Master Thesis

Evaluation of a Hospital Information System (HIS) implementation success from a users' perspective:

A Mixed Method Research

BART KUIPERS

January 2016

Version 2.0

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Abstract

Hospital Information Systems are complex systems and many implementations are found to fail due to technical, organizational, or individual factors. Success of IT implementation is difficult to define, and clearly depends on the setting, context, and the stakeholders. However success from a users' perspective can be seen as the perceived benefits of a system. This study tries to predict the success of a HIS implementation in an academic hospital context from the users' perspective in a mixed method research design. A conceptual evaluation model of HIS implementation success was developed based on the IS success model by Delone and Mclean and the model by De Waal and Batenburg. The developed model subsequently relates service quality factors during implementation (i.e. use participation, training and IT service quality), psychological ownership, user satisfaction and perceived benefits shortly after the HIS implementation. These relations were tested by survey data collected from 375 end-users. The results of the regression analysis showed that (1) participation is a key predictor of psychological ownership, (2) service quality factors are predictors of system and information quality, (3) psychological ownership, system quality and information quality are determinants for user satisfaction (measured as compatibility) and intention to user. Finally user satisfaction and intention are predictors of the perceived benefit. An interesting result from the full model analysis is that psychological ownership is also a driver of the perceived benefit. This shows the importance of user participation and creating a high feeling of involvement by users for a more likelihood of a successful implementation. These results were verified and mentioned also by participants of the focus groups. This study can contribute to the health IT research by proposing a valid model to evaluate a HIS from a users' perspective and providing best practices for managers implementing a HIS.

Acknowledgement

This document contains the master thesis: “Evaluation of a Hospital Information System (HIS) implementation success from a users’ perspective: A Mixed Method Research”.

With this thesis I try to provide insight in what influences a successful implementation of a Hospital Information System (HIS), and which lessons can be learnt from a case study from a HIS implementation at the University Medical Centrer Utrecht. This research focusses on an HIS implementation from a users’ perspective.

I also would like to thank my family and friends who have always supported through difficult times when writing this thesis. Finally, I would like to thank my thesis supervisors, Dr. Ronald Batenbug, and Dr. Rob de Leeuw, and my thesis committee, Dr. Marco Spruit, for their support and mentorship during the planning, conducting and analysis of this study.

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1 Introduction

Nowadays many organizations use complex information systems to control and assist in their business processes. Also hospitals are, as a result of a more patient centred approach, investing much money in Information Technology and Information Systems (IT/IS) to improve quality of care, efficiency and safety. However many of these projects fail due to technical, organizational, or individual factors (Rahimi & Vimarlund, 2007). Knowing about and paying attention to the early warning signs of IT project failures, increases project outcomes (Kappelman, McKeeman, & Zhang, 2006).

The number of studies that evaluate the implementation of Health Information Technology (HIT) are increasing, however it is still a small percentage of all medical informatics publications (Ammenwerth and De Keizer 2005). Evaluating healthcare information systems (HIS) implementation on how and why users accept a HIS will benefit decision makers and managers in healthcare to acquire knowledge about implementation processes and identify the key success factors to develop better implementation strategies.

The use of IT/IS in healthcare has many benefits, and is growing more important over the last decade. Buntin, Burke, Hoaglin, and Blumenthal (2011) showed in a literature review on benefits of health IT/IS, that 92% of the reviewed studies presented a positive outcome. However, they found that dissatisfaction with the implemented HIT among some users remained a problem and a barrier to achieve the potential benefits of HIT. Buntin et al. (2011) concluded that the "human element" must plays a critical role the implementation of HIT.

There has been an increase in studies researching this "human element" with focus on user attitude towards IT/IS including in the healthcare sector which evaluate the success of implementation. Success of IT implementation is difficult to define, and clearly depends on the setting, context, and the stakeholders of the system (van der Meijden, Tange, Troost, & Hasman, 2003). Furthermore, success is multidimensional (e.g. many implementation factors including e.g. user satisfaction), and is dynamic (e.g. success of implementation can changes over time) (Berg, 2001).

Many theoretical model have been developed to evaluate the success of an HIT and its implementation. A well-researched framework for measuring the complex attributes for successful IT/IS implementation is that of (Delone & McLean, 2003), the *Information System (IS) success model* (Palm, Colombet, Sicotte, & Degoulet, 2006; Sicotte et al., 2009). However, this model does not include system development (i.e. user involvement), implementation (i.e. user training) and organizational aspect attributes (i.e. management support), which are just as crucial for successful IT implementation (van der Meijden et al., 2003).

Though, little research has been conducted on evaluating HIS implementation and how user attitude changes over time, especially in a pre- and post-implementation context (Ammenwerth & De Keizer, 2005; Rahimi & Vimarlund, 2007). Most prior IT evaluation research focussed only on the new system implemented and not on the system to be replaced (e.g Sicotte et al., 2009). However it is important to measure users' attitude of the replaced system to determine users' satisfaction with the new system. To ensure that users are satisfied with the new HIS, the involvement of users in the implementation process is important (Berg, 2001).

Waal & Batenburg (2009) adapted the Delone and Mclean model and added the importance of users' involvement to evaluate an implementation of a new workflow management system at a large Dutch insurer. This evaluation study adopts the evaluation model of Waal & Batenburg (2009) adapted to the context implementation of a new HIS in a large Dutch academic hospital. Evaluation and analysis of the implementation of a HIS is crucial to assure and improve their quality and effectiveness, to steer the implementation project, and for future IT projects. This study focusses on two factors: (1) the user satisfaction with the implementation process, and the (2) user satisfaction with the HIS.

1.1 Objective and methodology of the evaluation

The present study is designed to evaluate the implementation of a HIS in a large academic hospital in the Netherlands. Previous studies have evaluated ICT implementations and users satisfaction in various healthcare setting. However, little research is done evaluating ICT implementation with a mixed method design, and over a longer period of time (longitudinal). As such, this study attempted to evaluate the new HIS from a users' perspective and to identify various factors influencing the users' satisfaction and success of the new system. The primary objective of this study was to determine the success factors of the HIS implementation and build a model of HIS implementation success that predicts the likelihood of implementation success. Studying user centric factors related to the implementation of HIS can help to determine what factors affect the success.

This evaluation study uses a multi research design, which are a quantitative and qualitative method to answer the research question.

