities found in scientific literature when looking at the EPR's four main tasks; documentation, communication, decision support, re-use of information (Freriks, 2010). Decision support could be found in the new strategy orientation. Communication is a major aspect in the internal cooperation and integrated care orientation. (Re)-Use of information could be found in the information management orientation. Comparing to the quantifiable benefits of an EPR systems found by Shekelle et al (P.G. Shekelle, S.C. Morton, & E.B. Keeler, 2006); data capture and access, decision support, quality of care, business

management and streamlining patient flow, some similarities can be drawn with the orientations found in this research. As the most quantifiable benefits, will most likely be mentioned when searching for success factors, data capture and access would fit in the information management orientation, decision support in strategy, quality of care and streamlining patient flow in integrated care and business management would fit into the strategy orientation.

Another review of literature from 2003, separated the benefits associated with an EPR system into these four categories: clinical, workflow, administrative, revenue enhancement (Erstad, 2003). Revenue enhancement would fit into the strategy orientation, the clinical and workflow categories would fit into the care process orientation and the administrative category is an orientation on itself.

Administration

Administration is one of the three orientations from the 2002 research by Spil and Michel-Verkerke. The administrative orientation is mainly the 'office automation' orientation. Supporting administrative processes like registering treatments, creating a schedule for hospital-bed availability. Or more general; retrieval, editing and storing of patient's medical records. This definition differs from the original definition in that it focuses more on 'general administrative tasks' and less on 'providing access to patient information'. Selection, filtering and 'intelligently' retrieving patient information fits in the orientation, 'information management'.

The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

Medical Technology

The second orientation from the 2002 research, the 'medical technology' orientation, finds its origins in the Picture Archiving and Communication Systems, systems which are called PACS nowadays. Clinical laboratories cannot accomplish their tasks without IT, IT systems are not only used for testing, but also for quality management, administration and distribution of the laboratory's findings to clinicians (van den Berg, van der Graaf, Helmsing, & Peters, 2000). Intensive care units are high-tech environments with many medical IT systems guarding the patient's condition. Comparable IT systems where information from medical equipment is automatically stored, and accessed via the EPR (or the EPR's connections to different medical IT systems) communicating with medical equipment, are all listed in the orientation medical technology.

The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

Care workflow

The definition of the third original orientation is slightly changed compared to the definition from the 2002 research. Where the 2002 research's definition focussed the care process's definition on EPR systems focussing on health chains, and initiatives for exchange of messages between hospitals and general practitioners, the definition used in this research is focussed on supporting care-processes within the hospital itself. Guarding medical protocols, providing decision support functionality, and making the care process more transparent.

The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

Information management

The new information management orientation contains success factors about the provisioning of patient information. EPR systems filtering out relevant information for its user depending on its user, the time of day, the patient or the 'view' on the information specific to the end-user's desire. Where entire boxes of plain A4 papers had to be read and summaries summarizing summaries had to be made, information management success factors are taking away the search for information and let the EPR system do the searching/filtering and the provisioning of the requested information, helping its users coping with large amounts of information, highlighting what is 'important' at that specific moment for that specific user and the requested record (this would require a lot of intelligence residing inside the EPR system). Want to know the amount of patients with condition X, the EPR system will provide you with a list using a few filters or a search operation.

The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

Strategy

The strategy orientation was initially split up in a 'strategy' and a 'management information' orientation. However, both orientations concerning success factors guarding the 'health' of the hospital's business-processes and guarding the 'direction' of the hospital, they were combined into the one orientation, strategy. EPR systems can give managers insight in the number of patients 'processed' by a specific department, or providing benefits to other care-providers in order to 'lock them in' and preferring working with you rather than with a different hospital, securing market share and relations.

The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

Internal Cooperation

The internal cooperation orientation focuses on EPR success factors concerning sharing information about the care for a patient with colleagues. These success factors could come from enhanced support for cross-functional teams, a second pair of eyes on a patient's status, or bridging a physical location gap between two different caregivers.

The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

Integrated care

Some of the success factors from the integrated care orientation were initially listed under 'internal cooperation', but success factors enabling integrated care are more specific to the EPR's system to support care protocols and guide a patient through his or her stay in a hospital. These could be department, hospital or regional-wide improvements. It guides the patient's information through different levels of care, e.g. primary, secondary and tertiary, or enables cooperation on the same level, e.g. cross-functional teams or even provide 'provider continuity', seeing the same physician each time.

The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

5.3.1 Summarizing the orientations

The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

5.4 Results from the study of scientific literature

Beside the orientations described by Michel-Verkerke and Spil (Michel-Verkerke & Spil, 2002), administration, medical technology, and care process, the literature research resulted in four more orientations from how success of EPR systems can be explained. The results can be found in Appendix IX Results from Scientific Sources and are explained bellow.

5.4.1 Administration

The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

Most important in administration is to work with reliable and accurate date, the EPR system provides this (C. Sicotte, 2009). Not only the information is reliable and accurate, but using an electronic system to access clinical information saves time compared to the old paper record keeping system (Erstad, 2003). The EPR can also alleviate some of the load from other, overused health services, by enhancing access to data (P. G. Shekelle, S. C. Morton, & E. B. Keeler, 2006). A system especially designed to provide access to patient's records will be more efficient providing clear access than other systems with this functionality as added in retrospect. It will also be more efficient than systems for which providing this service is a secondary task. Plan and simple retrieval and entry of files is that much smoother, quicker and adjustments are real-time updated for one single point of truth (Farsi & West, 2006).

Time required for most administrational tasks is decreased within months after EPR implementation (Keshavjee, Troyan, Holbrook, & VanderMolen, 2001). Beside the time it saves, additional benefits in administration processed by EPR systems provide improvements for the organisation. Economic incentives, such as improved coding accuracy, improved charge capture, and improved submission of billing claims are such improvements (Chiang, et al., 2008).

Healthcare industry has to bill its clients like any other industry. The big difference compared to other industries is that within healthcare, billing comes from great many departments within the organization. Within those many different departments, billing comes from often a huge number of different people, all billing for different medical interventions. Better capturing of these charges and decreasing billing errors promises instant benefits (Wang et al., 2003).

Low barrier of usability of technology for especially documentation purposes could motivate greater IT use for quality improvement (Miller, Hillman, & Given, 2004). Requiring computes to be used for key administrative tasks (Jha, Doolan, Grandt, Scott, & Bates, 2008) prevent errors and lower the accessibility barrier. Better

usability and greater motivation is something which help alleviates the pressure on the healthcare sector keeping employees happy, lowering the pressure on their job (Ubink-Velmaat, Broekhaar, & Bilo, 2000).

5.4.2 Medical technology

The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

The connection between EPR systems and medical equipment makes real-time analysis of clinical data possible (P. G. Shekelle, et al., 2006). This will provide a solid basis for future decision support capabilities of EPR systems or separate decision support systems or modules. Improving patients safety and aid in decision maker for both experienced and inexperienced physician (Müller et al., 2001).

5.4.3 Care workflow

The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

The electronic record keeping system provides a thorough and efficient way to manage patient information (Erstad, 2003). With relevant patient information available for the physician during his consulting hour, patients feel better when their attending physician creates a relationship of trust (Delpierre et al., 2004) showing he knows his or her patient (Margalit, Roter, Dunevant, Larson, & Reis, 2006).

Within the care process the EPR system acts already as a platform for decision support, improving the clinical processes. Most available evidence, like patient safety (in e.g. medical use), disease management, immunizations, shows the positive effects of ambulatory EHRs on the care process (P. G. Shekelle, et al., 2006).

Providing a clear overview on the patient's medical status the EPR system aids in savings for drug expenditures and improved utilization of radiology tests. Both for the good of the organization's expenditures and for the patient's health (Wang, et al., 2003). For example, less intake of medicines with harmful side effects. EPR trained physicians report an overall improvement of the quality of care using the EPR system (Farsi & West, 2006). In some cases staff time spend on charting increased with time. However due to the fact that nurses were given more responsibility for charting in many offices, combined with generally a greater number of nurses available, and nurses having lower wages, EPR supported charting will still provide a benefit for the hospital. Physicians' charting time also reported to have a chance to increase, but will go down the longer they use the system or the better training the system's users receive (Keshavjee, et al., 2001).

The EPR overall improves practice efficiency (Chiang, et al., 2008) and quality of care (Jha, et al., 2008) and increased accessibility to established care protocols (Delpierre, et al., 2004).

Due to the impact on the workflow of the end-users, and physicians' professional autonomy, sometimes it is more successful to start with a 'smaller scale' EPR, let the system and organization re-align after an initial implementation and start enabling working with decision support systems in later stage (van der Meijden, Tange, Troost, & Hasman, 2001). Only after enough process capability (well organized processes in a mature organization), the implementation of process aiding technology will be implemented and used successful (Walley & Davies, 2002).

5.4.4 Information Management

The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

With the huge amount of information available today, information management is as important as access to the information (Königer & Janowitz, 1995). Information management contributes to the success of information management by enabling the end-user to locate comprehensive information, relevant to the task at hand (Erstad, 2003). Kalogeropoulos, Carlson and Collison suggest further development efforts to be directed "towards the development and integration into the online intelligent clinical information management support system of the higher-level decision support. Functions embodied in the practice of evidence based medicine." (Kalogeropoulos, Carson, & Collinson, 2003).

Ease of use of EPR systems is an important aspect of quick and appealing information retrieval (C. Sicotte, 2009).

Also the patient's ability to manage his own information will strengthen success of EPR systems. Self management of patient's own health-care contributes to the demand driven care. The shift towards demand driven care will make the healthcare industry can work more efficient, with the EPR system as the indicator of this demand (Beun, 2003).

5.4.5 Strategy

The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

Decisions about what information system to implement, or which modules to activate in an EPR are strategic decisions (Wang, et al., 2003). An EPR system will help management to provide comparative information about what 'works' in using IT (Miller, et al., 2004). Management will be able to access overviews with performance information about specific departments, but also has insight in the

duration of a patient's stay in the hospital. Especially in the Netherlands, with the introduction of DBC payment structure, knowing which interventions pay out, and where costs are higher than benefits, or interventions go unpaid, this strategic information is vital (Kwa, 2010).

The patterns across countries reflect the effects of underlying strategic choices of policies within countries, including the extent to which payment practices and other initiatives are national in scope or depend on local, market-driven actions (Schoen et al., 2006). In each country in this study, the question of how to pay for care to reward and support improved performance. EPR systems help make healthcare more transparent, thus support these initiatives.

To enable empowerment of operations' maturity and development of clinical paths, IT maturity must coincide with projects and operations maturity (Walley & Davies, 2002). A successful EPR systems implementation trial will guide the organisation through thorough rethinking of business operations.

To keep business demand in line with the demand driven care, the EPR system will aid the development process of the organisation reflecting the orientation towards demand driven care (Beun, 2003).

Organizational change cannot be successful without support from top management and sufficient financial support (Katsma, 2008). To successfully implement an EPR system, direct financial support is another important lesson, is that without a considerable, concerted effort, which will likely include re-aligning financial incentives, EHR adoption in hospitals will lag behind (Jha, et al., 2008).

Where during the past decade the health-care sector developed healthcare management methodologies for hospital level management to the desired disease and patient management level, underlying information and knowledge management technologies have failed to be integrated into routine clinical practice (Kalogeropoulos, et al., 2003). An EPR using both information and knowledge as clinical objects at basis of clinical decision support, facilitates both the organised acquisition of clinical information and knowledge provides a solid foundation for effective knowledge-based decision support and clinical information management support systems.

5.4.6 Internal Cooperation

The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

People's live expectancy is higher every year, and therefore have more and more complex problems. The trend in hospitals is to work in more and more cross-functional teams, and to facilitate communication between these teams, the EPR system's role is vital (Sykes, Venkatesh, & Rai, 2011). Not only test results can be shared by multiple physicians, the patient does not has to restate his problems

each new face he or she encounters. Many eyeballs on the patient's file prevent medical errors or can catch potential complications earlier in the process (Raymond, 1999). EPR trained physicians note an instant improvement in communication, between colleagues and between departments (Farsi & West, 2006).

The development of the EPR system, is an ongoing process. Involving healthcare workers in this process is crucial, for both EPR system and organization (van der Meijden, et al., 2001). Organizational process and IT system will be more aligned, and the organization's performance improves (Ash & Bates, 2005).

5.4.7 Integrated care

The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

Also known as coordinated care, comprehensive, seamless or external care, integrated care is a worldwide trend in healthcare (Kodner & Spreeuwenberg, 2002). Organizations are reformed focusing on more coordinated and integrated forms of care provisioning. Aiding in this organizational refocus, and coordinating the care-process is the EPR system, even more improving the structure of care delivery (P. G. Shekelle, et al., 2006). Also outside the organizational boundaries the EPR system provides chart requests, referral reporting, provider-payer, and provides other health care information exchange and interoperability transactions (Walker et al., 2005). Condition for this interoperable healthcare information exchange is ubiquitous electronic clinical data exchange, something embedded in the roots of the EPR system (Miller, et al., 2004). EPR systems and especially the more successful implementations feature many links to other systems (van der Meijden, et al., 2001) and therefore are suited to play the hub role in the information architecture within the hospital and to provide ubiquitous information to relevant and authorized care-providers.

The EPR system especially stimulates to cooperate the physicians who are the less connected amongst their colleagues. Physicians who were better connected, both directly and indirectly, to their peers—that is, other physicians—for advice on their work, used the system less than those who were less connected (Sykes, et al., 2011).

With relevant patient information available for the physician during his consulting hour, patients feel better when their attending physician creates a relationship of trust (Delpierre, et al., 2004) showing he knows his or her patient (Margalit, et al., 2006). Seeing the same physician each time enables a therapeutic, trusting relationship (Gröne & Garcia-Barbero, 2002).

5.5 Results from the study of trade journals

Trade journals, reports from trade meetings and conferences have been researched for EPR system success factors. These success factors have been translated into system quality attributes and can be found in Appendix X Results from trade journals. The findings per orientation are explained bellow.

5.5.1 Administration

The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

One of the most clear success factors in the administration orientation is the ability to successfully declare a higher percentage of DBC's. Empowered by the emphasis of the demand driven care, the administration of a clinical path, and the direct connections to the DBC in one overview helps the organization prevent administrational errors and miss out on payments for treatments (Knotnerus & Stegwee, 2010). This process will also be more transparent for both patient and for Insurance company (Schilfgaarde, 2006). Because of clear process definitions, required by the EPR, and enforced by the EPR implementation process (business process reengineering), quality of those processes will be higher and administration will be more fluent (van der Meyden, 2011).

The shift to different tasks within the administration orientation made the clinic more accessible for its patients, for example; departments were much more accessible to be contacted by phone (Tan, 2009). No longer, administration will spend time searching for a specific record (Zwemmer, 2005), physical transportation and distribution of records (Veeze, 2001). Mundane tasks like data entry don't have to repeated for multiple systems (Plass, 2008).

The EPR's ability to integrate with different modules and systems eased the administrative burden significantly as more information was available in one system (Korporaal Heijman, 2010; Nelwan, van der Putten, Smits, & Slingerland, 2002).

Records from the EPR are ready to be processed or connected to scientific research without pre-processing from administration department (Veeze, 2001).

5.5.2 Medical Technology

The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

With a structured source of patient- and process information available in the hospital's own data-repository, real-time data-mining is possible. This will give insight in the performance of different processes and clinical paths (Schilfgaarde,

2006). Real-time information about patients in critical conditions is essential. Access to real-time data, from the CDR (clinical data repository), visible for multiple parties will attune actions in the care process. A graphical overview of the collected data helps motivating patients during their treatment (Veeze, 2001).

Multiple departments can request tests from internal or external laboratories, or request recourses from the hospital via computerized physician order entry, supported by the EPR system (Knotnerus & Stegwee, 2010).

5.5.3 Care Workflow

The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

The EPR enforces a structured approach with pre-defined processes which will help predicting, scheduling and attuning care processes (van der Meyden, 2011). A more complete planning and the overview of the entire clinical path makes the process much more predictable and smooth for both care provider and patient (Meulder, 2009). Important combinations of clinical parameters and trends will be noticed earlier on in the process, and, when implemented, by the decision support system/module. Outliers will be much easier identified because of the structured overview the EPR inherently provides. The ability to generate graphical overviews enhances this even more (Veeze, 2001). Problems with patients and their treatments are quicker recognizable (Klemann, 2001) .

With the introduction of the EPR system came also the 'clinical data repository'. A real time database with data from multiple clinical sources, providing an unified view on all the hospital's patients. It allows for quick scans and up-to-date access to medical information (Knotnerus & Stegwee, 2010). During transfers of patients, data doesn't have to be copied, but can be requested from the EPR on demand (Bart Kiers, 2009). Physicians don't have to re-order tests when they are already conducted or requested by someone else. Timeliness of test results is important (Bart Kiers, 2009).

Also, cross-functional processes are enhanced by sharing the patient's records (Hilderink, Goossen, & Epping, 2002).

Just the benefit from the time it takes to register the different treatments, and having to do this only once, at one place will make all the difference (Klemann, 2001).

The EPR aids medical staff to follow medical protocols much more strictly. Work is done more methodically and processes will be executed quicker and more effective (Klemann, 2001). When enhancing the workflow in this structured manner, it is easier to improve the process' quality (Vast, 2005). Uniformity of patients' records and more readable record keeping, will make the organisation more transparent (Tan, 2009).

Communication between patient and physician, patient and his own record, provided by an EPR system, is an important benefit in keeping the patient involved in his care-process (Kremer, 2009). The patient feels important and empowered when they have the ability to view their own record. They can add or explain to specific findings, providing more, and possibly important, information for the caregivers (Schilfgaarde, 2006). The patient feels 'part of the team', the team which is working to improve his health. Having access and responsibility helps the patient trusting the information in his record (Postma, 2009). Patients feel more at ease when their physician already knows their story from the EPR, without the patient having to inform yet another person (Bart Kiers, 2009). One single record with a clear overview is more accessible than a few records stored in multiple systems.