1. A quantitative questionnaire aimed to examine the satisfaction levels and experiences of users of the HIS. Three questionnaires were distributed at three time points; one month before the implementation of the new HIS to measure a baseline of users experience with the old HIS and the expectations. Two follow-up questionnaires, six months and a year after the implementation, to measure user satisfaction with the implementation process and the first experiences with the new HIS. An extensive questionnaire was send to the key-users (i.e. champions) and a shortened version to end-users (i.e. normal users). The results and findings from these questionnaire were used as input for the qualitative study.
2. Two qualitative focus group sessions were held for key-users and end-users separately after the second follow-up questionnaire, to gain deeper insight in users experience with the implementation measured in the questionnaires. Goal of the focus groups was to map the barriers and facilitators with the implementation, and validate the questionnaire findings.

Combining the quantitative and the qualitative conclusions can result in a robust evaluation model of the implementation of the new HIS, with lessons learnt and best practices for future HIS implementations as outcome.

1.2 Research Questions

This evaluation study was based on the Information System evaluation model of (de Waal & Batenburg, 2008) which was an adaptation of the Information Success Model by (Delone & McLean, 2003), which focuses on the satisfaction of users with a IS. The model of (de Waal & Batenburg, 2008) was modified and adapted to focus on the factors affecting success of the HIS during an implementation of a new HIS, in different phases of the implementation process. Furthermore, a successful implementation of HIS depends on a multiple set of complex factors which are dynamic and sometimes domain specific. This study divided into four stages: service quality during the implementation, psychological and technical factors, user acceptance and the success outcome. Main focus is on the involvement of users and the role with system success. The research questions that this study will answer are:

1. Is there a relationship between the service quality, the psychological state of involvement and technical factors
2. Is there a relationship between the psychological state of involvement, technical factors and user acceptance?
3. Is there a relationship between the user acceptance and outcome success?

1.3 Scientific and practical relevance

One of the most important factors for a successful implementation of ICT is the adoption of the system by the users. The satisfaction of health care professionals (e.g. physicians and nurses) has a significant influence on the adoption of a hospital information systems (HIS). Although, an organisation wide integrated HIS has potentially benefits for the efficiency, quality of care, and the patient safety, the implementation of these systems are not without challenges. The rate failed IT implementation projects varies among different studies, but has been found to be relative high (Kaplan & Harris-Salamone, 2009; Littlejohns, Wyatt, & Garvican, 2003).

By evaluating the implementation and first experience of the new HIS among users, lessons can be learnt to improve implementation and change processes for the current and future IT implementation projects. Identifying the factors that influence the satisfaction of users with a HIS implementation, and the lessons learnt will help managers and implanters to take proactive actions to ensure a successful implementation. This research may help in more successful implementations of a HIS in hospitals, satisfied clinicians and administrative staff, and ultimately a better healthcare system that is efficient, safe and effective.

Scientifically, this study is relevant to create a validated HIS success evaluation model centred on users involvement. Furthermore, this study is among few that do a longitudinal measurement over different stages in the implementation process and combines quantitative and qualitative results. This should give a more comprehensive picture about the workings of an implementation of a HIS.

1.4 Scope and limit

This study focusses on the first stage towards the development of a theoretical evaluation framework and the outcome of the qualitative focus groups, which structure is based on the framework. The scope of the study is the evaluation of a new HIS from a users' perspective. Although many factors are related to a HIS implementation, this evaluation study limits to the factors which are concern with the involvement of users during the implementation and the satisfaction of users towards the system.

2

Information system implementation in healthcare and hospitals

This section will describe the background of the study by discussing and defining the complexity of a HIS, and what challenges are involved to a successful implement of such an information systems. Finally we discuss how to evaluate the implementation of these systems. The success factors with an HIS implementation from a users' perspective are discussed and defined in the next chapter.

2.1 Hospital Information System

Healthcare is a complex and dynamic environment with many key players and their interaction. Healthcare is different from other sectors because it is matter of life or death, predominantly public (non-profit) sector.

The management of information in this complex environment of healthcare is fundamental for efficient management, furthermore there is an increasing need high quality information. The utilization of ICT in healthcare can be the answer to this ever increasing demand for information by means of electronic health information systems. There are various terminology in literature which all describe similar approaches of managing the information flow and storage in hospital care services, as: Hospital Information System or Health Information System, Clinical Information System (CIS), or a Patient Data Management System (PDMS) or Electronic Health Record (EHR). From this point on a Hospital Information System (HIS) is used to describe such a system used within a hospital.

A HIS includes all systems of a hospital dealing with data collecting, storing and handling. This can be paper-based or electronically, or a combination of both. A HIS handles both the administrative and clinical functions. A total HIS consists of a medical affairs system, an order-entry system, a retrieval system, and several subdivisions systems (Institute of Medicine, 1991).

Gartner defines a HIS as "the IT applications used to manage hospital operations (e.g., patient financials, registration, scheduling, general financials, back-office systems and order communications)". A HIS is essentially a computer system that can manage all the information to allow health care providers in a hospital to do their job effectively. A HIS can be compared conceptually with an Enterprise Resource Planning-system (ERP) for business. This is a software package for production companies to support the planned production capacities. A HIS is a general term, that supports a variety of healthcare activities in a hospital at an strategic, tactical and operational level (Yusof, Papazafeiropoulou, Paul, & Stergioulas, 2008).

The HIS made its first appearance in the 1960s, where it was used by staff primarily for managing billing and hospital inventory. Nowadays, due to improved infrastructure and faster computer, are being used

to real-time access electronic medical records, for clinical decision support, and training or research. Chaudhry et al. (2006) performed a literature study about the impact of health information technology on quality, efficiency and cost of medical care. The authors demonstrated the major benefits to be increased efficiency (i.e. decreased utilization of care) and better patient safety by better guideline based care, enhanced surveillance and monitoring and, decreased medication errors.

Within many hospital organizations the HIS is a patchwork of many applications for many different divisions and specialisms that have evolved over time, not a single, seamless, integrated system. Hospitals have for seeing flexibility, efficiency and multidisciplinary clinical processes connected and combined the (stand-alone) applications. A fully-integrated and full scale HIS is not necessary to see the benefits. However, because of the increasing complexity, patient-centric approach and increasing demand from patients does an integrated system more benefits. Information systems that manage data have been developed with different technologies and are difficult to integrate.

2.1.1 HIS core function

The Institute of Medicine described in a report published in 2003, the eight core functions of a HIS (which they termed as an Electronic Health Record or EHR). These functions include:

- *Health Information and Data*: An EMR must contain data about an patient for an health professional to make sound decisions. However these information needs are not always met. On the other hand it's important the user interface is well designed and does not give too much information which can overwhelm or distract a user.
- *Results Management*: All current and historic test results of all involved clinicians of a patient. This includes, reporting lists of laboratory, microbiology, pathology, radiology reports and consults and multimedia support for images, waveforms and scanned documents. Managing the results electronically has significant benefits in improving quality of care over paper-based reporting;
- *Order Entry/Management*: is referred in the literature as Computerized Provider Order Entry (CPOE). A CPOE assist in completing clinical tasks such as electronically ordering prescriptions, laboratory test, diagnostic imaging, or consults. Such system can improve workflow processes, and patient safety;
- *Decision Support*: helps health professionals with clinical decision making tasks such as determining diagnosis of a patient, or prescription ordering (via CPOE). These tasks are accomplished by clinical alerts and reminders;
- *Electronic Communication and Connectivity*: medical information exchange which is possible due to integrated systems within and across settings is critical for the quality of care. This communication can be among a (multidisciplinary) health care team and other care partners, and with patients;
- *Patient Support*: functions for a patient to access and consult their patient record (i.e. through a web portal), patient education, tracking and home monitoring (telemedicine);
- *Administrative Processes*: Access to scheduling and planning functions to support administration and patient services.
- *Reporting and Population Health Management*: internal and external management reports and management support information which includes patient safety and quality monitoring, but also public health reporting on for example diseases and epidemics.

2.2 Innovations in health care

Implementations of ICT in healthcare is significantly different from implementations in average business environments, due to the specific cultural environment of the health care sector (Wu, Wang, & Lin, 2005). The healthcare domain combines the complexity and uncertainty of decision making in clinical medicine, which makes it unique compared to other domains. These clinical decisions are often a matter of life or death. The organisational culture of health care is therefore characterized by higher uncertainty avoidance than other organisational settings. Furthermore there is a large influence of health care professionals (e.g. physicians and nurses) on the organizational adoption of technology. Health care professionals have a professional job autonomy. Meaning a specific kind of knowledge and achieved professional status of special power and prestige, which will require different needs for an technological innovation. Finally, in the health care setting there is a fuzzy definition of the term 'end-user'. An end-users may refer to a health care professional or patient. There are many different disciplines in healthcare with their own practices and demands.

2.3 A successful HIS implementation

2.3.1 Defining success

Before the "success" of a system implementation can be determined, success has to be defined. However, defining success is found to be difficult, as success is a subjective concept, which can be viewed from different perspectives. Success can be simply defined as turning the system on to actually having benefits for users over the old IS, but also differs for groups of users (Kaplan & Harris-Salamone, 2009).

One of the most common definitions of success in the HIS literature is, success is "not a failure" (van der Meijden et al., 2003). Meijden et al. (2003) states that "Clearly, the determination of success depends on the setting, the objectives, and the stakeholders. Only a thorough evaluation study can show whether or not a specific system was successful in a specific setting". Berg (2001) agrees that success could mean simply that the system is running and is a multidimensional concept and has a dynamic nature, meaning it depends on many different factors and can change over time. However, (Berg, 2001) state that "Alternatively, it could mean not so much the factual use of the system but the appreciation of this use by the users…". The satisfaction of users and their perceived benefit of the system could play an important role in determining success.

Delone & McLean (2003) measured success as the net benefit of a system for individual work practices and organisational impact through the factors system quality, information quality, service quality, the usage of the system and user satisfaction. These success factors were found to be also applicable for evaluating health information systems (van der Meijden et al., 2003).

To make determining a "success" of a HIS implementation easer, three categorisations of success are classified: (1) the total failure (the new system is never implemented or not adopted at all after implementation), (2) the partial failure (the major goals of the implementation are not met, or has a significant undesirable outcome), and (3) the success (in which major goals are met, and stakeholders experience not a undesirable outcome) (Heeks, 2006).

2.3.2 Successful HIS implementations

A survey of the Standish Group found that only 37% of the surveyed IT projects in 2011 were complete on time, on budget and complied with user requirements. However, the successful IT implementations double compared with findings in the 1994 survey, it's still a problematic low success rate. The Standish group found that 21% were considered a complete failure. This situation is not any different for health information system implementations. Even despite the increase in best practices research which have identified the success factors, health information system implementation project often fail (Berg, 2001). Kaplan & Harris-Salamone (2009) for example, report in an international study that between 30% and 70% of major health IT projects fail.

What these studies about the success (or failure) of health IT implementation recognize is that although technical issues is still a factor why implementation fail, the emerging consensus arises that this is more due to sociological, cultural, and financial issues which are more managerial than technical (Aarts, Doorewaard, & Berg, 2004; Kaplan & Harris-Salamone, 2009).

A much mentioned barrier to acceptance of health information systems is due to interference with established practice routines and work practices (van der Meijden et al., 2003). What makes an IT implementation in healthcare so difficult is the communication and identification of these work practices (Kaplan & Harris-Salamone, 2009).

Change management and a user centric design may provide the tools and methods that can be applied to meet these needs. Change management can be defined in this context as how to manage change for users on an organizational level. User centric design by the direct involvement of users developing and implementing the new technology (Edwards, 2006).

A combination of these approaches ensures that the system design meets the needs and requirements of the users by involving and preparing users for the changes when implementing the new system. The implementation of a HIS is a highly time and recourse intensive process which need to be planned in a realistic timeline (Karnas & Robles, 2007). The change to a new HIS has a large impact on the organization and the users. To minimize this impact the change has to be smooth and supported by users. A lack of acceptance and attitude of users towards the new HIS by users and staff have been found to be a key-factor why implementations fail (Ash & Bates, 2005). Croll (2010) found that a key-factor of a failed implementation of a HIS was not directly the quality and capability of the system but was mostly influenced by the user satisfaction towards the HIS. Furthermore, Berg (2001) argued that the major factor with an implementation process is not only technical, but an organizational development project.

This shows that the implementation process is important in the user initial acceptance of a HIS, and an implementation of a system in a healthcare setting is strongly associated with a high involvement of end-users. From the end-users perspective, the key concerning issues are implementation attributes which involve the support of management, design of the system, project management (e.g. IT support) and training or education and organizational aspects as culture, support, rewards and usage of champions (Gagnon et al., 2012; Häyrinen & Saranto, 2004; van der Meijden et al., 2003). These factors influence the user involvement during a HIS implementation which may explain the successful implementation of the information system.

2.4 Evaluation of information systems

Evaluation is a method to measure the success of a system and find bottlenecks and drivers so the implementation process can be improved.