5.5.4 Information Management

The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

The EPR system is a critical factor for clinical research. A direct connection to the database with uniform and structured data required for trials and research replaces the re-entering of data into forms, or translation into different templates, for different medical-trials (de Moor, 2009).

EPR's ability to connect directly to other systems and the role the EPR fulfils distributing the information from these systems is an important success factor (Korporaal Heijman, 2010). One of the bigger benefits from the EPR system is this availability of historical data. Data already documented by the system in a different department can be used, and cooperation is enforced, decision support and scientific research is made possible (Freriks, 2010). Adding enough context, or clear agreements on the exact nature of the data is important in order to make it valuable for re-use (Berg, Goorman, Harterink, & Plass, 1998). Enforcing standards is one way to achieve this.

When data is structured and stored more conveniently arranged, physicians are more likely to pick up on specific parameters and coherence between parameters form the patient's status. Information is better stored through time, and access to less-recent information is improved (Veeze, 2001).

Ordering the information in a clear and structured manner, and the representation of this information and its meta information is improved. There is less confusion about who added what information, for what purpose and when (Klemann, 2001). And no longer, records will be incomplete or lost (Tan, 2009).

Because the information is structured, medical guidelines are defined, templates are pre-made and available via the system, for example; referral letters can be (partly) generated, saving a lot of time for the physician (Tan, 2009).

5.5.5 Strategy

The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

EPR systems, and their inherent connections to different (external) systems are also used to strengthen the connection with third parties like GPs. Providing both patient and other health-care providers with (web)portals helps binding patient and GP to keep using your organization as primary information source, thus enabling future business (Bart Kiers, 2009). Also internal employees benefit from maximized 'professional support' from EPR systems, improving their motivation, important for a sector with a small labour offering.

To help management manage, specific queries and management summaries can be prepared, providing information for during audits of specific departments (Tan, 2009).

"One of the EPR's success factors is clear management information." (van der Meyden, 2011). The EPR provides management with important management information, providing insight in errors, wait-times, an patient population (Bart Kiers, 2009). The EPR provides management with an important historic overview (Vast, 2005). This will enable management to anticipate the different quality aspects of the different departments and helps management guard these.

5.5.6 Internal Cooperation

The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

Multiple departments can request tests from internal or external laboratories, or request recourses from the hospital via computerized physician order entry, supported by the EPR system (Knotnerus & Stegwee, 2010).

Especially for the healthcare process, it is important that all different healthcare providers who are involved in the treatment, are able to view each other's data. And simultaneously sharing the same patient record. The support for integrated healthcare and cross-functional teams are of great importance to diabetic patients (Schilfgaarde, 2006). Providing multiple physicians with the same record on every moment will lead to less medical- , less medicinal-, diagnostic and operational errors (Bart Kiers, 2009). Patients benefit a lot from internal communication among physicians, so much that better coordination even fewer patients end up on the operation table (Vast, 2005).

Internal cooperation during the development of the EPR system is also very much recommended, commitment from management and staff during the development process will lead to commitment to the EPR when the EPR is actually implemented (Korporaal Heijman, 2010).

Real-time access to information provided by earlier steps in the health-care process makes cooperation between geographically dispersed surgeons, radiologists and pathologists so much smoother. Every step in external care processes will take less time (Vast, 2005). And communication in cross-functional teams will be greatly improved (Klemann, 2001).

5.5.7 Integrated care

The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

EPR systems enable care across multiple organisations or departments, an important ability when boundaries are fading and more and more cross-functional teams are required in complex treatments (de Moor, 2009; Hilderink, et al., 2002; Meulder, 2009). The EPR provides access and guards medical protocols which enable multiple persons to undertake multiple steps curing one single patient (Hilderink, et al., 2002).

One of the bigger benefits is enabling access to patient's records to authorized care-givers and the ability to re-use information throughout the care process (Freriks, 2010). Providing a GP access to the medical records strengthens the relationship between GP and Hospital (Bart Kiers, 2009).

Via the EPR, information from all over the hospital is suddenly visible on one single screen (Nelwan, et al., 2002). The EPR provides the basic architecture to make this, and 'interaction between multiple applications or departments', possible.

5.6 Results from the study of interviews provided by IS&CM

Interviews conducted by the University of Twente's Information Systems and Change (IS&CM) department have been studied. Interviews found in scientific literature and in trade journals have been scanned for success factors. Data from the four conducted interviews for this specific research have been excluded in this chapter as they will be discussed separately. Appendix XII Results from conducted interviews gives an overview of these system attributes per source.

5.6.1 Administration

The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

While some interviewees claim it is better to have a basic EPR hospital wide, than to have an in depth EPR for only a few departments [Resp 1], others, [Resp 38] claim a hospital EPR can only be beneficial when the system is more advanced. A more advanced system is for instance able to interpret the data available within the system and to use this data to give some sort of feedback to its user. For example in the form of Clinical Decision Support systems, CDSS. The EPR should not only alleviate the construction of reference letters to GP's [Resp 2,3,17,18,22], but also support physicians during patient transferral [Resp 9]. Or just alleviate the general administrative burden [Resp 15,27]. The expected success comes from generation of referral letters say [Resp 30,35]. Some go even further and would expect the generation of quick summaries to be very beneficial [Resp 35].

The system should be flexible, and allow physicians to give their personal touch to the records and generated documents. Many of them like the paper record for the ability to make personal notes, and structure/edit the patient's records to their personal preferences [Resp 35].

Documents and fields in the EPR have to be adjusted specifically to the department or physicians' demand [Resp4].

An EPR system will be successfully adopted by physicians when the EPR system is able support them finish up their work, immediately or shortly, after their consultation-hour or their surgery-duty is over. Alleviating the burden of updating patient's records, and registering their (billable) actions into different systems [Resp 36].

One of the main benefits the EPR has on the old paper record, is the availability. Always and everywhere available is solving many direct problems for physicians [Resp 8].

Documents and files in the EPR will be more structured and standardized, this makes adjusting or adding information easier [Resp 8]. Physicians also appreciate the fact less forms in total have to be completed[Resp 19]. Because of support from the EPR, assistants will be able to carry out more tasks focussing on actual care and less on administration [Resp 15].

The combined effect of availability and a default location for specific information is that data will have to be entered into the system only once and physicians don't have to enter the same information multiple times [Resp 11,21,28].

The EPR will enable quick retrieval of records, no longer running through the hospital [Resp 18] or searching for records [Resp 19,20,28].

EPR systems are still designed from administrative perspective, the successful ones however, are the ones reviewed from a physicians point of view and equipped with a "physician's interface" [Resp 23].

With the overview and real-time data provided by the EPR, it is possible to, without spending a lot of effort into it, create a more efficient schedule [Resp 26].

A combination of user-friendly hard- and software is expected to be a major success factor [Resp 31] as it will make working with records more enjoyable and quicker [Resp 34].

5.6.2 Medical technology

The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

A direct connection with medical apparatus provides data to real-time guard quality control on the patient status, which is a main success factor for the intensive care department [Resp 24]. More benefits with for example specific otolaryngology apparatus are expected when connected to the EPR [Resp 28].

The direct connection to the database with ECG's provides the physician more tools than a print of a scan. For example, it is made easier to manipulate pictures, layer them, or compare them with historic data [Resp 18]. Printed scans don't last forever, digital scans don't lose their quality [Resp 18]. Success can even come from basic direct access to the (MRI) scans where physicians can review the scans themselves [Resp 29]. Overall quicker access to lab-results are expected to be a main driver for success for some departments [Resp 29].

Connection to data from medical equipment is expected to be more flexible as special 'connectors'/interfaces for the EPR are created, and after that, data is accessible via the EPR without the need to create new interfaces [Resp 30].

5.6.3 Care Workflow

The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

The EPR automates (or semi-automates) requests for specific tests and examinations [Resp 1].

The EPR supports the physicians in their specific workflow [Resp 1], providing support for medical paths, standards, regulations and protocol [Resp 10,19. The total care process will therefore take less time [Resp 19], if supported correctly [Resp 34]. Or expected to be a main success factor [Resp 26,27]. For example, physician and patient have less time waiting before they receive lab-results [Resp 29].

Generally speaking, information will be more 'on-time' and 'on the right place' than information from a paper record [Resp 31], which is expected to be a main driver for success. More connected healthcare related databases the better. Especially

insight into the medical history is desired [Resp 33]. For example, a simple connection to the DBC system will already improve the workflow [Resp 34].

The overview provided by the EPR, supports patient's medical paths and status. This 'overall view' enables for more efficient scheduling [Resp 2]. Less double tests and examinations will be requested, adding the availability of results from these tests and the rest of the record, diagnosis are constructed much quicker meaning more patients in the same time [Resp 14]. Which also proves to be time-saving thus beneficial for the patient.

Information about medication is more clear to use during the entire hospitalization process[Resp 5]. A few clicks will provide an overview about specific medication for a number of patients[Resp 18]. Guarding both quality, order management and research. Alarms on specific patients statuses or data-fields, complications as well as queue management, easier registration and the function to search through this data is possible [Resp 25]. Quality of care is expected to improve [Resp 27].

EPR's will be more successful when arguments about 'improving healthcare' prevail above pure economical concerns. The implementation should not be a hidden measure of cost control, and should not be used to correct workflows, but should be implemented aligned to workflow and used to support this [Resp 7,36. Although many physicians will agree with the statement; "Saving time is everything." and make this the main driver for success [Resp 13,14,15].

Because of support from the EPR, assistants will be able to carry out more tasks focussing on actual care and less on administration [Resp 15].

Patient records should be specific to the patient, and not to the department [Resp 36]. Updating the patient's status will be more structured, thus better readable and understood, meaning more generally agreed upon what status x actually means [Resp 37].

Healthcare is under pressure. A system supporting client transferral, smoother communication, better cooperation would be of great benefit. An EPR is such a system, improving the continuity of care [Resp 10].

Smart systems, supporting the care process intelligently will be expected to be most successful [Resp 38].

Better guarding of statuses and providing better access for both patient and care-provider, combined with quicker access to tests results give the patient more 'power to act' and participate in the care-process [Resp 14,36].

A lot of incidents happen from unclear or un available information or instructions. The readability of the physicians handwriting is a well known example, or unknown allergies or anaphylactic reactions. EPR systems are expected to be

successful when they are able to contribute to a solution of these problems [Resp 34].

When an EPR system has access to queue-data, agendas and contains knowledge about procedures (care paths), an intelligent planning can be generated by the EPR, and the organisation will be more flexible in its planning providing the patient, or GP, to (re)schedule their appointments for tests and consults [Resp 34].

Patients don't have to stroll through the entire hospital to make their appointments. Appointments for the entire organization can be made in one location, with one person, stimulating demand-driven care[Resp 36].

5.6.4 Information management

The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

There is an overlap with the 'care process' orientation and 'information management' orientation The EPR system should manage and cater the information specifically (intelligently or smart so to say) to a single situation, to that specific status of the patient [Resp 23,21].

The main success story for an EPR system is the availability of a patient's record, always and everywhere [Resp 2,7,17,24,32], from multiple sources [Resp 11], even accessible from home [Resp 20]. To be able to present a lot of information always and everywhere, it has to be presented user friendly, or the 'information' will be only a lot of words on the screen [Resp 4]. The system will only provide loads data, and the user will be unable to compile this data to (useful) information (data in specific context) [Resp 24].

The EPR systems provides easier and quicker operations to sets of data. For example, operations like 'the number of complications after surgery' can be listed much more easily [Resp 6]. Useful for both science and process improvement. Generated information will be more complete [Resp 11,28]. 'Intelligence', in design or algorithm helps the user gaining quick access to relevant information [Resp 38].

Reports, and reporting and patient information is standardized department-wide [Resp 8,22]. Benefitting both understanding of the situation and interpretation of the actual data. Giving a more effective, conveniently arranged overview for all care providers [Resp 10,25].

Administrative tasks will be supported because of quick retrieval of the correct information and instant access overviews like patient history and lab results [Resp 12].

Individual users will be able to configure and adjust the information to their preferred or relevant presentation [Resp 13]. And they will be able to actually locate the information in the records [Resp 15], and records will not be destroyed by passing time [Resp 18]. It has been said that success even depends on sexiness of the presentation [Resp 21], beside intuitiveness and the ease of use. One click access to the patient's overview or view on an anamnesis will greatly benefit the successfulness of the system [Resp 21,23]. Most important function of the system should be providing a quick and accessible overview [Resp 22]. Not everyone supports the sexiness factor and fancy colours, but still emphasise easy and quick information retrieval [Resp 23].

For some people, a great part of their work in the hospital is information gathering, in these cases, and EPR is expected to greatly improve the efficiency of these processes [Resp 26]. Another important part of a job in healthcare, is to check the history of the patients care-process, a task which can be improved with an implemented EPR system [Resp30].

5.6.5 Strategy

The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

The number one in the list of success factors would be 'commitment of the organization' [Resp 7].

The choice for a 'bigger' EPR package, with a larger organisation behind it is said to be a better choice [Resp 5]. There will be less conflicts with other systems, or with other required parts and functionality of the organization's IT system, providing the user with a benefit above 'best of breed' systems [Resp 5].

Because the nature of EPR systems, collecting and storing (specific, retrievable) data, the organisation builds towards a valuable collection of information [Resp 6]. This collection can be searched, it could for example generate a list with patients using, or having used, medicine X [Resp 18].

The system is expected to be most successful strategically when it aligns with the organisational model. Information should not be openly shared, but thought should be given who, and what to connect and where to use 'the power of the EPR' [Resp 38].

The EPR systems provides easier and quicker operations to sets of data. For example, operations like 'the number of complications after surgery' can be listed much more easily [Resp 6]. Useful for both science and process improvement.

For each specific diagnosis, the EPR is able to list what care-activities are actually executed, enabling more efficient planning and providing useful management

information [Resp 6,36]. Process quality control can be automated [Resp 10] and work-flow management/design can be improved [Resp 34].

Some say the higher goal, or the main goal, of an EPR implementation project is create a paperless record system. However, some people disagree and state the overall goal of the EPR system is to make 'care-giving' actually manageable and transparent [Resp 11]. Success factors come down to flexibility and alignment between the organisation and the actual software [Resp 30].

5.6.6 Internal cooperation

The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

When everyone is working in the same electronic record, a lot more information is shared much more easily[Resp 3]. Success from EPR systems can be found in simple improvement of communication amongst care providers [Resp 10,11,12].

The EPR is more successful generating overviews of medical treatments or used medicines, which, in turn are shared more easily amongst colleagues [Resp 5]. Mainly the information from the overview, but the actual overview on the computer screen as well. Medical anamneses can be shared hospital wide [Resp 37].

Not always, physicians have to wait for the cross-functional meeting, to know what his colleagues from other departments did, or what appointments with the patients have been made. Working together is easier this way, and the care-process is more accommodating [Resp 9]. Meetings purely to share patient information can be skipped because it can be shared digitally [Resp 23], creating more time more patient/process beneficial interactions.

Another success factors from an EPR, and more specifically its implementation, can be found in a much broader scope. Having gone through the EPR implementation process, sharing goals and views on the realignment of many business and care processes created a 'shared common feeling'. No pressure from the top of the organisation but a co-developed product. Discussions about project and EPR's goals were made during the design and implementation period. Agreeing on those best practises when implementation was completed, the resulting involvement from the entire medical staff was great [Resp 16]. *Although implementation process is not the scope of this research, this statement is worth mentioning as the 'shared view' and 'a system designed by its owners' is an ongoing success factor.*

Almost by definition, people working in medical care, like to work with people. Enthusiasm working with one common EPR system, and clear results and insight in how the system is beneficial had a contagious positive effect on the organization [Resp 18].

Something else mentioned; at all times, the physician will be able to coach his or her assistants or trainees. The EPR will provide an overview with procedures relevant to pupil's the medical education [Resp 36].

5.6.7 Integrated care

The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

A success factor residing within the integrated care orientation is the instant availability and information transferral while transferring a patient from one physician ore caregiver to another [Resp 9]. One characteristic of a successful EPR system is the ability to create different views on the data for different care giver's perspectives [Resp 12].

Appointments and tests can be combined, and through the shared view, and the view from multiple different caregivers, the care-process will be safer for the patient [Resp 14,27] (Raymond, 1999). The EPR will improve the communication within the health-care-chain. A nation-wide connection will mainly aid scientific research, while a connection to more nearby caregivers, like a GP will improve the patient's quality of care[Resp 25].

No longer, GP has to request a test, then await the test results, analyze them and then make a new appointment with his patient, the test-results will be available on demand for specific care-providers connected to the EPR system [Resp 17].

An important success factor is the standardisation of the data-exchange capabilities, in communication language and interfaces, as well as medical coding, used in the EPR system. The more standards adhered, the better the system will be able to communicate with other internal or external systems [Resp 20].

A request via a structured (by protocol and input fields, and overview etc) method, like an EPR, will force a 'request for care' from a different care-provider to be more specific [Resp 28]. In turn, enhancing the ability for the care-provider to provide the requested, and actually beneficial, care for the patient. Too often, the 'request for care' is incomplete or not specific when a patient visits a physician, directed from one of his colleagues (in different departments) or directed from the GP [Resp 37].

Because of the structured and protocol-aiding nature of the EPR, specific diagnosis will come with a specific request form [Resp 34].

5.7 Results from study of Conducted Interviews

The four conducted interviews have been studied. The results can be found in this chapter. During the interviews, 'patient empowerment' was explicitly mentioned and discussed.

The full interviews in audio format and as a written summary are available by request to the researcher.

A written and translated summary of the interviews can be found in Appendix XIV Written summary of the conducted interviews. The summary of these interviews per use-it factor can be found in Appendix XIII Interview Results Per USE-IT factor.

As the interviews did not strictly focus on a specific EPR system's success factors and accompanying quality attributes, quotes have been added to the table instead of system quality attributes.

Appendix XII Results from conducted interviews lists these quotes per orientation.

5.7.1 Administration

The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

The structured nature of the EPR's data input fields make for good support during administrational tasks. The system provides 'building blocks' which help the user generating specific documents [Int 3].