Ammenwerth et al. (2004) defines evaluations the evaluation of information technology specific in a healthcare setting as: *"…the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation), the result of which informs a decision to be made concerning that system in a specific context".*

Performing an evaluations may be viewed as a duty in being a member of a social system. *"All social institutions or subsystems, whether medical, educational, religious, economic, or political, are required to provide 'proof' of their legitimacy and effectiveness in order to justify society's continued support."* (Suchman, 1967).

Evaluation is based on comparison, which can be a comparison of the before situation with the after (pre/post), or whether expected effects and goals have been established. The purpose of evaluation studies is to provide feedback to assure improvements in the given process and is a final step in any implementation process. There are many reasons why an health information system should be evaluated, e.g. to measure the cost and benefit of a system to users and the organisation, as justification of the investment made, improve the quality of the system and healthcare provided (decrease vendor lock-in). Evaluation is not only useful for accountability, but also to improve a general understanding of the role of information technology in healthcare and to deliver high quality systems that offer clinical and economic benefits (Heathfield, Pitty, & Hanka, 1998).

It's difficult to discern the effects of an HIS implementation to changes in clinical outcomes (such as improved quality of care and patient safety). Changes could also be explained by many other factors like organizational changes, and can become apparent only after several years of implementation.

Health IT systems are considered mission-critical, complex systems used in complex organizations by a large number of widely ranged and multidisciplinary users. Friedman & Wyatt (2006) states: *"The causal links between introducing an information resource and achieving improvements in patient outcome are long and complex compared to direct patient care interventions such as drugs...it is thus unrealistic to look for quantifiable changes in patient outcome following the introduction of many information resources until one has documented changes in the structure or processes of health care delivery".*

However, evaluation studies focused on the development, implementation, operation and utilization of information system in the healthcare domain has grown over the years (Ammenwerth & De Keizer, 2005). Studies that map the dimensions influencing an implementation of a HIS and its effects on the healthcare may contribute to the emergence of an evidence-based health informatics. These evaluation studies help decision makers, managers and managers to acquire knowledge about successful implementation projects and impact of a HIS and help them to make decisions (Talmon et al., 2009).

2.4.1 Evaluation research approach

There are several approaches for evaluating information systems in a healthcare setting. These approaches depend on in what phase of the IS lifecycle the system is being evaluated, and what aspect is being evaluated. Evaluation of IS is based on comparison, this can be between different phases of the life cycle, cross-sectional or between different roles or characteristics. The evaluation of a newly implemented HIS can either be compared with the status or attitude of users before the implementation

(i.e. pre-implementation) or with the replaced system (Bürkle, Ammenwerth, Prokosch, & Dudeck, 2001).

Basic distinctions in different evaluation types are a formative and summative evaluation (Friedman & Wyatt, 2006). Formative evaluations tend to be conducted during a project (e.g. HIS implementation project) with the objective to provide direct input to steer and improve the project in a positive way. A summative evaluation on the other hand, attempt to assess concrete achievements, and is usually done after the project has finished.

Furthermore two evaluation methods can be distinguished: objectivist and subjectivist view of evaluation (Friedman & Wyatt, 2006). The objectivist evaluations is derived from the logical-positivist philosophical orientation, which is defined as: ”*which assumes an external and knowable reality that can be objectively measured; an impartial researcher; and the possibility of producing generalizable statements about the behaviour of the natural and social world*” (Greenhalgh, Potts, Wong, Bark, & Swinglehurst, 2009). Many quantitative research methods such as survey’s, system audit logs and ROI analysis belong to this category of evaluation. In contrast, subjective evaluation is derived from an “intuition-pluralist” worldview, which includes the Interpretivist position and is defined as “*…assumes a socially constructed reality that is never objectively or unproblematically knowable, and a researcher whose identity and values are inevitably implicated in the research process*” (Greenhalgh et al., 2009). Methods that typically belong to the subjective category are interviews, focus groups, observations and document studies. A objective approach uses measurable data that can be interpreted through statistical applications (Bürkle et al., 2001), while subjectivist approaches focus on description and explanation derived from observations, interviews and review of documents (Friedman & Wyatt, 2006). An evaluation project may consist of a combination of these basic types.

A traditional objectivist approach for evaluating health IT is the randomized clinical trial (RCT) due to the success in medicine research (e.g. drugs trials). However, it is difficult to use this method in health IT evaluation due to a number of reasons:

- Full-scale implementation of a health IT system affects the whole organization (all employees, departments and whole hospital)
- The effects of a health IT system are difficult to contain within the limits of the randomized groups.
- Making hospitals the object of randomization means limiting evaluation studies only to few national scale projects.
- A user of a health IT system can never be blinded to what type of system they are assigned to which violates an important principle in RCT.
- Finally, it can be considered unethical and unacceptable to assign only to some departments the new (and more useful) functionalities of a health IT system, and leave out others.

Moehr (2002) sums the use of the RCT method in health IT evaluation studies up as ”*The randomized controlled trial design is frequently considered the epitome of the comparison study, because it ensures utmost objectivity. My argument though is that this objectivity comes at a tremendous cost when applied to the evaluation of information systems in the manner devised for controlled trials with physical interventions*.”

Bürkle et al. (2001) and Stoop & Berg (2003) suggest to use a multiple approach to IT evaluation in healthcare that uses both objective and subjective methods in order to encompass the entire spectrum of the complexity and dynamics of healthcare information systems and their impact in the organization.

The time phases in evaluation are pre-implementation, during implementation and post-implementation. The overall aim of evaluation in these phases is usually different (Stoop & Berg, 2003):

- *pre-implementation* criteria is concerned with the need, feasibility and expectations of the implemented system,
- *during implementation* provides feedback of the implementation process and first experiences using the system, and
- *post-implementation* is usually concern about the final outcomes or impact of the intervention (i.e. summative).

Bürkle et al. (2001) describes four phases of IT evaluation over time (see Table 1). Phase one is the verification of the system (and implementation process) if it is meeting the desired specification. Next, the system should be validated if it complies with the work practices, and third if it is accepted by users. Phase four can be performed when the system is accepted, and the benefits of the system become apparent.

#	Evaluation phase	Main question
1	Verification	Has the system been developed according to its specification?
2	Validation	Does the system perform the tasks for which it has been designed in the real working environment?
3	Evaluation of human factors	Will the system be accepted and used?
4	Evaluation of clinical effect	How does the system affect patient outcome?

Table 1. four phases of IT evaluation (adapted from Bürkle et al. (2001))

3 Literature Review

In this section the theoretical context for the system success will be discussed. Firstly by discussing different important IT adoption and evaluation models, on which the framework for this research will be based. These frameworks argue how the adoption process might occur. Secondly, the different support factors involved in a HIS implementation will be discussed through reviewing literature about implementations and evaluation studies of health information technology.

3.1 Adoption and diffusion of innovations

User acceptance of technology is an extensively discussed topic in adoption literature in many domains. One of the models that lay the foundation for user acceptance research is the diffusion of innovations theory (Rogers 1995). Diffusion research focuses on the conditions which increase of decrease the likelihood an innovation is adopted. Diffusion has be defined by Rogers (1995) as "*the process by which an innovation is communicated through certain channels over time among the members of a social system*". According to the Innovation Diffusion Theory, coined by Rogers, potential users make decisions to adopt or reject an innovation based on the beliefs they form about the innovation. He categorizes the diffusion process in five stages: knowledge, persuasion, decision, implementation, and confirmation (see Figure 1).

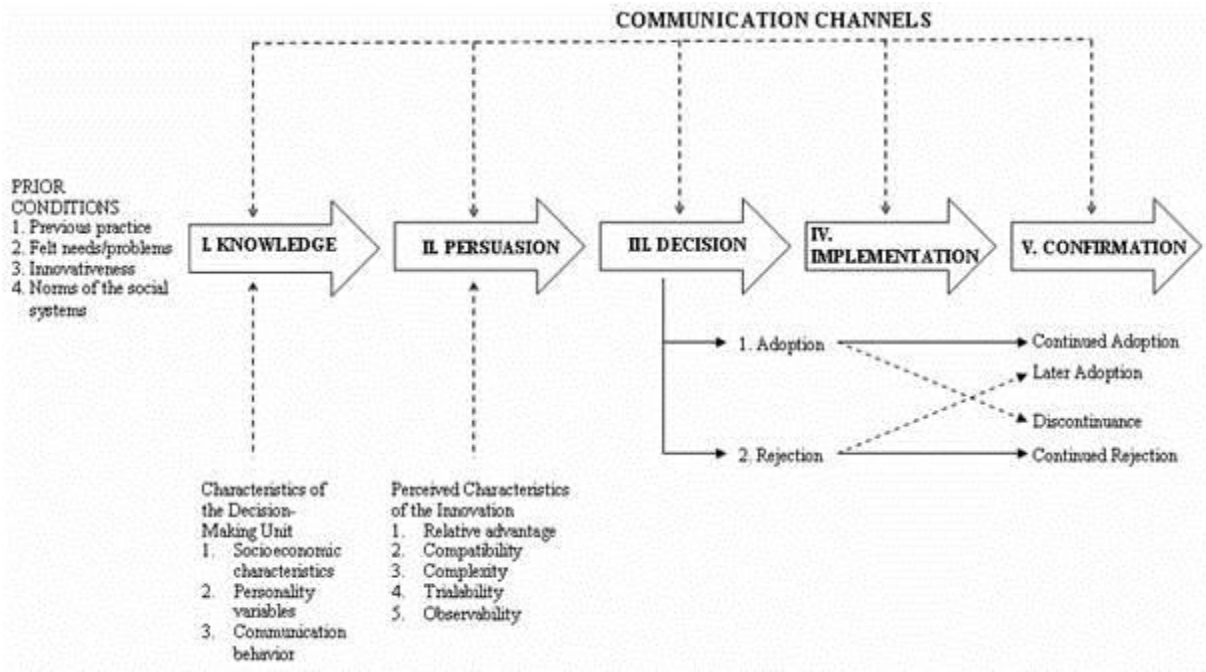

Figure 1. Diffusion of innovation model (Rogers, 1995)

Several processes occur before the implementation of a new technology. The users of the technology must be made aware of the implementation, and they have to be aware of the impact and benefits the new technology has (in comparison with the current or pre-implementation situation) to persuade the users. This may follow by the adoption of the new technology by users which is the decision to use the innovation. The decision of adoption can be made optional (decision is made individually), collectively (decision by a group consensus), or authority-based (decision made by few or one individual for whole group). When the technology has been adopted (or in other words have been accepted) the implementation phases starts where the innovation is being introduced to a particular setting, and users determine the usefulness of the innovation (Rogers, 1995).

However there is a distinct difference between diffusion and adoption. Where adoption is an individual process in which many factors influence the decision making, diffusion is the way how an new innovation is being adopted in a group or collective over a period of time (Rogers, 1995).

Several theories have been developed to model the adoption and acceptance of technology over the past decades. These models describe how which factors influence the behaviour to acceptance of new technology, and how an implementation of new technology can be successful.

3.1.1 Theory of Reasoned Action (TRA) & Theory of Planned Behaviour (TPB)

Theory of a reasoned behaviour (TRA) was originally proposed by (Fishbein & Ajzen, 1975) to understand behaviour and predict outcomes, and is being successful used in many different domains (see Figure 2). The main assumption of TRA is that an individual takes into consideration the implications of their actions before deciding to actually engage or not in a certain behaviour. It also posits that the main determinant of a person's behaviour is their behavioural intent. This behavioural intention is affected by attitude towards the behaviour, and the subjective norm (what other people think).

The attitude towards behaviour is defined as a "person's positive or negative feelings about performing target behaviour (Fishbein & Ajzen, 1975). Subjective norm is the influence of social pressure perceived by an individual to perform or not perform a certain behaviour (Fishbein & Ajzen, 1975). Behavioural intention is the level of commitment that an individual is willing to put into performing a certain behaviour, and is determined by the attitude and subjective norm. Behaviour is defined the actual behaviour of an individual (Fishbein & Ajzen, 1975).

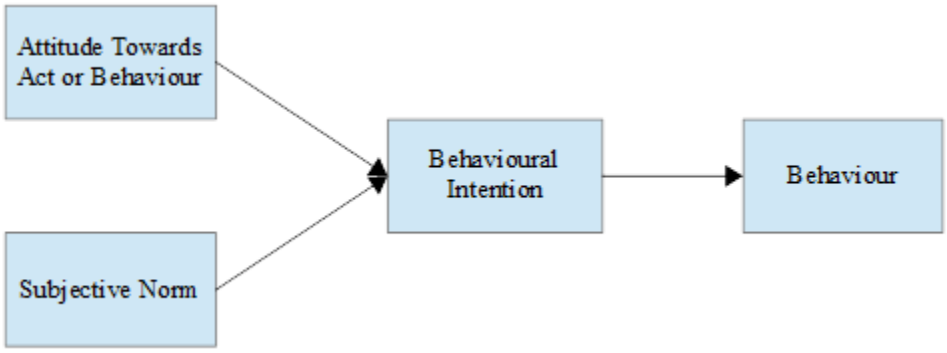

Figure 2. Theory of Reasoned Action framework (Fishbein & Ajzen, 1975)

One limitation of the TRA is that it lacks the influence of social factors on the individual behaviour. The behavioural intention is not always a determinant of actual behaviour. To overcome this limitation, Ajzen (1991) modified the TRA by adding a third dimension of belief called perceived behavioural control which influences intention to behaviour and the actual behaviour (see Figure 3). Perceived behavioural control is defined as "the perception of an individual for the difficulty of performing an behaviour" (Ajzen, 1991).