The EPR's ability to log user's actions and retrieve a history of these actions make the EPR a suitable source to rely on as an accountability mechanism [Int 4].

5.7.2 Medical Technology

The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

The EPR's ability to directly connect into the laboratory and radiology systems provide the user with direct access to test-results and scans. Scans are connected to patient's files and can be viewed, reviewed at any time. Test results are available as soon as they are entered into the system, for everyone with access to the patient's record. To ensure this direct connection into medical systems, and links from the EPR system to different IT systems, a special IT committee tests and reviews requests for new equipment to secure their compatibility [Int 1].

5.7.3 Care Workflow

The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

However the actions registered into the EPR and the diagnosis treatment combination registration system (DBC registration system) are not the same, registrations in the EPR and/or a connection to the DBC registration system make for more efficient remuneration of actions [Int 1]. A reduction from 30% to 5% discarded DBCs (thus unpaid actions) have been reported [Int 1]!

When the care-process is supported by an EPR system, the EPR enforces the pre-defined care protocols onto the workflow of the care provider. This structured workflow and resulting list of actions and registered results form the foundation for generation of 'building blocks' for more efficient reporting [Int 3]. With the history kept by the EPR system, you can review the care process. Not only the system can provide a list of next possible actions, but also provides the user with the ability to back-track decisions and other decisions based on decisions. With a current set of data available to a care provider, he can make a different decision then what he could have decided at any time in the past. He can trace the implications of the previous decision and take effective actions against the after-effects of that decision based on the new information available. Also medial errors can be detected, their repercussion taken care of more effectively [Int 3]. The annulment ('optie om gegevens ongeldig te verklaren') of certain decisions within the EPR system makes this possible [Int 3].

The EPR system very much operates in 'a new world'. Sometimes called 'the connected' or 'the 2.0'-world, the EPR's ability to connect the hospital with this new world is deemed a factor of success [Int 4].

Coding of medical terms, and support for these codes from the EPR helps streamlining communication and adhering standards [Int.4]4].

5.7.4 Information management

The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

From the interviewed physician's point of view, the main success factor is the availability of the information within the EPR. Care providers can be granted permission to log on to the system from everywhere. The connectiveness to other hospital information systems and equipment makes data much more mobile [Int 1]. Before the implementation of the EPR system, it wasn't possible to 'bring your work with you' [Int 1]. The mobility of the data also supports the increasingly mobile patient [Int 4]. The EPR should support creation of accessible data and the structured way of making this data available [Int 2] and making it exchangeable [Int 4].

A lot of effort should go into the interaction between the user of the EPR and the design of the interfaces and presentations of the data [Int 4].
Each department has its own customized view on the patient's record. The EPR supports creation of multiple views on this data. Customized views for the different department increases the data's readability and enforces a more uniform work flow or registration [Int 3]. Access can be authorized and users can be identified using identification tokens, which will make this customized view

available everywhere [Int 3]. The EPR only works if authorization problems are overcome and the availability of the system is near a 100% [Int 4].

The EPR should contain all 'knowledge' of the hospital [Int 4].

5.7.5 Patient empowerment

The first time, real patient empowerment is mentioned. Patient empowerment gives the patient the power to participate in the care-process on equal level with his or her caregivers. This goes beyond insight in his patient records or the ability to schedule appointments.

The EPR should provide a way for the hospital's patients to view their records [Int 1,3] Although the development of EPRs from the patient's perspective should not stop at simply collecting and showing the data about him or her, the EPR should take the direction of the central hub for a community platform [Int 4]. The platform should help the patient to navigate through the different 'streams' of data available about him and manage these [Int 4].

5.7.6 Strategy

The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

Exact medical information provided by the EPR should be able to support the data required for higher levels of clinical decision support [Int 1]. Implementing modern coding languages like ICD-10 will support this process. And an excellent way to prepare your hospital for the future is to start implementing this 'unity of language' [Int 2]. Offering services like access to this information to GP's or other health-care providers improves both customer's and health care provider's retention.

The EPR should be able, and flexible enough, to 'react' to information requests from both patients, and other care providers, internal and external. Securing relations with both primary care and smaller hospitals, as well as supporting hospital's outposts [Int 3]

The EPR should prepare the hospital for 'the new world', and support the idea of a 'virtual hospital' [Int 4]. Data for the backend for these systems can be provided by the EPR [Int 4].

5.7.7 Internal cooperation

The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

The EPR should provide access to all available patient data, for everyone, from everywhere[Int 1].

5.7.8 Integrated Care

The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

The EPR should be supported and implemented hospital-wide [Int 1] to support the trend in cross-functional teams working on more and more complex problems [Int 4].

6 Discussion

In the discussion chapter you will find the answers to the research questions. This research will be put into perspective, discussing this research's validity, generalizability and this chapter will reflect on the research and the method itself.

Before answering the research questions, a few interesting findings will be discussed.

Implementing EPR (like) systems in healthcare, improvement of quality of care is expected [Resp 27],none of the studied sources explicitly stated this improvement of quality of care. Scientific studies on the impact of EPR systems on quality of care are not conclusive (Delpierre, et al., 2004; Ludwick & Doucette, 2009). There is, however a reduction in medical errors measurable (Chaudhry et al., 2006; Kaushal, Shojania, & Bates, 2003) and substantial savings in costs (Hillestad et al., 2005; Schmitt & Wofford, 2002; P. G. Shekelle, et al., 2006; Wang, et al., 2003), although there is relatively little empirical evidence to substantiate many of the claims (Black, et al., 2011).

Caregivers seem to have yet to find out how to enable real 'patient empowerment'. For now 'excelling at your job', using EPR systems, will benefit the patient, as the reduction of administrative duties will free up more time caring for the patient.

During the study of the interviews, standardized communication was only mentioned once [Resp 20] although this is the basis enabling interoperability, integrated care and cooperation with colleagues in different department.

Switching from the paper patient record to the electronic patient record, the familiar overview provided by 'tabs' in the paper record was not replaced in the electronic patient record.

If there is resistance from a physician using EPR systems, but you ask this physician the question "How could your work be executed more efficient?", the answer will be "Layout of the patient records". If you ask the following question next: "What do you need to improve the layout in the patient records?", the answer will be: "Define a set of repeatedly occurring elements." and you will end up discussion an EPR implementation [Int 4].

Before EPR systems will be fully accepted, one problem needs to be fixed; more work expected from Specialist X entering data in the EPR system, would mean less work for Specialist Y. X will have to do more work, while Y will have his job made easier. This is not yet reflected in financial feedback or any way at all [Int.2].

Health-care education needs to be changed and adjusted to working with EPR systems, medical training is still to traditional. People are more used to technical

innovations like iPads, social networks etc, but the art of practicing medicine hasn't really changed [Int 4].

There is an important different view on the evolution of EPR systems from the interview candidate from the nation-wide organization supporting IT in healthcare and the hospital CEO. One view is, hospitals are cooperating more and more, and this is how a 'core record' and a 'specialist record' will evolve[Int 1]. On the other hand, hospitals will follow their own strategy and use EPR systems to secure market share and offer unique services to health-care providers. Thus not cooperating at all [Int 4].

6.1 Answers to the research questions

This chapter will answer the research questions, starting by answering the sub-questions to conclude an answer to the main research question.

6.1.1 "What are last decade's relevant topics about EPR systems?"

During the success factor desk research, different success factors have been put in a concept matrix. Grouping these success factors into different orientations revealed four new orientations:

- strategy
- internal cooperation
- integrated care
- information management.

These orientations are last decade's relevant topics.

The conducted interviews, and a few sources in trade journals revealed the 'patient empowerment' topic. As mentioned by one of the experts during the conducted interviews: "What is discussed on trade-meetings and in trade papers, is between 5 and 10 years ahead on the actual real situation.". The 'patient empowerment' topic will be more relevant in the (near) future, but not enough success factors in the 'patient empowerment' orientation have been found to make this a distinct relevant topic itself. Most of the times 'patient empowerment' was discussed, the success factor would better fit into the 'care workflow' orientation, promoting the EPR system's 'accessibility' for both patient and hospital(employee)-end-user.

Strategy and management information were initially two separate orientations. As discussed, these two orientations have been combined to one single 'strategy' topic. The EPR's success factors revealing management information mainly relate to managing the hospital, or a specific department, according to the hospital's strategy.

Orientation / *System quality*	**Administration**	**Medical technology**	**Care Workflow**	**Information management**	**Strategy**	**Internal cooperation**	**Integrated care**	***Total***
Accessibility	4	1	**7**	**9**		3		**24**
Accuracy							1	1
Auditability		1	2	1	2			6
Availability	1	1	1	4			1	8
Compatibility	1	**2**	1		1			5
Configurability				1				1
Connectability		1	1			2	1	5
Customizability	2	1	2	3			2	**10**
Demonstratability					1	1		2
Discoverability			1					1
Durability				1				1
Ease of use	2			4				6
Efficiency	**17**		5	2	**3**	1		**28**
Interoperability	1	1	4	3	1	**9**	**6**	**25**
Mobility			1	2		1		4
Operability			1			1		2
Process capabilities	1		5		**3**			9
Relevance	1		1	7	**3**	1	2	**15**
Reliability	1			1				2
Resilience					1			1
Responsiveness				3				3
Robustness	2			2				4
Standards compliance	1	1	1			1		4
Tailorability	1							1
Timeliness		2	2	4	1	1	1	**11**
Ubiquity	1	1	2	3				7
Upgradability	1		1					2
Usability			1					1
Total	37	12	39	50	16	21	14	-

Table 3 - System attributes per orientation

6.1.2 "What are currently critical success factors for EPR-systems?"

Critical success factors have been defined as EPR system attributes. EPR system's success factors from the interviews have been combined and displayed in Table 3 . Per orientation, the highest scoring system quality attribute is made bold and is underlined. The total occurrence of a system quality attribute is found in the 'total' column. The total amount of times a success factor was found in an orientation is found in a 'total' row at the bottom.

Listing the most important system quality attributes(1), and the most important orientations(2), then displaying these attributes per orientation(3) will give us the most critical success factors (4).

(1) System Quality attributes

Starting with the system quality attribute most mentioned, thus most critical success factor, to system quality attributes less mentioned, (but still relevant) and mentioned 10 times and more, this is the list of most important system quality attributes:

1. Efficiency (28)
2. Interoperability (25)
3. Accessibility (24)
4. Relevance (15)
5. Timeliness (11)
6. Customizability (10)

(2) Orientations

Starting with the most mentioned, thus most critical, orientation, to the orientation least mentioned:

1. Information management (50)
2. Care workflow (39)
3. Administration (37)
4. Internal cooperation (21)
5. Strategy (16)
6. Integrated care (14)
7. Medical technology (12)

(3) System quality attributes per orientation(3)

A combination of high scoring system quality attributes per orientation will represent EPR systems' success factors.

1. Information management –accessibility (9) followed by relevance(7)
2. Care workflow – accessibility (7) followed by efficiency (5)and process capabilities (5)
3. Administration – efficiency (17) followed by accessibility (4)
4. Internal cooperation – interoperability (9) followed by accessibility (3)
5. Strategy – relevance (3), process capabilities (3) and efficiency (3)
6. Integrated care – interoperability (6) followed by relevance (2) and customizability (2)
7. Medical technology – compatibility(2) and timeliness (2)

(4) Thus, critical success factors for EPR systems are:

- The EPR system provides accessible support in information management displaying relevant information.
- The EPR system provides tailored support to the workflow in an accessible manner, making it more efficient .
- The EPR system makes administration more efficient and accessible.
- The EPR system efficiently supports the hospitals strategy by its process in a relevant manner.
- The EPR system provides interoperability enabling integrated care and is customizable and relevant in doing this.
- The EPR system is compatible to medical technology displaying information in a timely manner.

6.1.3 "How can the 2002 model be updated to explain the success of EPR systems implemented in the Dutch Hospitals?"

With new relevant orientations discovered and the orientations weighted, the model can be updated as reflected in Figure 12.

The scores of the different system quality attributes per orientation, which are found in the previous chapter, are placed into a model. The surfaces or the orientations, sizes and positions of the system quality attributes are all weighted by their score.

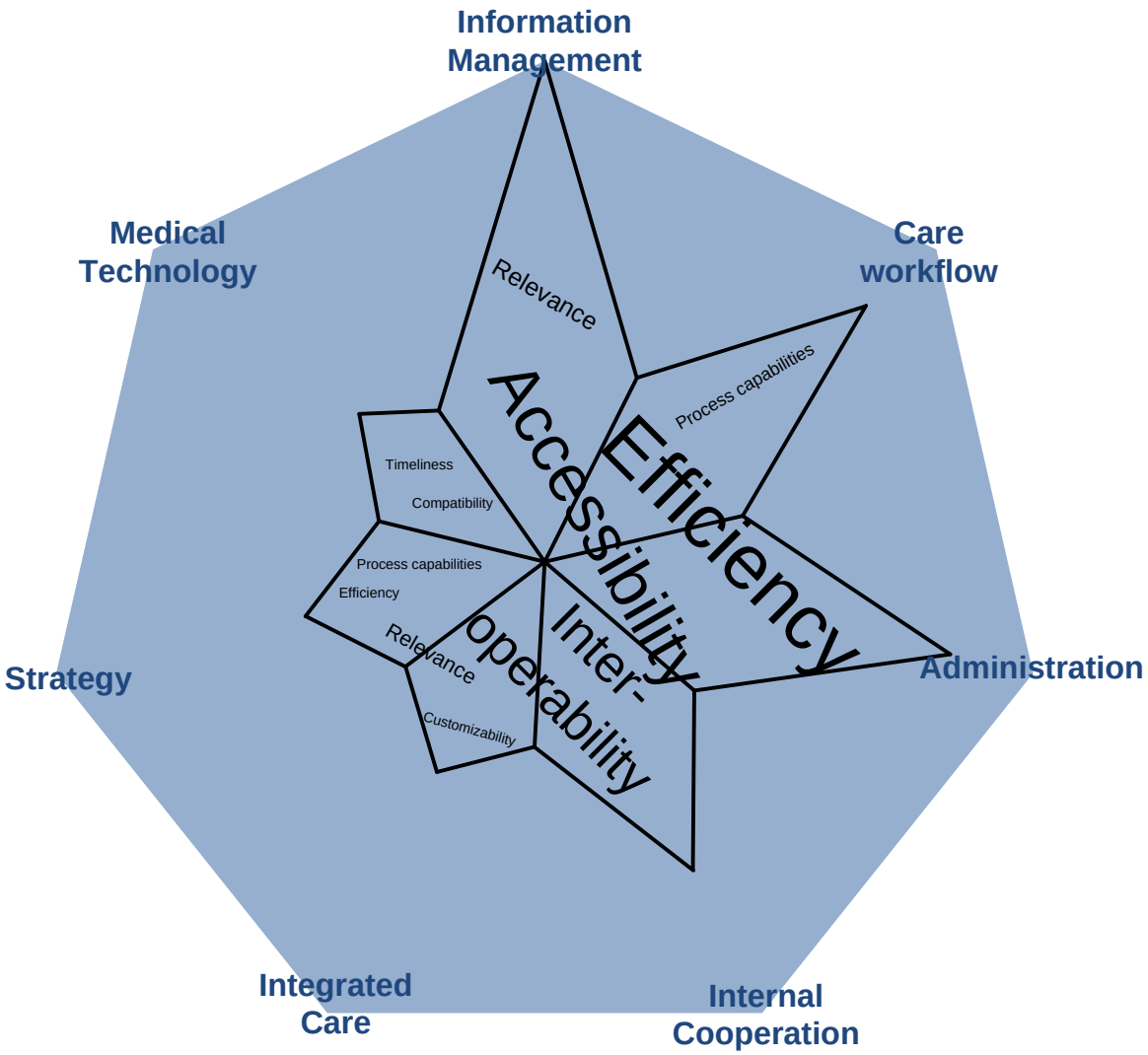


Figure 12 - Updated conceptual model explaining EPR system's success

6.1.4 "What are possible future scenarios?"

With the knowledge gained studying 10 year of patient record developments in the Netherlands, a few future scenarios can be presented.

Scenario 1

Hospitals will implement large-scale EPR packages replacing all the legacy systems in the hospitals individual departments. EPR systems will be the core of the hospital information system, providing communication with other hospital information systems and providing access to patient and hospital information to authorized relevant caregivers other than the hospital itself. Services will be added for these relevant caregivers in order to strengthen relations between the hospital's departments and relevant caregivers outside the hospital.

Scenario 2

Hospitals will provide a 'core record' EPR system for the hospitals individual departments to connect to. Hospitals focus on the administration and strategy aspect of the patient records, while departments cater their EPR systems' implementation towards care process.

Scenario 3

Per specialism, national specialist organisations will define a standard (technical) patient record layout according to the specific demand of the specialism. National institutions define standard languages in attempt to make these records compatible.

Scenario 4

A third party, for example; a patient organization, insurance company or the national government defines a standard language and layout. The responsibility and complete access is given to the patients. Patients choose what caregiver gains access to specific information.

6.1.5 Answer to the main research question

"How can EPR Success Factors within Dutch Hospitals over the past decade be explained; and what topics are most relevant for the next decade?"

Past decade, hospitals have been trying to replace or connect legacy systems to hospital-wide EPR systems. Departments tried to align the 'layout' of the hospitals patient records with their care processes. Benefits like 'access to information' and more efficient administration were main drivers to implement EPR systems, where in the newer generations of EPR systems the focus will be on interoperability supporting internal cooperation, integrated care and cooperation within the healthcare chain. Standard languages will be even more defined and only after a critical mass of a patient-representing-organization have been reached, patient empowerment will really be realized. EPR systems will be used by hospitals management to manage hospitals department realizing the hospital's strategy.

6.2 Value of this research

Only after the researcher has finished his or her research he has the complete overview to define specific orientations and value specific thoughts. Only now that the research-aspect of the research is complete, the complete research method is clear. Next desk-study / literature research done by the researcher, more effort will be spend on the initial research discovering and mastering a specific research methodology to follow throughout the research itself. This specific research method should provide more structure. However with the strengths of the researcher not be reflected in the desk-study / literature-research research method.