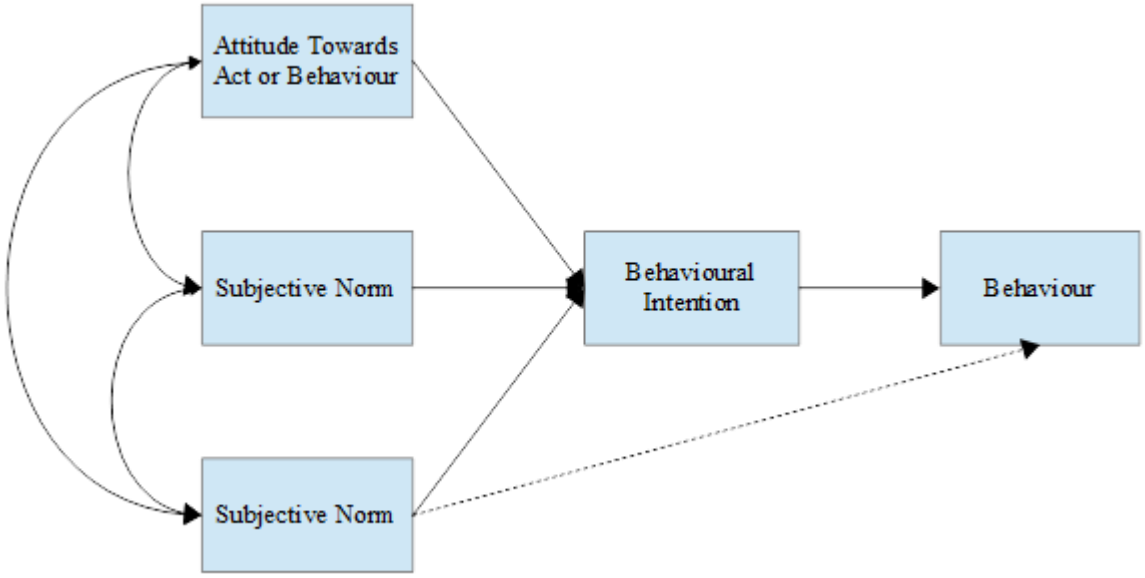

Figure 3. Theory of Planned Behaviour framework (Ajzen, 1991)

3.1.2 Innovation Diffusion Theory (IDT)

Rogers (1995) identified in his diffusion studies five general attributes of innovation that influenced the adoption process: (1) relative advantage (degree to which the innovation is perceived as being better than its precursor), (2) compatibility (degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters), (3) complexity (degree to which an innovation is perceived as being difficult to use), (4) observability (degree to which the results of an innovation are observable to other), and (5) trailability (degree to which an innovation may be experimented with before adoption). Rogers (1995) states that a greater relative advantage, compatibility, trailability, observability, and less complexity of an innovation has a positive influence on the adoption rate.

3.1.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (see Figure 4) is considered the most influential and most applied theory for describing individual's acceptance of new information systems, originally developed by Davis (1989). TAM is an adaptation of the Theory of Reasoned Action (TRA) specifically for user acceptance of technology. The model is being used for predicting and explaining the adoption of new technology by an individual.

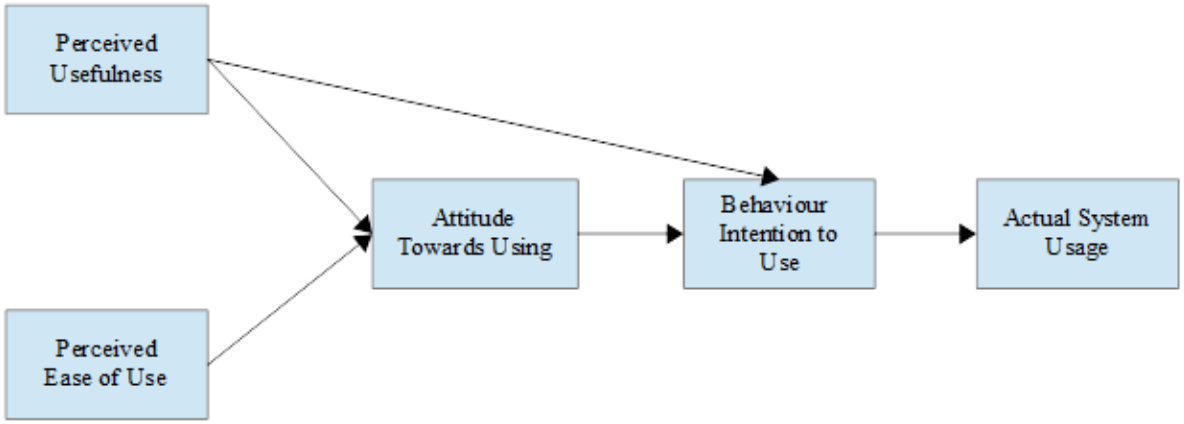

Figure 4. Technology Acceptance Model framework (Fred D Davis, 1989)

TAM assumes that two behavioral beliefs about perceived usefulness (PU) and perceived ease of use (PEOU), influence the attitude toward using, the liking or dis-liking for the behavior. Similar to TRA, the attitude subsequently influences an individual's behavior towards the intention to use a system which leads to the actual use of the system (Fred D Davis, 1989). PU is defined as the "extent to which a person believes that using the system will enhance his or her job performance", whereas PEOU as the "extent to which a person believes that using the system will be free of effort". In addition, TAM also stated that PU was directly influenced by PEOU because of the reasoning, the easier a system is to use the more useful it can be.

TAM has been widely applied in the healthcare context and predicts a substantial portion of the use of acceptance of health IT (Holden & Karsh, 2010). Research suggests that TAM is more appropriate for explaining physicians' IT acceptance than TPB (Chau & Hu, 2002). However TAM does not incorporate individual, organizational or social factors which also clearly influence the user acceptance of new technology.

3.1.4 Information System Success Model

Several conceptual frameworks have been developed to guide adoption evaluation of information systems. Perhaps one of the most widely known framework for measuring the complex attributes for successful IT implementation is the "Information System (IS) Success Model" by DeLone & McLean (1992) (D&M) (see Figure 5). This framework consisted originally of six major dimensions of measurement:

1. *System quality:* engineering-oriented characteristics of the system e.g. ease of use, system reliability, accessibility, flexibility and integration;
2. *Information quality:* perception of information accuracy, timeliness, completeness, reliability, conciseness, and relevance, addressed mostly from the perspective of the user (subjective measures);
3. *Usage:* includes the usage by stakeholder, frequency of use and extend of use (this measure is only valid if system use is not mandatory);
4. *User satisfaction:* is a subjective measure from the perspective of the user. This dimension was included in addition of usage as alternative measure in case of mandatory use of a system;
5. *Individual impact:* measures the impact of a system on users' behavior (e.g. efficiency, task accomplishment, quality of decision making);

6. *Organizational impact:* impact on organizational measures such as cost reduction, and return of investment (ROI).

The model can be viewed from two perspectives: (1) a logical sequence from system creation to utilization to the impact of the system, and (2) from a causal perspective; system quality and information quality impact system use and user satisfaction, which are related to the impact on a individual and organization. DeLone and McLean (DeLone & McLean, 1992) concluded success should be measured as a multidimensional construct and evaluation of success was dependent on the objective of the study and organizational context.

In a review by DeLone and McLean of there IS Success Model the authors looked back on how their model was applied over the last decade. The authors refined their original framework in three distinct ways (Delone & McLean, 2003):

1. by adding a third dimension "Service quality" (which measures the perceived quality of the IT service) to the two original system characteristics, system quality and information quality,
2. substituting "intention to use" for use as a measure of system usage by users,
3. combining the individual and organization impact into one variable named "net benefit". Net benefit has a positive impact on intention to use a user satisfaction.

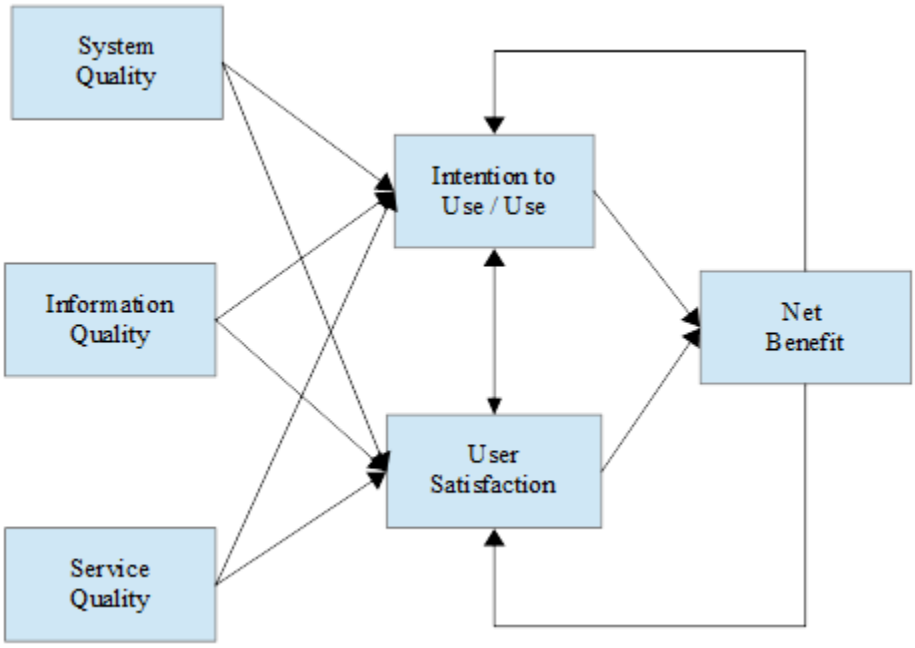

Figure 5. Revised Information System Success Model (Delone & McLean, 2003)

Use of the DeLone & McLean framework is been supported and validated in many IS evaluation studies in the health care context. In a review of literature on evaluation of patient care information systems published from 1991 to 2001 van der Meijden et al. (2003) identified determinations that were used to assess the success of such systems and to test the ability of the Delone and McLean framework for management information systems. A variety of relevant attributes could be assigned to the six dimensions of the model. However, some attributes (predominantly in case of project failure) could not be categorized. These factors were found to be related to system development, implementation and organizational aspects.

3.1.5 Towards a use centric approach of implementation evaluation

Several acceptance models and the factors influencing a successful implementation were discussed earlier. This study is based on the framework developed by Waal & Batenburg (2009), who extended the IS success model of Delone and McLean. The IS Success model is a much used and validated evaluation model for measuring success of implementation and use of IS in the healthcare setting. However, the model of Waal & Batenburg (2009) focuses mainly on the system and technical determinations of (intention to) use and satisfaction of users. Prior research clearly states that individual, organizational and social factors are major factors influencing the utilization of IS. Waal & Batenburg (2009) developed a framework based on the IS success model with adaptations towards a user centric approach of evaluation, by explicitly including the process between the designer and user.

Firstly the authors adapted the model by focusing on system quality only, excluding information quality and service quality as determinations for intention to use and user satisfaction. The authors finally extended the IS Success Model with the concepts user participation and user involvement from two other adoption models:

1. Barki & Hartwick (1994) model of participation, involvement and system use. This model related user participation with the intention to use, and centered on the relation between system designer and the user in the development stage of IS implementation. They distinguished between user participation and user involvement, defining user participation as "as the observable behaviour of system users in the information system development process, i.e. their participation in information system development and implementation activities", and user involvement as "a psychological state of system users, i.e. as the importance and personal relevance of a system to use". Barki & Hartwick (1994) claimed that user participation influences user involvement, and that the effects of user participation on intention to use were mediated by the psychological concept of user involvement.

1. The second model by Kappelman & McLean (1991) overlaps with the model of Barki by using the concepts user participation and user involvement. In the (Kappelman & McLean, 1991) users only participated in the system installation and conversion phase, or what the authors coined as 'later-phase participation'. The concept of user satisfaction was created by the satisfaction of the information. Kappelman & McLean (1991) showed that more user participation increased the feeling of involvement by users, which influenced the user satisfaction. They even argued that user involvement is a more important in understanding user satisfaction than user participation.