During the process of labelling quotes with system quality aspects, some distinctions are hard to make between the variety of system quality aspects, especially:

- auditability/reproducibility
- customizability/tailorabilty
- compatibility/interoperability
- evolvability/upgradability
- integrity/auditability/understandability
- robustness/reliability

Especially during the study of the interviews, a lot of 'possible' and 'expected' success factors were mentioned by the experts. After valuing these expert's expertise the decision was made to include these possible success factors in the research.

The resulting scores for orientations and system quality attributes have no statistical blackening whatsoever. They are just a way to 'display' the results of this research.

The 'medical technology' orientation from the 2002 research by Spil and Michel-Verkerke did not have a high score. A possibility could be that (connection to) medical technology is less of a concern for the EPR systems end-users, and seen as a technical challenge to overcome with enough effort from the EPR system's implementation team.

6.2.1 This research in relation to other research

This research gives an overview of last decade's relevant topics about EPR systems in the Netherlands. The research updates the 2002 model from the research done by Spil and Michel-Verkerke to reflect the situation a decade after. This research

uses system quality attributes to try and define success factors in different orientations of an EPR system and studies success factors of EPR systems in actual use. Most other research explains 'how an EPR system could work' or defines a 'defines a standard language how EPR systems should communicate' or studies a lot of articles why EPR systems are good or bad for healthcare. No other research was found mapping system quality attributes to success factors for EPR systems.

6.2.2 Strengths and weaknesses of this research

This research studied the majority of Dutch trade journals of the last decade and combined success factors of successful EPR implementations in one model. It delivered an easy model to use as tool to focus your EPR implementation project.

This research did not apply any statistical analysis to the data found. The conclusions are based on the articles found and accepted using the inclusion and exclusion criteria. An exploratory literature research was done, and with this body of knowledge, success literature study was done without the notion of creating a concept matrix. This success literature study has been repeated using a mind-mapping tool and using the concept matrix later on. More time could have been spend searching for success study literature.

6.3 Addition to the field of science

Applying this research's model to an EPR system in development, focus can be aimed at specific system attributes. For example, 'interoperability' should be stressed and not neglected, and not a lot of time should be spend discussing connections to medical technology. The EPR is more than an information system and should be aligned with the hospital's business processes and fit into the hospital strategy and used accordingly.

This research mapped system quality aspects to different success factors in EPR. It provides an up to date conceptual model adding four orientations to the 2002-model.

6.3.1 Generalization

As the Dutch health-care situation is an efficient national healthcare system, hospital practises are globally acknowledged practices, and an implemented EPR system's functionality and the hospital's processes should be aligned anyway, this research applies to comparable 'situations' beside the Dutch hospitals. Other developed nations, and larger health-care institutions can apply this research to their own situation as the inclusion and exclusion criteria allowed this research to use literature applicable to Dutch hospitals and comparable situations.

6.4 Unanswered and new questions

This research did not propose 'one perfect EPR system', as there is none. An EPR system should be aligned with the hospital's (individual) department's processes and the hospital's strategy. A new question could be: "Which of the proposed

scenarios is most likely to happen?". Or: "How could a standardized way of supporting processes be created, from all different hospital's specialist departments in one EPR system?"

Decision making satisfaction, a measure of how well a system supports decision and problem solving activities of the user (Garrity & Sanders, 1998). Generation 4 and more advanced EPR systems offer decision support functionality, "Could this generation of EPR systems satisfy its users more easily?".

Using data from the EPR should not be a one way street. Intelligence should be added like medical alerts, prescription system and medical protocols (Atkinson & Peel, 1998; Safran, Sands, & Rind, 1999; van Dijk, 2006). Concluding from this statement, one could say that only a 3RD generation and higher EPR system can be successful?

Purely from a study through scientific literature, trade journals and interviews, while searching for EPR system success factors, this research revealed seven orientations for EPR system's success. These orientations might not be unique and could be explained in different success models or in other research. It would be interesting to look for similarities in different applications of these models.

7 Conclusion

Only with the following orientation contributing to the EPR system, the system will be a success:

- information management
- care workflow
- administration
- internal cooperation
- strategy
- integrated care
- medical technology.

Successful EPR systems support their users filtering, sorting and selecting relevant information aligned to the care process making information more accessible. They alleviate the administrative burden. EPR systems should comply to standards and should be interoperable supporting internal cooperation and integrated care. A successful EPR system should be aligned to the hospital's strategy making the care process auditable and information traceable. Information from medical technology should be timely and accessed from everywhere.

Administration is still an important EPR system's success factors. The EPR system should make hospital administration more efficient and accessible. Where possible the EPR should function as the main registrar system for physician's procedures and should make the administration in the patient's records accessible.

In order to connect with systems throughout the entire hospital, for the entire time the patient "resides in the healthcare system", EPR systems' compliance to standards and ability to connect systems on different locations in the care process, is a main driver for success. The EPR system should be able to support the care process and should fit into the daily practice of the health-care professional (Lovis, Lamb, Rassinoux, & Geissbuhler, 2003). Modelling these workflows is a precondition to a successful hospital wide EPR implementation, in such way that the workflows have to modelled that they maximally contribute to the hospital's goals (Sutherland & Van den Heuvel, 2006).

Not only the administration of procedures should be supported by the system, also the retrieval of a patient's file, history, or past communications should be accessible. The information management orientation of a successful EPR system

makes data residing within the EPR system more accessible and will show it's user relevant information.

The strategy dimension is as important as the internal cooperation dimension, but both are less important than the EPR system supporting the care process. Where management plans the EPR implementation according to the hospital's strategy, it should be supported by all the different hospital's departments in order to achieve this support to the internal cooperation. However, the system's alignment to the care-process, is even more important.

The noticeable small medical technology orientation might be a major concern 20 years ago, but information systems' architecture has changed significantly since then. Connection to medical equipment or other information systems is merely a technological concern which is easily overcome. Ubiquitous and timely access are the main system quality aspects and drivers for success in this orientation.

Interoperability is an important system quality aspect of a successful EPR system. It enables connectivity with other systems, in order to gather information from multiple sources, to make this information more accessible, enables connectivity with other information systems in order to facilitate integrated care and internal cooperation.

As in the current Dutch situation none of the EPR market leaders offers a truly interoperable EPR system (T. Spil, Katsma, & Stegwee, 2007). As this interoperability is one of the main system quality aspects, national steps in order to make systems interoperable should be taken. A National critical mass has to be reached for each department (gastroenterology, otolaryngology, radiology etc) agreeing on their specific specialists record structure and language. These records will have to be made interoperable and compatible with the hospital's "core record". When such an EPR is designed and implemented, focusing on the discovered system quality aspects in their orientations, an EPR will be a great strategic tool, used to align and optimize workflow (the care process) and will support new important aspects in medical care like integrated care and cross-functional hospital teams.

A Dutch EPR system will be successful when:

- it provides accessible provides information management displaying relevant information.

-it provides tailored support to the workflow in an accessible manner, making it more efficient .

- it makes administration more efficient and accessible.

- it efficiently supports the hospitals strategy by its process in a relevant manner.

- it provides interoperability between systems and organizations, enabling integrated care and is customizable and relevant in doing this.

-it is compatible to medical technology, displaying information in a timely manner.

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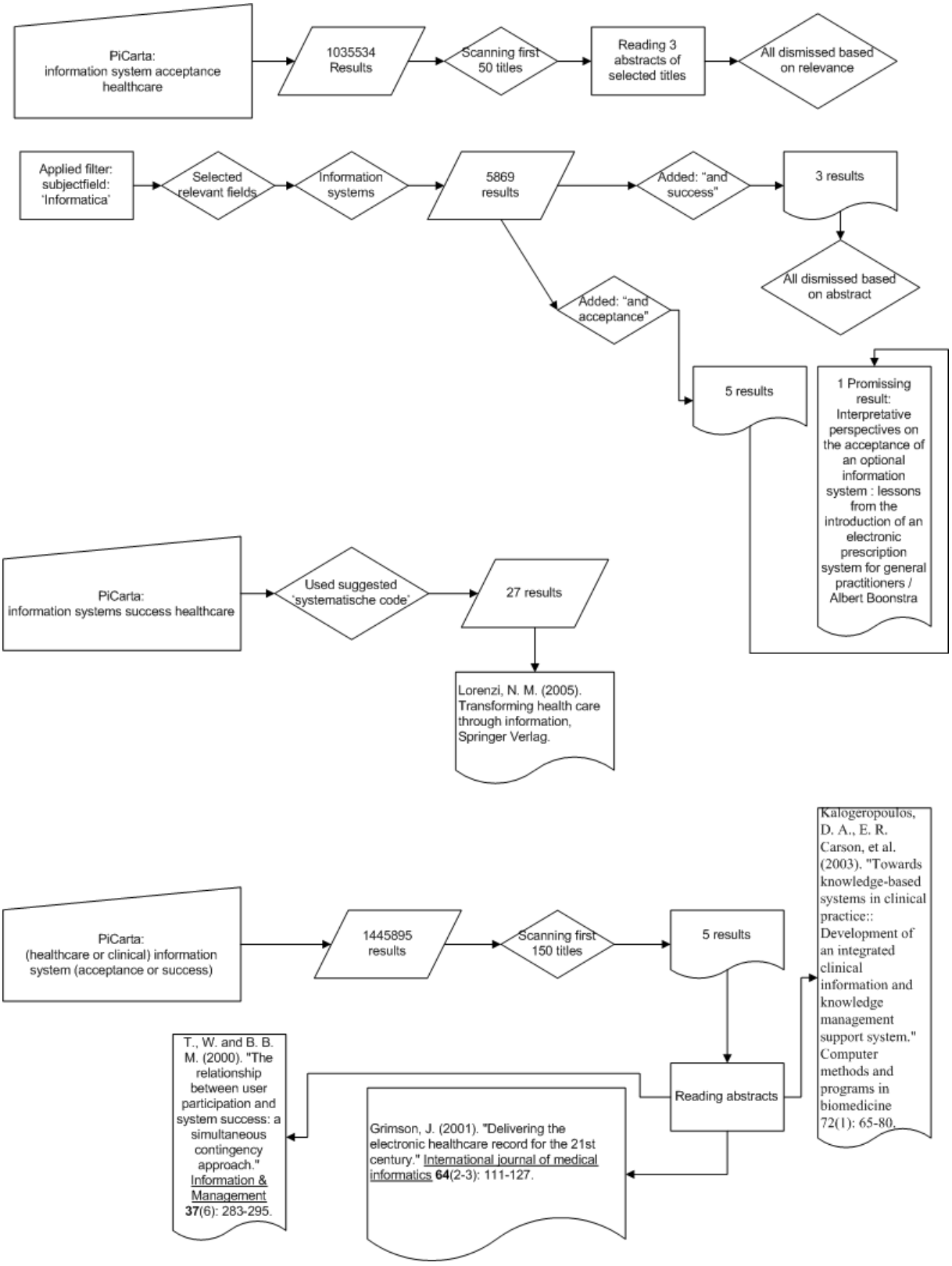
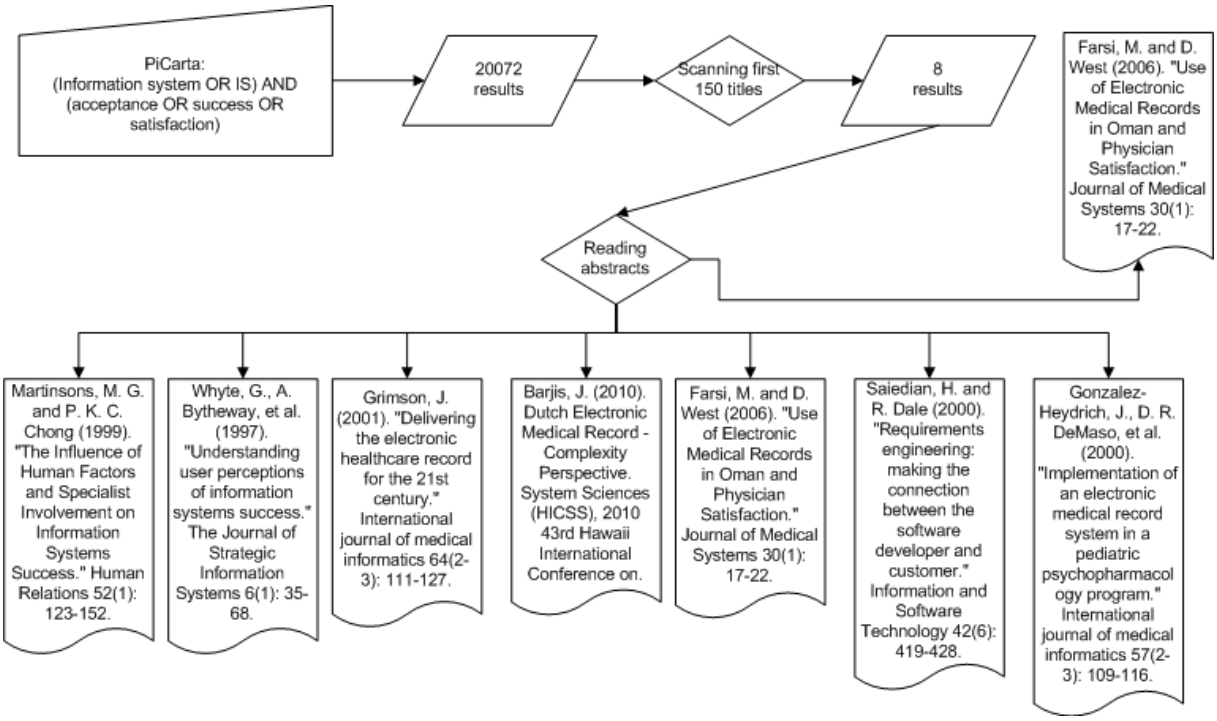
Appendix I Search Method

Systematic representation of the search-method.




PiCarta:
(Information system OR IS) AND
(acceptance OR success OR
satisfaction)
20072
results
Scanning first
150 titles
8
results
Farsi, M. and D. West (2006). "Use of Electronic Medical Records in Oman and Physician Satisfaction." Journal of Medical Systems 30(1): 17-22.
Reading
abstracts
Martinsons, M. G. and P. K. C. Chong (1999). "The Influence of Human Factors and Specialist Involvement on Information Systems Success." Human Relations 52(1): 123-152.
Whyte, G., A. Bytheway, et al. (1997). "Understanding user perceptions of information systems success." The Journal of Strategic Information Systems 6(1): 35-68.
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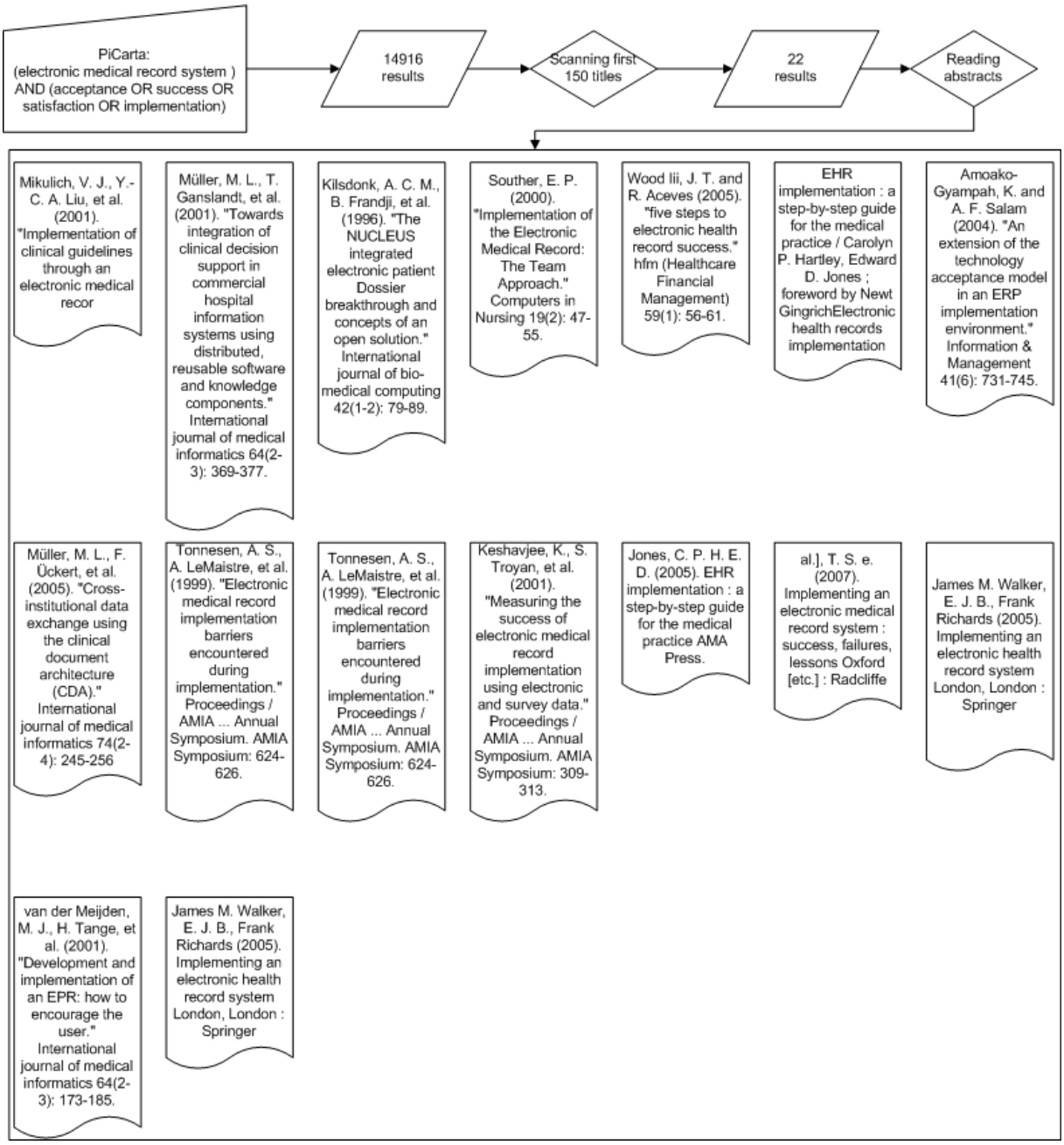
PiCarta:
(electronic medical record system) AND (acceptance OR success OR satisfaction OR implementation)
14916 results
Scanning first 150 titles
22 results
Reading abstracts
Mikulich, V. J., Y.-C. A. Liu, et al. (2001). "Implementation of clinical guidelines through an electronic medical recor
Müller, M. L., T. Ganslandt, et al. (2001). "Towards integration of clinical decision support in commercial hospital information systems using distributed, reusable software and knowledge components." International journal of medical informatics 64(2-3): 369-377.
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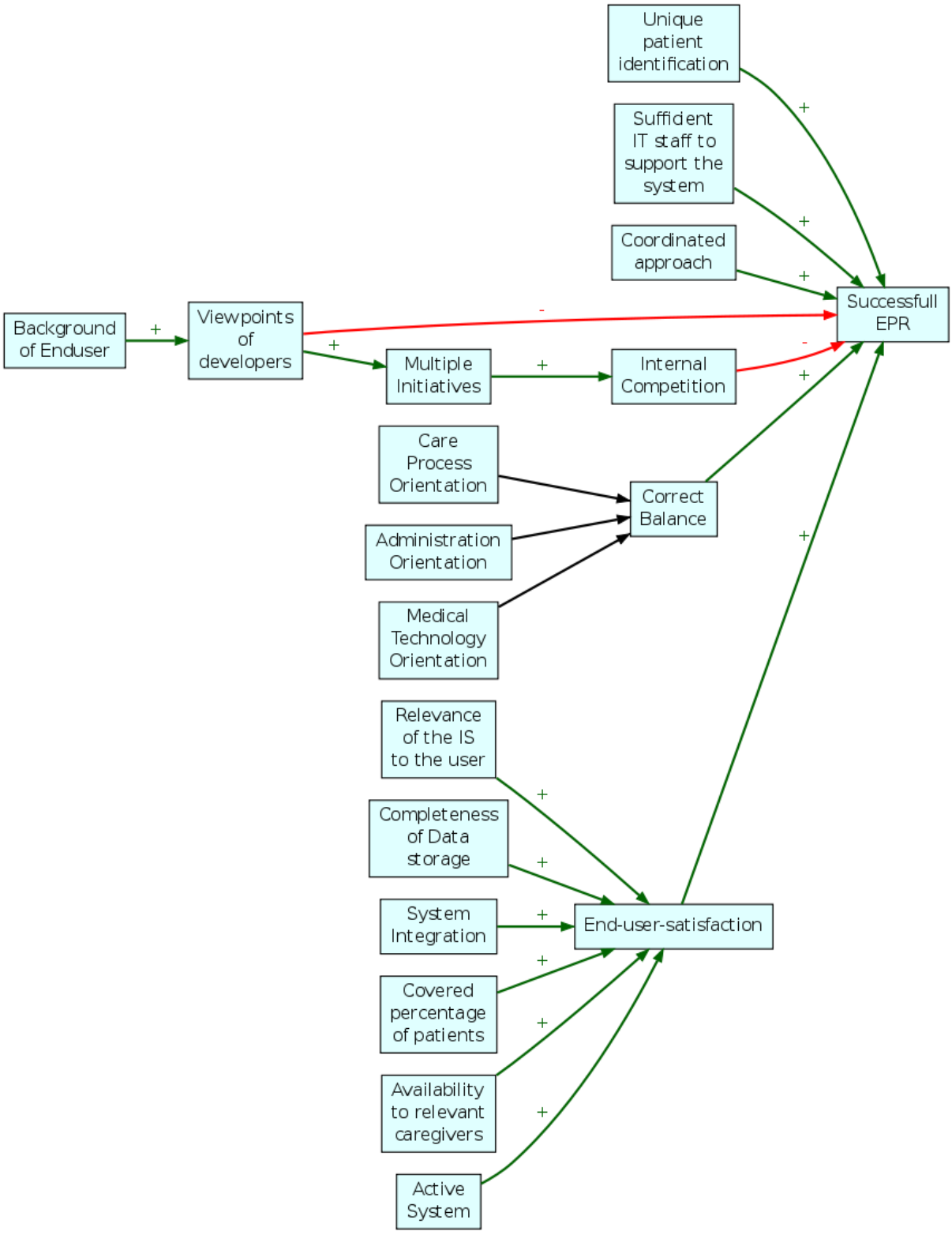
James M. Walker, E. J. B., Frank Richards (2005). Implementing an electronic health record system London, London : Springer
van der Meijden, M. J., H. Tange, et al. (2001). "Development and implementation of an EPR: how to encourage the user." International journal of medical informatics 64(2-3): 173-185.
James M. Walker, E. J. B., Frank Richards (2005). Implementing an electronic health record system London, London : Springer

Appendix II Theoretical model

A Theoretical model based on Michel-Verkerke's work. (Michel-Verkerke & Spil, 2002)



Appendix III Goals overview

IJssel land ziekenhuis http://www.ysl.nl/het-ziekenhuis/organisatie/missie-en-visie/

Het IJsselland Ziekenhuis verleent professionele specialistische zorg voor een ieder in het verzorgingsgebied van het ziekenhuis.

De zorg wordt geboden vanuit betrokkenheid, in een veilig klimaat en met respect voor de levensopvatting van iedereen die hulp nodig heeft. Hierbij staat de zorgvraag van de patiënt centraal.

Belangrijke cultuurwaarden zijn wederzijds respect, vertrouwen, samenwerking, verantwoordelijkheid nemen en verantwoording afleggen.

Amphia Ziekenhuis http://www.amphia.nl/WerkEnLeren/Pages/OnzeVisie.aspx

Medewerkers als visitekaartje

Gemotiveerde en geïnspireerde medewerkers: ze vormen het visitekaartje van het Amphia Ziekenhuis in Breda en Oosterhout.

(The rest of the vision is about achieving excellence through employees, about open communication and transparency)

Gemini Ziekenhuis http://www.gemini-ziekenhuis.nl/page.asp?mid=20000&mn=2

Het Gemini Ziekenhuis biedt gespecialiseerde medische zorg aan, die gebaseerd is op de behoeften van patiënten in de regio Noord-Holland Noord en Texel. Dit gebeurt door een hecht en toegewijd team van medewerkers met specifieke kennis en kunde in een herkenbare en vertrouwde omgeving.

BovenIJ ziekenhuis http://www.bovenij.nl/smartsite.dws?id=780

Het BovenIJ ziekenhuis wil hét ziekenhuis zijn, dat veilige en kwalitatief goede medisch-specialistische zorg levert aan de inwoners van de regio Amsterdam-Noord en de omliggende regio's. Het ziekenhuis streeft er naar de bewoners van haar verzorgingsgebied goede basiszorg te bieden én modern geoutilleerde diagnostiek. Het ziekenhuis kent de grenzen van haar (on)mogelijkheden. Daarom werkt het met anderen samen en kent het een helder doorverwijsbeleid. Het BovenIJ ziekenhuis streeft naar gestructureerde samenwerking met de aanbieders van eerste- en derde-lijnszorg. Het ziekenhuis vervult hierin een coördinerende rol.

Het BovenIJ ziekenhuis wil graag 'het vriendelijke en kleinschalige karakter, de openheid, de korte communicatielijnen en de laagdrempelige toegang' bewaren. Het ziekenhuis streeft er naar die prettige omgeving

te blijven waar patiënten tevreden zijn over hun behandeling en waar medewerkers en medisch specialisten graag willen werken.

Spaarne Ziekenhuis	http://www.spaarneziekenhuis.nl/nl/over-spaarne-ziekenhuis/organisatie/Paginas/Missie-en-visie.aspx

Het Spaarne Ziekenhuis biedt medisch specialistische zorg aan de inwoners in de Haarlemmermeer en omstreken. De vraag van onze patiënten staat hierbij centraal.

Bronovo	http://www.bronovo.nl/Bronovo/nl-NL/bronovo/Over+Bronovo/Stichting+Bronovo-Nebo/missie_visie/

Bronovo:

Wil een ziekenhuis zijn dat uitstekende patiëntenzorg biedt met een hoog serviceniveau

Wil voor patiënten zorg op maat bieden in multidisciplinaire teams onder de noemer 'De kracht van samen zorgen'

Wil hét ziekenhuis zijn voor de bewoner in het verzorgingsgebied

Wil een ziekenhuis zijn met een 'menselijke maat'

Wil een ziekenhuis zijn waar naast de patiënt ook de medewerker centraal staat

Wil werken op basis van algemeen christelijke waarden en met respect voor andere levensbeschouwingen

Wil een ziekenhuis zijn dat samen met andere zorgaanbieders een netwerk van zorg vormt

Visie

Het werk binnen onze stichting rust op vijf pijlers. Dit zijn:

Patiënten en cliënten centraal

Centraal in onze zorg staan onze patiënten en cliënten met hun eigen mogelijkheden, wensen, overtuigingen en waarden. Mensen die zich toevertrouwen aan onze zorg hebben recht op de bescherming van hun persoonlijke levenssfeer en integriteit.

Met passie en compassie

Wij beoefenen ons vak met hart en ziel. Omdat wij vinden dat zorgvragers recht hebben op de scherpste diagnose, de betrouwbaarste onderzoeken, de beste medische behandeling en meest toegewijde verpleging en verzorging. Kortom, van alles de hoogste kwaliteit.

In multidisciplinaire teams

Door met de bril van meerdere disciplines naar zorgvragers te kijken, zien wij 'de hele mens' in plaats van een orgaan of een lichaamsdeel. Daarom werken er bij ons niet alleen artsen en verpleegkundigen maar bijvoorbeeld

ook fysiotherapeuten, ergotherapeuten, maatschappelijk werkers en geestelijk verzorgers.

Samen met andere zorgverleners in de keten

Wij werken onder andere samen met huisartsen, andere ziekenhuizen, andere verpleeg- en verzorgingshuizen en mensen in de thuiszorg. Samenwerken in de keten voorkomt wrijvingsverliezen, blinde vlekken en dubbelingen. Het resultaat: betere kwaliteit in de zorg.

In een groeizaam opleidingsklimaat

Stichting Bronovo-Nebo stimuleert de ontwikkeling van medewerkers enerzijds om aan te kunnen (blijven) sluiten bij de markt en anderzijds om persoonlijke ontwikkeling te stimuleren omdat wij vinden dat investeren in medewerkers loont.

Rijnland ziekenhuis	http://www.rijnland.nl/nl/p46729182d7910/Onze-ambities.html

Rijnland Ziekenhuis, als onderdeel van Rijnland Zorggroep, draagt verantwoordelijkheid voor hoogwaardige medisch specialistische zorg in de regio Rijnstreek. Wij willen mensgerichte, veilige en betaalbare zorg bieden op het juiste moment en op de juiste plek. Dit is mogelijk door nauwe samenwerking met de verpleeg- en verzorgingshuizen van Rijnland Zorggroep en andere zorgaanbieders in de regio. Deze gezamenlijke verantwoordelijkheid komt tot uiting in de missie, visie en kernwaarden van onze organisatie.

LangeLand Ziekenhuis	http://www.llz.nl/Over_het_LangeLand/Visie

Voorwaarden voor succes

Aan deze kernfuncties hebben wij de volgende voorwaarden verbonden:

- betrouwbare medische en verpleegkundige kwaliteit
- een prettige omgeving voor zowel patiënten, bezoekers als medewerkers
- verbondenheid met de Zoetermeerse gemeenschap: dicht bij huis, laagdrempelig en huiselijk
- uitstekende service: korte toegangstijden, korte wachttijden, ruime bedrijfstijden, voldoende éénpersoonskamers, hoteldiensten en alerte en warme benadering
- moderne technologie die het verpleegkundig en medisch proces ondersteunt.

Franciscus Ziekenhuis Roosendaal	http://www.franciscusziekenhuis.nl/over-franciscus/algemene-informatie/visie

Het Franciscus Ziekenhuis wil, door middel van een procesgerichte organisatie, op een persoonlijke en betrokken manier onderzoek en behandeling van haar patiënten waarborgen . Het geïntegreerd medisch specialistisch

bedrijf vormt de basis, en hoge kwaliteit is het uitgangspunt. Dit alles kan alleen bereikt worden met vaardig, enthousiast en goed opgeleid en goed geïnformeerd personeel, in een bedrijfsmatige en servicegerichte organisatie met goede arbeidsomstandigheden.

Albert Schweitzer ziekenhuis	http://www.asz.nl/organisatie/organisatie/visie/

Het Albert Schweitzer ziekenhuis heeft bij de oprichting een visie ontwikkeld waaraan we blijven werken. Thema van deze visie is kort samengevat in de zin: Zorg met hoofd, hart en ziel.

MST: Medisch Spectrum Twente	http://www.mst.nl/voormedewerkers/beleidsplan/onze%20visie/

Onze visie op besturing stoelt op de volgende uitgangspunten:

- zorg voor de patiënt is leidend
- eenduidige aansturing van de organisatie op alle niveaus
- integrale managementverantwoordelijkheid
- managementparticipatie van medisch specialisten op alle niveaus (operationeel, tactisch en strategisch)
- zo min mogelijk hiërarchische lagen
- zo groot mogelijke eigen verantwoordelijkheid en bijbehorende bevoegdheden voor medewerkers / decentrale organisatieonderdelen met betrekking tot de zogenoemde operationele taken.

Vlietland ziekenhuis	http://www.vlietlandziekenhuis.nl/index.php?page=missie-en-visie

Wij leveren goede zorg dichtbij huis, die voldoet aan uw wensen en behoeften. Doordat we nauw samenwerken met huisartsen en zorginstellingen, loopt de medische zorg feilloos in elkaar over zonder dat u zich daar zorgen over hoeft te maken.

Als organisatie trachten we onze medewerkers een plezierige en professionele werkomgeving te bieden, waar samen wordt gewerkt met de huisartsen en zorginstellingen in de regio. Hierdoor wordt de zorg op een hoger niveau gebracht.

St Antonius	http://www.santeon.nl/nl/over-santeon/missie-en-visie

(Santeon)

Als Santeon ziekenhuizen werken we samen aan de hoogste kwaliteit van zorg, veiligheid en gastvrijheid.

Samen sterker

We wisselen kennis, talent en vaardigheden uit. Zo bereiken innovaties en verbeterde behandeltechnieken in het ene ziekenhuis snel de andere ziekenhuizen. Door samenwerking bij inkoop, personeelszaken, automatisering en gebouwenbeheer besparen we kosten. Er blijft daardoor meer geld over voor de zorg.

Voor de patiënt

Onze patiënten profiteren van ons streven naar nieuwe wegen, creatieve oplossingen en vooruitgang. Zij blijven gewoon in behandeling bij hun eigen ziekenhuis en specialist. In heel bijzondere gevallen, bij zeldzame aandoeningen, kunnen patiënten terecht in een gespecialiseerd kenniscentrum van een ander Santeon ziekenhuis.

Maasziekenhuis Pantein https://www.maasziekenhuispantein.nl/visie

De cliëntenraad van Maasziekenhuis Pantein is een vanzelfsprekende samenwerkingspartner van de ziekenhuisdirectie. In het overleg met de directie fungeert de cliëntenraad als klankbord en als pro-actief meedenker.

De cliëntenraad onderschrijft de ambitieuze visie van het ziekenhuis waarin professionaliteit en gastvrijheid centraal staan. De raad praat, in een vroegtijdig stadium, vanuit cliëntenperspectief mee over ontwikkelingen in de organisatie die de cliënt direct of indirect raken.

Cliëntperspectief

Rekening houden met de belangen van de cliënt betekent volgens de cliëntenraad:

dat cliënten mogen rekenen op volledige en duidelijke informatie, afgestemd op de persoonlijke behoefte van de cliënt. De cliënt weet zich gesprekspartner bij de keuze van behandeling;

dat cliënten respectvol worden bejegend en

dat zorg aansluit op de wensen en verwachtingen van de cliënt.

Appendix IV List of EPR acronyms

Electronic Health Record (EHR) – basic generic form

A repository of information regarding the health status of a subject of care, in computer processable form.

Electronic Health Record (EHR) – for integrated care (ICEHR)

A repository of information regarding the health status of a subject of care in computer processable form, stored and transmitted securely, and accessible by multiple authorised users. It has a standardised or commonly agreed logical information model which is independent of EHR systems. Its primary purpose is the support of continuing, efficient and quality integrated health care and it contains information which is retrospective, concurrent, and prospective.

Computer-based Patient Record (CPR or CBPRS)

CPR, as used by Gartner. The CPR system makes the records available throughout the owner's organization, but also facilitates other independent organizations and multiple of patents and members within those organizations. It serves purposes of information analysis, information exchange and personal health management (Handler & Hieb, 2007).

And the definition from the Institute of Medicine, United States: A computer-based patient record (CPR) is an electronic patient record that resides in a system specifically designed to support users by providing accessibility to complete and accurate data, alerts, reminders, clinical decision support systems, links to medical knowledge and other aids (Office of Health and the Information Highway, 2001).

Computerised Patient Record (CPR)

The more commonly accepted acronym for CPR, mainly used in the USA encompassing a wide range of meanings amongst them EMR or EPR. One of the largest EPR (or CPR) systems in use is the Department of Veteran's Affairs' EPR system, with over four million veterans in its electronic medical records[3].

Computerised Patient Record System (CPRS)

Also CPR.

Electronic Health Care Record (EHCR)

The EHCR is a term which was commonly used in Europe, including the CEN 13606 (a reference model, underpinning the exchange of EHR information, chapter 2.3.2 Communication) standard, Health informatics – Electronic healthcare record

[3] http://www.va.gov/health/default.asp

communication. It may be regarded as synonymous with the EHR and EHR is now rapidly replacing the term EHCR in Europe (Services, 2005).

Electronic Client Record (ECR)

A special case of the EHR where the scope is defined by the non-medical health professional group utilising the record within their health discipline (e.g. physiotherapist, chiropractor, social worker) (ISO, 2005).

Personal Health Record (PHR)

The key features of the PHR are that it is under the control of the subject of care and that the information it contains is at least partly entered by the subject (consumer, patient). The PHR focuses on enabling the patient/consumer to create, enter, maintain and retrieve data in a form meaningful to them and control their own record, as well as the standardised architecture behind the PHR will ensure the enabling of sharing of information between the health provider and the patient/consumer. Four different forms of PHR can be considered (ISO, 2005):

a) A self-contained EHR, maintained and controlled by the patient/consumer.

b) The same as a) but maintained by a third party such as a web service provider.

c) A component of an ICEHR maintained by a health provider (e.g. a GP) and controlled at least partially (i.e. the PHR component as a minimum) by the patient/consumer.

d) The same as c) but maintained and controlled completely by the patient/consumer.

Electronic Medical Record (EMR)

The EMR could be considered as an EHR or EPR restricted in scope to the medical domain, or at least, very medically focussed. The term is widespread in North America and other countries including Japan. The Japanese Association of Healthcare Information Systems (JAHIS) has defined five levels of EMRs (JAHIS, 1996).

1) Departmental EMR – contains a patient's medical information entered by a single hospital department (e.g. Pathology, Radiology, Pharmacy).

2) Inter-departmental EMR – contains a patient's medical information from two or more hospital departments.

3) Hospital EMR – contains all or most of a patient's clinical information from a particular hospital.

4) Inter-hospital EMR – contains a patient's medical information from two or more hospitals.

5) Electronic Healthcare Record – longitudinal collection of personal health information from all sources.

Electronic Care Record (ECR)

One individual record from a larger record keeping system. A term mainly used when talking about records in the computer systems of the NHS. There are two types of these records (NHS, 1998):

1) The summary record – accessed anywhere in England by NHS staff who are directly providing care to that specific patient. It consists repeat prescriptions of the last 18 months and acute prescriptions of the last 6 months. It will also include significant and recent diagnosis and problems and any adverse allergic reactions to medication. The exact content, however, is still under discussion, and is likely to be expanded over time.

2) The detailed record - detailed parts of the record may be shared when providing care to a patient who has decided to have an electronic care record. For example, a consultant at hospital might need more information about a patients care in general practice and could access the record to find this out.

Patient Care Information System (PCIS)

A more general term for systems concerning patient care information, not strictly limited to record keeping.

Different names for different information systems could reflect to a different system's focus, to a different point of view from creators of the system, reflects the different points of view of the authors, or to reflect the systems (Michel-Verkerke & Spil, 2002). Hospitals could, for instance, to emphasize the hospital-wideness of the system, and refer to the EPR just as part of the Hospital Information System (HIS), where Gartner uses the term Computer-based patient record (CPR) while comparing their version of the CPR system to other 'record systems'.

A definition like the Institute of Medicine's (Dick & Steen, 1997) definition focuses on the means, and functionality of the system, (computer system, complete, accurate, alerts, reminders etc) and not on the purpose of the system.

"An EHR is a patient record that resides in a computer system specifically designed to support care providers by providing accessibility to complete and accurate patient data, medical alerts, reminders, clinical decision support systems, links to medical knowledge and other aids".

A different view on EPR systems, will lead to a different definition. Where Kilsdonk, Frandji and van der Werff (Kilsdonk, Frandji, & van der Werff, 1996) use the EPR as 'core of the HIS', they define the "Healthcare Electronic Patient Record" the following:

"All information electronically recorded with respect to the past, present and anticipated health and disease of the patient. and all information electronically recorded with respect to the associated care, which has been, is being and will be provided."

This definition focuses on the question 'what to store', as each physician and specialist might request different information to store. Using an EPR system as a NUCLEUS, 'the core' of an information system, the definition of an EPR should focus on different views of information, not on different values.

In the Netherlands, for the last few years, a lot of effort was spend on connecting different the Dutch EPR systems via a special hub[4] which uses the HL7 standard. It is worth looking into its definition of an EPR system:

- Longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or healthcare provided to an individual
- Immediate electronic access to person- and population-level information by authorized, and only authorized users
- Provision of knowledge and decision-support that enhance the quality, safety, and efficiency of patient care
- Support of efficient processes for healthcare delivery.

In the standard, each of those bullet points are further defined with a detailed list of minimum requirements.

Appendix V Communication

It is almost impossible to create a map of the different (connected) IT systems in use in the Dutch Hospitals. To enable sharing of data between these different IT systems need to speak the same language. The better these applications are able to communicate, the better they can provide it's users with relevant information.

The Dutch healthcare sector is composed of separate operating islands. Hospitals, nursing homes and other institutions all have their own ICT systems that do not talk to each other. These islands must be interconnected. It should comply with certain conditions, including unique patient identifiers, and data security standards for information exchange (Bart Kiers, 2004).

This highly 'loose' architecture with many 'application silos' or 'islands of automation' is comparable to the islands in the manufacturing sector. It is the result of poorly designed and non-integrated medical technology strategy. And when those isolated systems, one system for each department, become embedded, they will lock in bad operations practice and the system will fail to reach its full operational potential (Walley & Davies, 2002).

[4] Also Landelijk Schakel Punt (LSP)

In the previous chapter, we have seen EPR systems interact with many other systems in the hospital where it will function like a hub to distribute information and provide a standardized means of communication amongst all those different siloed applications.

The importance of this standardized communication can be explained by Figure 13 - Simple information flow.

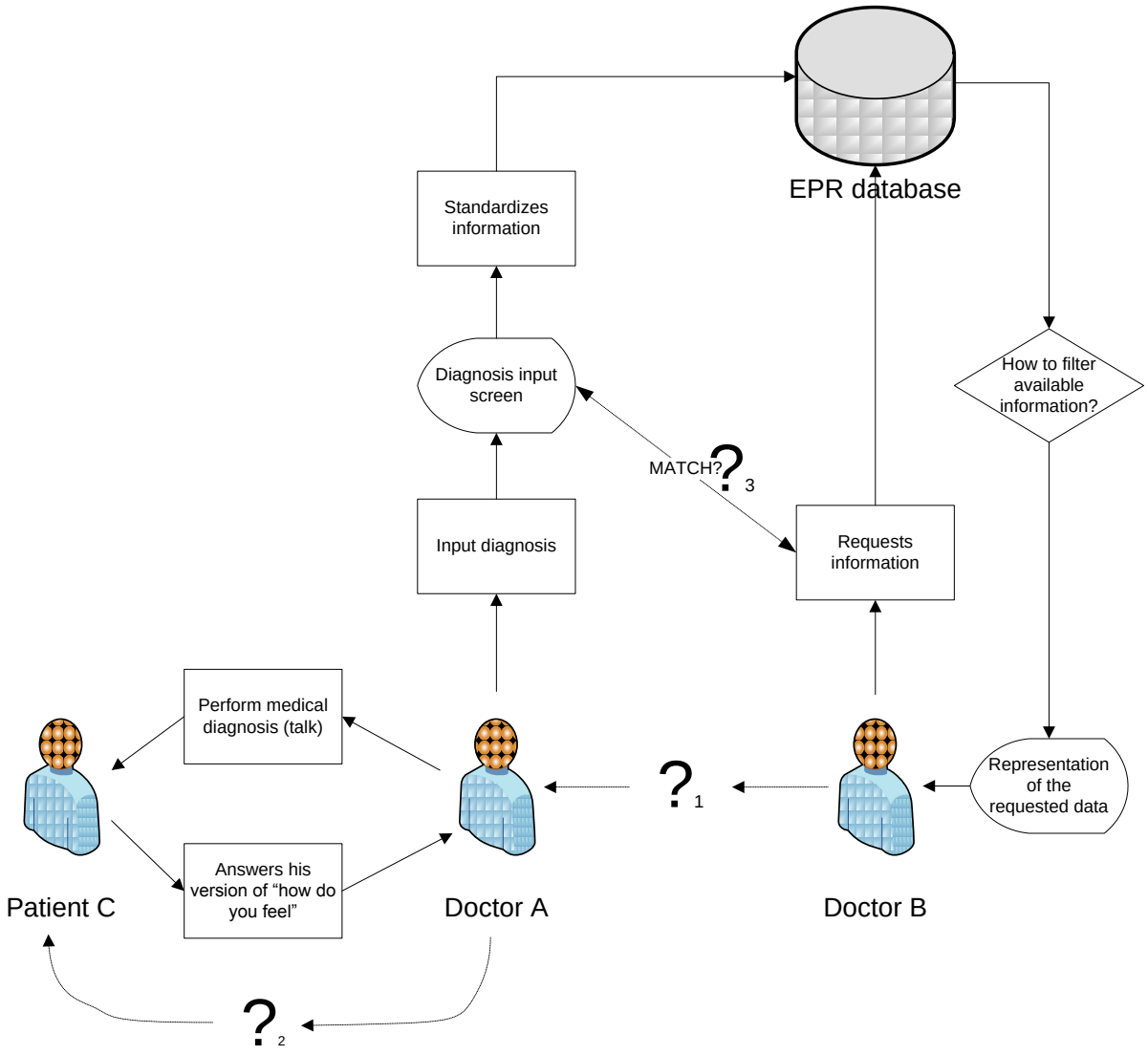


Figure 13 - Simple information flow

In this simple example, Doctor A (could be a GP) performs a medical diagnosis on Patient C ($?_2$). Doctor A has to process and summarize this conversation, weigh the different statements Patient C made, and has to process these statements into the correct Diagnosis-input-screen-fields. 'Behind' these diagnosis-input-screen-fields is software which translates different diagnosis to a standardized language, ICD10 or SNOMED for example.

When Doctor B needs specific information about Patient C, he needs to request this information from the EPR. When his query is common or default, a pre-defined field could already be custom to his or her screen. When Doctor B has specific questions, Doctor B relies on:

- perception of Doctor A from the conversation with Patient C,
- doctor A's information processing from the conversations with Patient C,
- the ability of Doctor A to enter this information correctly into the system,
- for the system to translate the diagnosis into standard language and store this,
- and the system to correctly display this information when it is requested by Doctor B.

The requested information via the system, multiple times processed, should be the same ($?_3$) as when Doctor B had a face to face conversation with Doctor A ($?_1$) or even a face to face conversation with the patient him/her self ($?_2$).

In practice, this information passed through multiple systems, and could be entered, by multiple doctors. For a message to successfully travel from a sick patient, through a number of doctors, input fields, databases, standardized languages and communication between systems and actors is very important.

Trust

A certain level of Trusts needs to exists between Doctor A and Doctor B to enable effective communication (Loomis, 1959). During the medical diagnosis between Doctor A and Patient C, there needs to be a certain level of trust. A conversation via a telephone, or an electronic consult might take this away (Margalit, et al., 2006). During physical interaction with the patient, the doctor can rely on more input mechanisms like studying the patient's behaviour, smell, alertness, movements, etcetera.

Different levels of communication

Health-care professionals should be able to communicate throughout the many systems, but also applications need to communicate internally. Knowing what to communicate is vital, and therefore you need to know what the other person wants to know. You need to incorporate relevant facts into your message, these facts may not be relevant for you, but might relevant for people you might not know yet. This makes the agreements on standard languages especially important. Organizations must come to an agreement on a structured language. This will enable the creation of patient databases, eliminate manual chart auditing, and improve coding. This improvement in data management will cut costs by enhancing efficiency, and more accurate coding will increase revenue (Erstad, 2003).

Communication in healthcare can be between physicians within a department, between physicians and GP's, between organizations, between patient and doctor etc. These different levels of communication, lead to different implemented standards. In the growing evolving field of healthcare informatics, lack of standards is no problem, the great many different standards are. Within the Netherlands different communication standards are in use. Instead of integration of systems or direct interaction, there are multiple layers of interaction to be distinguished *(Michiel Sprenger, 2010)*:

- Edifact messages: used in the first and second line of care and within the first line
- OZIS: mainly used during 'dienstwaarneming' first line care between general practitioners and apothecaries
- HL7 V2: mainly used as communication standard in hospitals and large organizations
- HL7 V3: used mainly for data-exchange on nation-wide level using the LSP (a specialist hub)
- Secured email: mainly used to communicate when there is no much IT implementation possible or achieved, for example; paramedics
- Cross Enterprise Document Sharing (XDS): is used to exchange (mainly) pictures across organizations
- Portals: however they are not exchange of messages, portals are used to provide caretaker and patient access to medical records stored on the organization's own systems.

SNOMED CT

For a collection with the full name Systematized Nomenclature of Medicine - Clinical Terms, this systematically organized computer processable collection of medical terminology will find its use in most areas of clinical information systems (Aschman, 2003). The collection aims not only define illnesses and medicines, but also procedures and micro-organisms. This broadened scope should help reducing the variability in the way data is captured, thus help in presenting more relevant information to the end user of the system its used in. IT allows appropriate retention, processing and exchange of unambiguous records, and enable these records to be transferred between healthcare providers. Also referred to as 'semantic interoperability. The same information will be recorded in different ways depending on the recorder, time and interest of the person recording. Using a systematized nomenclature helps preventing this (Pare & Elam, 1999).

ICD9, ICD10, ICD11

The International Classification of Diseases (ICD) is the international standard diagnostic classification for all health management and general epidemiological purposes and clinical use.

It is used to classify diseases, signs and symptoms, abnormal findings, complaints, and many other health problems. It is maintained by the World Health Organization (WHO) and allows for more than 14.400 different codes. ICD9, 10 and eventually ICD11 differ in that ICD10 permitted tracking of many new diagnoses and procedures, where ICD11 will feature EHR readiness, and will be officially endorsed in 2015 (World Health Organization, 2012).

OpenEHR

The aim of OpenEHR is also to provide ICT in healthcare with a set of semantics. OpenEHR approaches this with an open platform providing high-quality and re-usable models, known as archetypes. OpenEHR is an open standard, it is publicly available and maintained by the openEHR foundation (Foundation, 2012).

EDI based communication

EDI stands for Electronic Data Interchange and is a standard aiming to facilitate exchange of business documents and facilitate order management. EDIFACT and HL7 are examples of used EDI-standards used in healthcare. Open standards and XML are replacing EDI-messages.

CEN 13606

The CEN 13606 reference model that underpins the exchange of EHR information. This model is an information model that contains a set of classes and attributes. The CEN 13606 approach is to represent the reference model as a set of unified Modelling Language (UML) diagrams. The outcome is a hierarchical model reflecting the hierarchical nature of real heath records. The 13606-1 reference model is composed of a number of classes which build on each other to provide the representation of an EHR extract (Services, 2005).

Mapping languages

Because of the multitude in languages and standards, a lot of mapping languages are also compiled by the various standard developing organizations. A mapping language translates 'data fields' from Language A into 'data fields' in Language B.

Specialist languages

DICOM or Digital Imaging and Communications in Medicine is a standard for handling printing and storing medical imaging. The National Electrical Manufacturers Association (NEMA) holds the copyright holds to the standard.

Further development and adoption of computer-based terminology and communication standards, such as SNOMED and DICOM, will promote the large-

scale dissemination of EHR systems, so that the full range of their benefits may be realized by the largest possible community (Chiang, et al., 2008).

Appendix VI The Interview Model

Macro Resistance • Opportunity to change • Ability to change **Micro Resistance** • Parochial self interest • Misunderstanding or lack of trust • Different assesments • Low tolerance of change	**Macro Relevance** • Economic improvements • Social improvements • Functional improvements • Savings of time and effort **Micro Relevance** • Absolute value of relevance • Here and now value • Low initial costs • Immediacy of the reward
Macro Requirements • Strategic policy • Clear objective **Micro Requirements** • Timeliness • Accurateness • Ability to integrate • Content	**Materiële Resources** • Costs • Hard- and software • User and designer time **Immaterial Resources** • Adaptiblity • Capabilities • Reliability

Introduction about the research for the interviewee.

Introduction of the person by the interviewee.

What is your general feeling about developments in healthcare on the subject of EPR implementation?

What should be the goals of any EPR implementation project?

For the end users

For the organisation

How do they generally come to existence?

What is the general development project, and how is the project group created?

What is the general implementation project, and how is the project group created?

Are there any operationalized goals created?

Information quality	Completeness, data accuracy, legibility
System quality	Ease of use, time savings, reliability, workflow support, interoperability, customization possibilities, expression power
Service quality	Availability, support, responsiveness

Main driver implementation EPD. Goals to implement the system? What kind of culture does the organisation stand for, and its employees? (Experience with other IT projects?)

After implementation, who was most content with the result?

After implementation who has the most benefits?

Who are the system's "Users", can they be grouped? Which other EPR like systems are in use?

What should a hospital do to successfully implement an EPR system?

Macro Resistance

- Opportunity to change
- Ability to change

Micro Resistance

- Parochial self interest
- Misunderstanding or lack of trust

What were given opportunities to learn to work with the new system?

-

How did the organisation cope with lack of trust?

What did the organisation do with people who had a very outspoken 'view on the matter'?

Was there active policy to add these people to the project group?

What was the main reason to reject the system?

What was the main reason people started to use the system, what benefit of the system did they like the most? (what changed in their workflow?

Macro Requirements

- Strategic policy
- Clear objective

Micro Requirements

- Timeliness
- Accurateness

How did the EPR fit in the strategic vision of the hospital?

How did the project group adapt the EPR to the work flow or expectation of its empolyes?

Was there active policy for this?

-

How did the organisation prevent mistakes or errors during implementation. What is the ability for the organisation to change the project's results?

Who is responsible for adding the data into the system?

What other systems connect to the EPR?

Macro Relevance

- Economic improvements
- Social improvements
- Functional improvements
- Savings of time and effort

Micro Relevance

- Absolute value of relevance
- Here and now value
- Low initial costs
- Immediacy of the reward

Did the project start with a business case?

What are the main benefits? (monetary and none quantifiable)

Does the system support connection to future IT systems, like connections to GPs, pharmacies, DBC/DOT systems?

How does the system change the user's habbits of coping with information? (search, store, retrieve) How do specific benefits arise from this?

How will the system change communication within the Hospital? And within its environment?

Is the system designed 'future proof'?

-

Is there active policy to make the EPR relevant for all the hospital's empolyees?

What will change in the life of an employee using the system?

What needs to be invested/sacrificed in order to 'effectively/successfully' use the system?

When are potential benefits arise, when does the pay-off start? And what are these benefits?

Materiële Resources

- Costs
- Hard- and software
- User and designer time

Immateriële Resources

- Adaptiblity
- Capabilities
- Reliability

Wat zijn de kosten, hoe schat je die, en wat zijn ze in verhouding met andere (IT) projecten. Is dit een reden om het niet/wel te doen?

What will be the main costs of the system, how do you compute them.

What other software has to be changed? Any plan of action made in advance about this?

How would you draw a productivity curve before, during and after implementation?

-

How will employees be supported to learn and deal with the new system (before, during and after implementation)?

Before implementation, are employees skilled enough to use the system?

What is the employee's level of trust in change in general, in a new IT system, or compared to this project? Will they 'go for it'?

How will management steer in using the new system. How will the organisation attack the 'eilandjes cultuur'?

Appendix VII The orientations

1. The administration orientation concerns EPR success factors alleviating the 'administrational' burden created from health-care specific- and required for supporting-processes.

2. The medical technology orientation concerns EPR success factors enabling and improving users' convenience and interaction with medical equipment or technology.

3. The care workflow orientation concerns EPR success factors supporting the EPR's user's workflow guiding the patients through the care process.

4. The information management orientation concerns EPR success factors supporting the EPR's user searching and filtering information, making 'the required' information available at the right place at the right time.

5. The strategy orientation concerns EPR success factors supporting hospital's management managing the hospital and securing the hospital's future (focus).

6. The internal cooperation orientation concerns EPR success factors enabling sharing of information with colleagues.

7. The integrated care process orientation concerns EPR success factors supporting the patient's convenience through the care-process.

Appendix VIII System quality attributes

Accessibility	Accountability	Accuracy	Adaptability	Administrability
Affordability	Agility	Auditability	Autonomy	Availability
Credibility	Process capabilities	Compatibility	Composability	Configurability
Correctness	Customizability	Debugability	Degradability	Determinability
Demonstrability	Dependability	Deployability	Discoverability	Distributability
Durability	Effectiveness	Efficiency	Evolvability	Extensibility
Failure transparency	Fault-tolerance	Fidelity	Flexibility	Inspectability
Installability	Integrity	Interchangeability	Interoperability	Learnability
Maintainability	Manageability	Mobility	Modifiability	Modularity
Nomadicity	Operability	Orthogonality	Portability	Precision
Predictability	Producibility	Provability	Recoverability	Relevance
Reliability	Repeatability	Reproducibility	Resilience	Responsiveness
Reusability	Robustness	Safety	Scalability	Seamlessness
Self-sustainability	Serviceability (a.k.a. Supportability)	Securability	Simplicity	Stability
Standards compliance	Survivability	Sustainability	Tailorability	Testability
Timeliness	Traceability	Ubiquity	Understand-ability	Upgradability
Usability				

Table 4 - System Quality Attributes (Jung, et al., 2004)

Appendix IX Results from Scientific Sources

Source	Administration	Medical Technology	Care Workflow	Information management (filter/presentation)	Strategy	Internal cooperation	Integrated Care
(C. Sicotte, 2009)	Accuracy Reliability		Usability				
(Erstad, 2003)	Usability		Usability Reliability Efficiency	Ubiquity Relevance			
(P. G. Shekelle, et al., 2006)	Accessibility	Timeliness	Ubiquity				Process capabilities
(Wang, et al., 2003)	Credibility Precision Traceability Accuracy		Process capabilities Reproducibility				
(Walker, et al., 2005)							Interoperability Reproducibility
(Farsi & West, 2006)	Reproducibility Accessibility Relevance		Process capabilities			Interoperability Communicatibility	
(Kalogeropoulos, et al., 2003)				Upgradability Modularity Ubiquity			
(Keshavjee, et al., 2001)	Efficiency		Efficiency Ubiquity Understandability				
(Sykes, et al., 2011)							Connectability

(Chiang, et al., 2008)	Accuracy Robustness Efficiency Auditability	Efficiency				
(Ash & Bates, 2005)						
(Miller, et al., 2004)	Usability Process capabilities			Auditability Traceability		Ubiquity
(van der Meijden, et al., 2001)		Understandability Process capabilities			Operability Customizability	Ubiquity Interoperability
(Walley & Davies, 2002)		Process capabilities		Operations maturity Relevance		
(Beun, 2003)			Understandability Accessibility	Evolvability Relevance		
(Jha, et al., 2008)	Accessibility Efficiency	Process capability		Effectiveness Affordability		
(Schoen, et al., 2006)				Traceability Understandability Integrity		
(Delpierre, et al., 2004)	Efficiency	Accessibility Process capabilities Tailorability Relevance				

Appendix X Results from trade journals

Source	Administration	Medical Technology	Care Workflow	Information management	Strategy	Internal cooperation	Integrated Care
(Knotnerus & Stegwee, 2010)	Auditability Traceability		Precision Robustness Standards Compliance			Efficiency Accessibility	
(Kremer, 2009)			Communicatibil ity Ease of Use				
(Meulder, 2009)			Extensibilty				Connectability
(de Moor, 2009)				Ubiquity Standards compliance			Extensability Upgradability Ubiquity
(Pieterse, 2009)	Reliability						
(Plass, 2008)	Efficiency						
(Schilfgaarde, 2006)	Understandabili ty Auditability	Timeliness Ubiquity	Accesability Understandabili ty			Interoperability	
(Postma, 2009)			Auditability				

(van der Meyden, 2011)	Process capabilities Efficiency Ubiquity		Process capabilities Configurability		Process capabilities Relevance (to business process)		
(Freriks, 2010)				Ubiquity Interoperability Standards compliance			Interoperability Standards compliance
(Bart Kiers, 2009)			Understandability Simplicity Efficiency		Relevance Interoperability Ease of use Usability	Mobility Accessability Timeliness Interoperability	Interoperability
(Hilderink, et al., 2002)			Ubiquity Interoperability Process capabilities				Interoperability
(Veeze, 2001)	Ubiquity Mobility	Connectability Understandability	Effectiveness Operability Tailorability Understandability Accessibility	Relevance Upgradability Understandability		Accessibility	
(Klemann, 2001)			Effectiveness Efectivity Process capabilities	Auditability Process Capabilities			Communicatability
(Nelwan, et al., 2002)	Communicatibility					Modifiability Tailorability	Standards Compliance Modifiability Tailorability

(Vast, 2005)		Process capabilities	Compatibility Interoperability	Traceability Accuracy	Mobility Process capability Timeliness	Mobility Interoperability Process capability Timeliness
(Zwemmer, 2005)	Robustness Usability	Reliability Stability				
(Tan, 2009)	Efficiency	Ubiquity Accessibility	Configurability Efficiency	Auditability Robustness		
(Korporaal Heijman, 2010)	Modifiability		Modifiabilty Timeliness		Demonstrability ? Relevance?	

Appendix XI Results from the study of interviews

	Administration	**Medical Technology**	**Care Workflow**	**Information management**	**Strategy**	**Internal cooperation**	**Integrated Care**
[Resp. 1]	Upgradability		Process Capabilities Interoperability				
[Resp. 2]	Efficiency		Accessability Discoverability	Timeliness Accessibliity			
[Resp. 3]	Efficiency					Interoperability	
[Resp. 4]	Tailorabilty			Accessibility Ease of Use			
[Resp. 5]			Interoperability Accessiblity		Interoperability Compatiblity	Interoperabilty Accessibility	

[Resp. 6]				Relevance	Relevance (Resilience) Efficiency Auditability		
[Resp. 7]			Process Capabilities Relevance	Responsiveness Reliability Availability	Demonstrability Relevance (commitment)		
[Resp. 8]	Availability Standards compliance ubiquity		efficiency	Ubiquity			
[Resp. 9]	Efficiency					Connectability Accessibility Timeliness	Timeliness
[Resp. 10]		Auditability Standards compliance Ubiquity	Standards compliance Ubiquity	Accessability Interoperability		Interoperability Connectability Communicatability	
[Resp. 11]	Efficiency			Mobility Availability Ubiquity	Process capability Auditability	Communicatability	
[Resp. 12]				Efficiency			Customizability
[Resp. 13]			Efficiencey	Configurability Customizability			

[Resp. 14]			Efficiency Timeliness Accessability Timeliness	Interoperabil ty Timeliness Accessability		
[Resp. 15]	Efficiency		Operability Ubiquity	Robustness		
[Resp. 16]					Relevance	
[Resp. 17]	Efficiency			Availability Interoperabili ty		Interoperabili ty Connectabilit y
[Resp. 18]	Accessibility Efficiency	Interoperabili ty	Auditability	Durability Robustness	Demonstrabil ity	
[Resp. 19]	Efficiency		Process Capabilities			
[Resp. 20]	Accessibility Robustness			Timeliness Accessibility		Communicata bility Interoperabili ty Standards compliance
[Resp. 21]	Efficiency			Accessability Ease of Use Customizabili ty Relevance		
[Resp. 22]	Efficiency			Relevance Ease of Use Accessibility Customizabili ty		

[Resp. 23]	Customizability Relevance			Responsivnes s Ease of Use		Efficiency Interoperability Communicatibility	
[Resp. 24]		Compatibility Timeliness		Availability Relevance			
[Resp. 25]	Compatibility Interoperabilty		Accessibility Usability	Relevance			Interoperability

Possible success factors

	Admin	Medical tech	Care Workflow	Information managmenet	Strategy	Internal cooperatoion	Integrated Care
[Resp. 26]	Efficiency		Efficiency Process capabilities	Efficiency			
[Resp. 27]	Efficiency		Efficiency				Process capabilities
[Resp. 28]	Efficiency Robustness Reliabilty	Compatibility Connectability		Accessilibity Relevance			Relevance
[Resp. 29]		Timeliness Accessability Availability	Timeliness Accessability Availability				
[Resp. 30]	Efficiency	Flexiblity		Auditability Ubiquity.			

[Resp. 31]	Ease of Use Accesibility	Interoperibilit y				
[Resp. 32]			Mobility Accesability Timeliness Responsivenes s			
[Resp. 33]		Interoperabilit y Connectability Compatibilty				
[Resp. 34]	Ease of use Accessilibity Process capabilities	Availability Accessability		Process capabilities Efficiency		Availability Interoperabilit y Customizabilit y Accuracy
[Resp. 35]	Efficiency Customizabilit y					
[Resp. 36]	Efficiency	Process capability Customizabilty Accesibility Mobility		Timeliness Efficiency	Mobility Communicatib ility accessability	
[Resp. 37]		Accessibility			Operability	Interoperabilit y
[Resp. 38]		Customizabilit y Upgradability	Relevance	Relevance Process capability		

Appendix XII Results from conducted interviews

Source	Code	Administration	Medical Technology	Care Workflow	Information management	Strategy	Internal cooperation	Integrated Care
Physician	[Int.1]		Gekoppeld met lab en radiologie systeem. Aanschaf apparaten/it via Commisie to secure compatibility.	Betere DBC registratie.	Benefits worden weer gehaald uit de beschikbaarheid van het systeem. Gekoppeld met lab en radiologie systeem. Kon vroeger niet zo snel, en kon je niet mee naar huis nemen.	Exacte diagnostische informatie is nodig om goede Clinical decission support te leveren. Service aan huisartsen (inzage brieven/aantekeningen etc) als binding.	Ziekenhuis breed product.	Inzage in alles, inloggen vanaf overall. Ziekenhuis breed product.
National Coordinator	[Int.2]				Toegankelijke information op gestructureerde manier beschikbaar maken.	Start met eenheid van taal binnen hele organisatie.		

EPR-Project leader	[Int.3]	Bouwstenen (protocoleerd werken) voor creatie lappen text.	Gegevens ongeldig verklaren om te kunnen backtracken. Bouwstenen tekst wanneer geprotocoleerd gewerkt owrdt	Maatwerk per specialisme. Leesbaarheid informative. Uniformere workflows/registratie. Overal dossiers i.c.m. tokens.	EPD kan goed reageren op informative aanvragen van 'omgeving' van ziekenhuis, en vragen van patient. Ziekenhuizen eerste lijn binden, voorposten inrichten. Sluit huisartsen aan om markt af te bakenen.	Er moet een behoefte zijn bij alle partijen om informatie te delen.

Hospital CEO	[Int.4]	EPD geschikt als verantwoordings middel.	Hoe presteert het system in 'deze nieuwe wereld'. 'communicatie' met 1 format. (codering)	100% beschikbaarheid, geen problemen met autorisaties. Veel aandacht naar mens-machine interface. EPD bevat alle kennis ziekenhuis. EPD moet uitwisselbare gegevens bevatten.	Hoe presteert het system in 'deze nieuwe wereld'. 'Virtueel ziekenhuis' ondersteunend. EPD kennisbron hier voor. Het elektronisch dossier gaat richting een online community platform.	In toenemende maten worden patiënten door meerdere specialisten gezien worden. Hierdoor is het van belang dat er uitwisselbare gegevens zijn.

Appendix XIII Interview Results Per USE-IT factor

	Dutch coordination platform	Hospital CEO	EPR Project Leader	End user / Specialist
Definition of EPD		Hard to define, thus, create a general definition.		A new EPR system has to include all functionality of the systems it will replace, and perform equally or better.

Working on?	Creating IT model on hospital level[5].	Transferring old EPR to new EPR including a digital version of all records. Designing an interactive 'care file'.	Connecting different departments to the EPR	Implementing hospital-wide EPR, change workflow to a soon to be activated fourth generation. Creating budget accountable departments
Current focus of EPR systems	Separating 'Kerndossier' from 'specialist view' and establishing these views nation wide.	Making paper records available. From 'closed systems' to 'open systems', from 'thousand flowers' to 'one single format'.	Cutting the next constrain, avoiding limits of physical paper records by replacing it with EPR	All-or nothing, (no way back) approach. Features management information, DBC/DOT, Messaging, hospital-wide records. Globalaccess.
Future focus of EPR systems	Integration with systems outside of the hospital	Central gateway to access and coordinate healthcare related 'data flows' around and a person.	Transform the hospital in a new digital way of working via the EPR. Patient logon with security tokens.	Suggestion of clinical protocols provide decision support,
Connections to other systems	Interfaces for GP's, connecting everything to ZIS	Top down approach with an e-hospital in mind.	Start at two departments and use the experience to connect the more difficult cases. Very problematic for product planning.	The EPR replaced most systems, connects to all equipment (via purchasing dept.) The EPR will be the center of to be offered future services.
Privacy	Mainly a political issue, 'how the product is sold'	Patient organizes his own 'record', grants people access, joins social communities, facilitates communication using the EPR, etc.	It's an ownership discussion, the author is the owner, patients can remove their information by request.	Login gated access, warning if user has no 'connection' to the record and 'break the glass' procedure.

[5] Referentie domeinen model ziekenhuizen

Focus	Divide the record in core and manage nationwide uniform specialist record.	Per patient central location of all health-care related 'data objects' about that patient.	Having all data available also in the EPR	Hospital wide replacement for a lot of systems, DBC/DOT proof.
Resistance Macro	Business case, work will be more efficient	Created an 'information department' alongside the 'IT-department'. Monthly meetings with 10 focus groups. Top down active policies, 'everyone has to use it' and obligatory training.	Encapsulate resistance in collegues, use demonstrations and tell the TOC story.	Risky all-or-nothing approach, but old web of different systems didn't function any longer.
Micro	Talk to enthusiastic colleagues	This is the future, own responsibility to learn to cope with it. There was lack of a 'global (chronological) overview'.	Problematic cases where physicians are pampered by support staff. And had bad experience with other IT projects. Ignore those departments for now	Comprehensive new way of working, protocols and workflows to be adjusted for everyone.
Requirements Macro	Hospital's focus is on survival	Protecting the future of the hospital being on time creating an 'e-hospital environment'.	All data also available in the EPR	Most full featured offering. Best of class in all features.
Micro	How to get work done more efficient, update workflow around patient records.	Let early adopters solve much of the growing pains. Doctors traditionally exchange and increase knowledge through intervision/conversations, thus organize these sessions about EPRs.	Finally able to decipher what's written in the records. More uniform workflow within the departments	

Relevance Macro	Less time and effort retrieving files	Less FTE in archiving department. Securing the hospital's sustainability via electronic platforms and the e-hospital paradigm.	Offer services to other institutions to secure market share.	Hospital could not cope with even more IT systems. Management information to manage specific depts.
Micro	Integrate other systems so less procedures need to be executed during day-to-day workflow.	Higher quality record system. Solves communication issues and it is easier to master 1 big system than multiple separate systems.	Back- and forwards tracking of errors, accountability built in.	Own filter in the record's overview, More freedom with own financial dept.
Resources Material	Medical Specialist craft associations need to adopt and push 'a system'.	Most effort goes into connecting current IT-systems and machines. Designing the interfaces is also very important.	The EPR is very much built on top of the running systems.	All new workstations and emergency workstations. Redundant backup server stand by.
Immaterial	Collegues	People need to learn to work with the system, or there is no place for them in a modern hospital.	Demo sessions and change agent demonstrations.	2 full days of training, and many 'evening sessions'

Appendix XIV Written summary of the conducted interviews

Expert from Dutch National ICT for healthcare expert-centre

Every sector and every hospital has its own EPR implementation or development projects. Even within the hospitals, each specialism is running its own projects. Slowly there is movement towards a split in a 'specialist record' and a 'core record' (kerndossier). Also the nursery's department is working on connecting its electronic nursing record, ENR, to the hospital-wide EPR. Some hospitals are analyzing the all-in-one package offered by some suppliers.

Also trending is connectivity to the outside world. NICTIZ is working on regulating the 'core record' to give this a default structure in all the different patient records. Some hospitals are using a 3-layered model, 'core records', 'shared records' and 'specialist records'.

Centred on the patient, each specialism have a very different view on the patient. Specialists should agree on which set of date is verified and accepted as a shared view.

"Specialisten moeten het onderling eens worden over een set gegevens waarvan de inwisselbaarheid is gecheckt, zowel informatie als betekenis, ook wel semantiek."

We are beyond the stage that technical or information layers are hard to share, but sharing information on organisational level, responsibilities and semantics are a different story. Responsibility to get this done is in the hands of the specialists, or the specialists' associations, they need to agree on the semantics in the patient records. When you ask the question: "How could your work be executed more efficient", the answer will be "Layout of the patient records". If the next question is: "What do you need to improve the layout in the patient records?", the answer will be: "define a set of repeatedly occurring elements" and EPR implementation will be mentioned. The otolaryngology (KNO) society contacted NICTIZ to design this core KNO record. There is an increase in cooperation amongst hospitals which will increase the 'core records' and 'specialist records' view, as well as the interoperability.

Preparing and summarizing consults with patients will be different in the future, this will change the workflow. More work summarizing results by Specialist X could mean less work for Specialist Y. Also, Specialists have a tendency to stockpiling work on their desk.

When a previous result of a test is not, or not suitably located in the system, specialists rather enlist the patient for another test than searching for it.

"Wanneer er een onderzoekje moet gebeuren, vragen ze het liever opnieuw aan dan om te kijken of het al een keer is gebeurt. "Komt u maar volgende week terug en laat u uw bloed etc. nog maar een keer prikken." Bij een goede organisatie/indeling, krijgt de specialist al de informatie al van het wellicht eerder uitgevoerde onderzoek."

Resistance is counteracted via colleagues. Seeing the EPR in action and here and then discovering the benefits of the system, people can be turned.

"Via collega's wordt weerstand bestreden, ingekapseld in collegae kan iemand laten zien dat een EPD wat toegevoegd, en langzaam bijdraait."

Hospitals are generally more concerned with survival than with long term strategy. EPR like projects are preferred to be undertaken top-down. Building the 'core record' by a specialist association like Maastro for radiology is a step in the right direction. Each hospital will need its own reason to implement an EPR system. Specialists started ten years ago implementing theirs. Now, the need for a 'core record' arises.

Patients don't mid their medical status to be shared by hospitals. The interviewee himself would like to see accessible patient data shared in a structured manner. Patient's status, enhanced by graphs, clickable icons, and connections made between entities in the backend of the system, leading to a decision support system.

Ultimately, a lot of information has to be shared with colleagues, this will require extra effort.

CEO of a big regional Hospital

Willingness to share information is more important than the technical aspect. An EPR could speed up communication, but more important is the human interface. Electronic communication will improve correctness of your raw data by multiple tens of percents, but is not perfect an sic.

There are always users of the system with their own agenda, keeping separate records outside the system, using the system in different ways.

A successful EPR is certainly not a replacement for the paper records, these paper records were not really successful. A successful electronic record, containing the P for Patient or not, is a records beneficial to the health of the client. Data-systems are successful when they are added value to the experience or wellbeing of the patient. Only when these systems can proof this, people will stop using the paper records. These paper records are still being used to represent the users accountability, or to display chronology.

A plain replacement of the paper records, is an outdated goal. An electronic patient record will be about 'data streams' about a person in a region, facilitating patient empowerment. Patients have the insight in where the data is, the ability to communicate about their data with the specialists or the patient's fellow sufferers. An EPR is impossible to define, therefore create a more general definition. An EPR is successful when it addresses the latent needs of patients. A 'core record' is a dataset and part of this.

Operationalized, or measurable goals of a successful EPR implementation are to be divided into three separate perspectives; Technical, satisfaction and stability. A special new department in the hospital was brought to life. This "information management" department was responsible to specify the ERP's requirements and facilitate contact with specialists to communicate between the development group and the end users.

From the technical perspective, no use of paper, systems should be always available and there should be no authorisation problems. In case of emergencies, certain data should be accessible. Is the old world gone?

From the satisfactory perspective, are the users, the doctors of the system satisfied? Do they see the benefits of the system or do they keep complaining about the responsiveness, and speed of the system. "This is not for me", "I'll never be able to operate this system", "I cannot type on a keyboard". It boils down to machine interfacing.

From the stability perspective, it is important to determine emergency procedures, what happens when the system goes offline? How well does it cope in this new world?

For years IT was overlooked because of the wilfulness of specialists and maybe hospital CEO's (half joking). Changes are so rapid nowadays, and patients are mobile, you just need IT to cope with the sheer amount of data to be shared.

The hospital worked out a strategy, it involves minimum requirements for the EPR's supplier, financial requirements and communication standards and connections to other systems. The multiannual strategy involves the transaction to a virtual hospital, the EPR will be the knowledge centre within this hospital. Management information and competitive comparisons will be made with information from the EPR.

"In toenemende mate worden patiënten door meerdere specialisten gezien worden. Hierdoor is het van belang dat er uitwisselbare gegevens zijn. Deze uitwisselbaarheid van gegevens zorgt voor uniformiteit in formats. Dit neemt sterk toe. De patiënt wordt complexer/ouder met verschillende aandoeningen, in toenemende maten moet je naar multidisciplinaire klinieken waardoor je naar één format moet."

More and more, patients will have complex problems and will need multiple specialists to work on their illnesses. Exchanging data will be of vital importance, and will require uniformity in format. In the future, clinics will be very multidisciplinary, they will still share one date-source, but each discipline will require some extra data fields.

Physicians don't like to be watched, they do, however, like to use the EPR to proof their accountability, or to communicate within the healthcare chain. EPR improved transparency, physicians invite patients to take a look into the patient's records, and in the future they will be able to logon and browse through the files themselves.

The biggest resistance is in the field of professional autonomy. People like to do their job their way and now they have to obey the system. Two trending topics are to be detected, from closed to open systems, and from 'a thousand flowers' to one single format. The open characteristic of the system makes it harder for the user to directly get to just the information he or she desires. For each specialty, special views have to be created. Special codes for specific ailments have to be used and defined in protocols. Getting these protocols defined, is the responsibility of the CEO, keeping the records up to date is the physician's responsibility as is knowing what to add to the record. The patient has no responsibility about the record's contents.

If systems are to be used by individual clinicians, a number of important personal issues must be considered. It must be un-derstood that physicians are not resistant to technology; theyhave embraced many new medical technologies with no hes-itation. They are embracing use of personal digital assistants(PDAs) for clinical purposes with amazing speed. In contrast, however, they are reluctant to adopt new ways of doing things that interfere with their workflow and that they perceive take time away from their patient care work (Ash & Bates, 2005).

Implementing and working with an EPR will change the workflow. Benefits arise in later stadia, active policies and top-down steering will get you there. Work for the specialists changes, consults will take longer, as he will have to enter the data into the system instead of having his staff work this out. Efficiency benefits will occur in later stadia, as less assistance and 'layers' will lead to less issues with communication. When the right people work on the system, the system will keep evolving and improving. 'People' feel the importance of the EPR, there is a certain excitement as initially it will require some extra efforts with an uncertainty for errors. There is a certain level of trust, meetings and courses helped to achieve this. There is also room for participation via the client board.

Other software and other machines have to be connected to the system, interfacing is the important topic at hand. Interfacing with both other systems or equipment and with the users. Portable (tablet) PCs and voice recognition are the future.

After the EPR implementation overview in the records was gone. Paper records had a default (chronologic) overview and tabs to help find specific data more quickly. This was compensated by having lab results available and the electronic record being very up to date.

About 65% of the employees are accustomed to the new system, for 20% it takes a lot of effort to keep up with the new system, 10% is early enthusiastic adopters and 5% don't want to use the new EPR. There are courses for employees, and everyone who still refuses to work with the system simply doesn't belong in the organisation.

To make the EPR appealing to use, it has to include a feedback loop. The system has to scan results, should throw an alert when result X is expected, but Y is found. A special module to assist in training for new employees or interns, special views and modules could be defined with background information. The EPR could automatically generate an information brochures relevant for a specific patient's illnesses. This will also cut costs in organizing, locating, ordering the current paper brochures.

An EPR could also unlock information to different science projects, it could automatically generate specific data required for different medical trials. Nowadays, specialists have to literary enter the same date from system X to the medical trial system Y.

From a patient's perspective, the EPR could be the communication hub to get in contact with peers or specialists, to discuss their illnesses. Simple questions could be 'answered' by the system itself. A great example of such a project is Jan Kremer's Digitale IFV poli (Kremer, 2009).

Project leader of EPR implementation project group

An important factor to notice during EPR implementation, and during requirement specification is the different 'user groups' which the system has to deal with. The number of patient request to have insight in their own 'EPR' grows day by day. Although the EPR is not a plain A4 paper, or linear paper which you can print out and hand out to obey this request, you do have to tailor a solution for these kind of requests. An EPR project is all about 'how to unlock data from a great many sources'. In that way, a hospital EPR will increasingly function like a regional or even national EPR system.

The care process is viewed by the theory of constraints, where each iteration the bottleneck in the process will be detected and improved. At this moment, most pressure is on locating paper records (Zwemmer, 2005).

Hospitals still working with paper records notice their total costs to maintain these records are higher than hospitals who switched to electronic records. The healthcare environment demands more and more information from a hospital, delivered in electronic manner. Also pressure from patients to have insight in their records and 'to know what is going on with their files' is rising. From business/economic point of view hospitals still have data-exchange low on their list of priorities. Implementing EPR just for the sake of cutting costs in typists, archivists, without taking factors like 'improvement of data quality' and 'reduction of errors', in account, this specific hospital could save €700.000,- annually. This is a pretty strong business case.

"Er is een businesscase gemaakt die puur bekeek hoeveel FTE aan typisten, archivarissen er bespaard kond worden. Kwaliteit, fouten, is niet naar gekeken. Puur op de kosten kant zou het al 7ton besparen in 1 jaar."

Regional incentives are mostly market forces and the requirement to work more efficient. Hospitals will define their markets by providing services via the EPR to smaller institutions. This strategy will increase the need for more effective exchange of data or patient records.

One of the biggest success factors to start using an EPR system, is solving 'here and then' problems. When the old way of working takes a great deal of extra effort, a new EPR system sounds more appealing. A simple example is the 'old way' of exchanging patient records, by car, in boxes which have to be locked. This not only feels old-fashioned, it takes a lot more effort to locate these records, transport them, and get them back, complete, with new added data, checked for errors, into the archive.

To start the EPR implementation project, two departments solicited to be the pioneers. The project group's gained experience was used to slowly roll the EPR out to different departments. A carefully selected implementation schedule was created.

For every department a unique mini-EPR was constructed, with all the power to specify forms and what data should be collected where. Departments viewing each other's records, will get the view of the original department. From practical experience there was learned that people will understand this. The higher general structure of the patient records turned out to be suitable everywhere, every department uses a history, conclusions, policy and they all write referral letters. Family history, treatment history, allergies, were placed in a generic record. This strategy works out very well within the walls of the hospital, when data needs to be exchanged with the outside world, it is a different story.

In 2006 a 5-year strategy was created and a choice was made to implement a EPR with properties resembling a second to third generation EPR (Chapter 2.4 Different generations of EPR systems). A complete third generation, or even a fourth generation EPR would require the clinical staff to work with clinical paths, change their workflow according to a new EPR implementation and accept the EPR as a decision support system. Suppliers claim their offerings are ready to support these features, but the medical staff is simply not trained or ready to do this. Medical education follows a very traditional path. Beside a shift to focus on patient communication, 'practicing medicine' hasn't changed.

The 5-year horizon was selected to slowly transform the hospital and all its employees to a 'new digital way of working'. The goal was 'everything has to end up in the EPR' but no strict goal to abandon all paper was set. Still, order communication between radiology/lab and the outpatient department is still pretty much on paper.

Benefits of the system are hard to define, they are different on person to person basis. In the case of clinic coordinators and secretary, they are finally able to decipher the exact physicians message.

"Per persoon die je ondervraagt, brengt het systeem andere voordelen. Policoördinatoren en medische secretaresses kunnen eindelijk lezen wat de dokter schrijft."

The EPR system enforces a new, more uniform, way of working. There was always a difference between the physicians' efforts to document and time spend administration, but now the system enforces a specific minimum level. Using security tokens, records are available when access to the internet is available. Within the next 5 year patients will have access to a 'view' of their records, although the EPR will still be a 'network' with different information sources, and not be translated to linear sheet of paper.

The privacy discussion, is also an ownership discussion. The data entered in the EPR is an aggregation made by the physician, therefore he is the owner of the data. Patients can request access to their data and even have the ability to be 'removed' from the system. The patients' address details will be replaced by a generic string, in order to not compromise the database.

Lack of participation was not specifically managed. However, joining the EPR system, was a bargaining tool for the hospital to grant departments permission to, for example, hire new personnel. Demonstration sessions were organized, and reasons to join like; "the patient's records are accessible everywhere", "you will hinder the workflow of your colleagues" were widely communicated. However, some departments like cardiology, were that much spoiled by their supporting

staff that most benefits did not affect them directly. Experience with earlier IT projects and general attitude also factored in.

Possible errors in the EPR system can be highlighted, and data can be marked 'invalid'. No data can be removed, this way, conclusions based on invalid data can be traced backwards and forwards. Not all invalid data is also a mistake, a different conclusion can be drawn from different data available at that specific moment. Conclusions on a specific moment, with a specific set of data available can be the right or logical conclusion at that moment. Colleagues, and medical review committees can be granted access to this data. Also, the many eyeballs principle (Raymond, 1999) is applicable on this shared view of patient records.

One of the bigger risks is the EPR's connection to other systems. During project planning, time to connect to all other systems has to be estimated, This is a very unpredictable practice, but will be of vital importance to the usefulness of the system when the EPR is delivered. Each connection is not only a technical challenge, but all connections come with a specific work-flow.

There is no critical mass to support one product. This is where patient empowerment and social gatherings can direct their force. When big organizations like GGZ (Dutch mental health care organization) decide to implement everything via, for example, Facebook, things will change.

End user Physician

Two and a half year ago, this hospital started the project to implement a big hospital wide EPR product. This time is excluding an extensive pre-selection and package configuration. The implementation was executed in 3 phases. XXXX During the project's initiation, a requirements document has been created. Top down, the decision has been made to implement a fourth generation EPR. The previous systems pretended to be first or second generation, but it was a mess with many different sub systems. Main driver for the selection of the EPR was the size and thus trustworthiness of the supplier. Maintenance should be taken care of by the hospital's own IT department, but beside that, the supplier had to have a lot of experience implementing its product. Most EPR products didn't have all of the required features. After the third implementation iteration, the EPR included support for; reporting, access to lab results, access to pictures of scans, order management, planning, polo clinical reports, diagnosis-treatment-combination (DBC) registration, general practitioner referral and email/communication.

The decision was made to implement a 'core-record' and a specialist record. There is one single view on the records, there is a chronological summary page and specialist sub pages. Filters hide or show a physicians own edits, his colleagues', appointments or drug subscriptions. Each specialists has –after logging in- permission to edit only his view of the records. For each input field, appointments

are made about what the field should include. In weekly sessions, a project group of physicians from multiple orientations have been validating the system's build progress. And designing the view for his/her specialism. The new EPR system is a big change and it took 3 full days of training to learn to work with it and adjust the workflow accordingly.

All of the old paper records are scanned and digitally represented in the system. All the paper files will be destroyed. For each patient, a medical viewer will show the scans of the paper records. All employees with the rights to read patient records, have access to all the information, that said, psychiatric records are not yet added to the main EPR. There is the possibility to 'hide' certain parts of the record, but also the 'break the glass' procedure, where you will have access to everything in the file. (a fire alarm analogy, and only in case of emergency) There is a registration system which checks if a user is 'connected' to a record in any way, when you are the doctor of a patient, you have access, when you are a physician from a different department just browsing through records, you'll get a warning and will be logged. Security is improved over the paper record system. The EPR is in use for eight months, and the first security problem has yet to happen.

Connection to the nationwide hub (LSP) or other systems haven't been taken into account. There were too many unanswered questions to design the system with these in mind.

Many (mainly academic) hospitals have a lot of small sub-systems, their users are all very satisfied about their own small systems, but they are all silos. Rights management, appointments, sharing information, with all these smaller systems in place, this is a big mess.

The supplier of the EPR states, only 1-3% of the users will not be, after training, and some time with the system, able to work with it. The EPR requires more time from the specialists themselves, but the records never get lost, and the system is always and everywhere available. Messages or discussions about a record can be made without locating and sharing the physical record. A message with a direct link attached can be send from within the EPR. A lot of time has spend on training and to get the system accepted, therefore the choice for a hospital wide rollout was made.

Within two years the very comprehensive, expensive ERP implementation will reach its financial goal. A 30% to 5% DBC discard ratio translates to 25% extra income for the hospital. Also the system is future proof (DOT proof), activities can be connected to a specific DBC. Preparing for a consult takes less time. A pre-defined snapshot of a patient's can be generated real-time.

Future strategy includes 'mychart', a module where patients will have an own login code. The better type of security can be implemented, the more vital information

will be shown. At the start of the project, only appointments and basic information will be available. Future plans include insight in the complete record, communication with physicians, overview of pictures of scans, connections to illnesses, treatments, and information brochures. Even videos about procedures can be shown. An interconnected information network will be created. When ICD-10 is fully implemented, and a foundation of clinical knowledge is available in the system, the decision support module will be activated. Clinical protocols will be suggested, but the real-life experience of the physicians themselves will play the most important role of accepting or adjusting the suggested protocols.

The EPR also generates management information. This way specific business units can be managed and have their own budget responsibility. For them, this includes more freedom to improve or innovate.

Emergency procedures are available, every 15 minutes, a second server will be updated, extra workstations are stationed on certain locations. Every year, a new version of the EPR will be implemented. A current (2011 version in 2011, etc) version in a test environment, and a year old version in the hospital itself.

Appendix XIII Interview Results Per USE-IT factor, summarises the results per USE-IT factor.