The conceptual model developed by Waal & Batenburg (2009) was statistically validated in the context of a large Dutch social insurance company to evaluate a newly implemented Workflow Management System (WMS) and its impact on the quality of work. The use of the WMF system was mandatory by users. The results of the 143 users surveyed showed that the experience of a degree of influence in the implementation facilitated the users perception of quality of the system (i.e. usefulness and usability), users attitude towards the system and the perceived involvement of the system in users work (i.e. user involvement). The perceived system quality subsequently, was a main driver for the user satisfaction (i.e. satisfaction of information and service quality) and the intention to use of the system. The satisfaction of users was only found to be a main determinant for the net benefit of the system, measured as the perceived quality of work as a result of the system (i.e. workload, autonomy and information of work). The authors conclude that these results show the importance of active user participation for successful IS implementation projects. However, besides the participation of users, influence of other implementation factors (e.g. training and management support) were not integrated in the model.

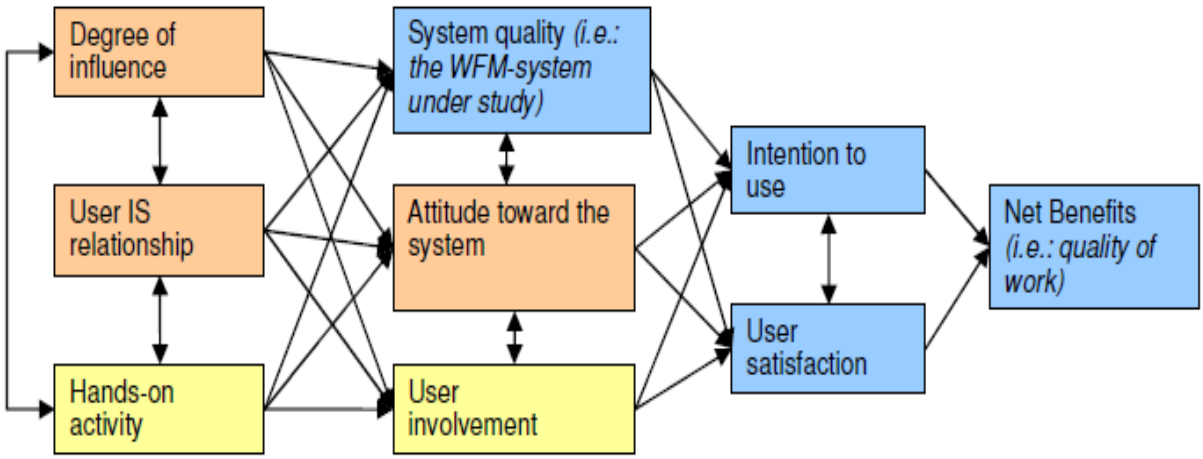

Figure 6. Adapted Information System Success model by de Waal & Batenburg (2009)

3.2 Factors related to HIS implementation success

A HIS can improve the quality of care, efficiency and patient safety by reduced medical errors for hospitals, resistance of users is found to be a barriers for a successful implementation of the system and acceptance of users. Several organisational and individual factors have been attributed to this resistance, which are discussed in the following section (Morton & Wiedenbeck, 2009).

Most evaluation studies focused only on the new system, few also on the replaced system while little studies focused on both in a longitudinal study. Many evaluation studies are of successful implementations. However some failed studies have been published which are very useful at determining the challenges with HIS implementation (Rahimi, Vimarlund, & Timpka, 2008; Scott, Rundall, Vogt, & Hsu, 2005). The evaluation studies are helpful for identifying factors which can predict a successful HIS implementation. The success factors of a HIS implementation were identified for this study as a combination of factors related to the success of a system and the implementation context based on an extended model of Delone and Mclean (Lau, Price, & Keshavjee, 2011). The factors related to a successful implementation were measured from the point of view of the user and their experiences. The success factors related directly to the adoption of a HIS were perceived net benefit, the user satisfaction, usage, perceived system, -information, and IT support quality, the attitude towards the system, user system involvement and the psychological ownership of IT. The success of an implementation is key for the acceptance of the system, and key implementation factors were the user participation, user training, and support of IT.

3.2.1 Service Quality

The user service quality is a key factor for assuring successful HIS implementation by facilitating users' needs and demands (Fernando, Georgiou, Holdgate, & Westbrook, 2009). Hospitals should encourage user involvement in HIS development and implementation strategies (Hsiao, Chang, & Chen, 2011) and provide them high quality service during the implementation. The quality of the implementation plays an important role in increasing the likelihood of implementation success (Ludwick & Doucette, 2009; Sellitto & Carbone, 2007).

The service quality was added as an important dimension to the updated Information System Success model by Delone & McLean (2003). The idea of including service as an aspect for system success evaluation originates from Pitt, Watson, and Kavan (1995), who argued that the focus on measuring

success of IS is too much on the technology rather than the service. Service quality were identified to include helpdesk support, training program, and top-level support (Lee, 2012) and determine the implementation success of an health information technology (Aarts et al., 2004).

This section discusses how user participation, user training, and an adequate helpdesk can influence the success of a HIS implementation.

User participation

The introduction of a new information system changes the work practices, therefore it is useful to model these work practices as a starting point for the implementation. After establishing the workflows the system can be developed or designed, and implemented. It is for users difficult to articulate their needs and see the benefit of an information system, which is called the "paradox of expertise" by (Friedman & Wyatt, 2006, p. 46). This illustrates the need of user participation for health information system implementations (Anderson & Stafford, 2002).

An influential factor determining technology adoption is the involvement by users (e.g. physicians) in the design and implementation process. However, where the user involvement is defined as the psychological state (i.e. psychological ownership) or attitude of users towards the process or information system, user participation is the observable behaviour of users in the information system development and implementation process (Kappelman & McLean, 1991). Prior research has confirmed this active participating role of physicians in information technology implementation. Physicians participation leads to higher rates of adoption and a higher user satisfaction towards the new technology (Morton & Wiedenbeck, 2009). The earlier the participation of users starts the better. User participation in the design process has been showed to have a positive result on the user satisfaction (Nykänen & Karimaa, 2006). From a case study of an information system development project Vimarlund and Timpka (2002) suggested that the benefits of investing time and effort in allowing users to participate, can outweigh the costs.

Participation of users in the development of the system should not stop after the implementation of the system. The participation of users is of key importance to ensure that changes and updates comply with users' needs. Kappelman & McLean (1991) coined the term "later-phase participation.

Training and education

Training has been identified by many previous evaluation studies as an essential factor of HIS and other health information system implementation (Littlejohns, Wyatt, & Garvican, 2003; Terry et al., 2008).

A literature review of qualitative studies by Rahimi et al. (2008) found that education of the end-users to be a key issue when implementing a HIS. The benefits from a HIS can only be apparent if the end users fully utilize the system. A adequate training and education of users will ensure that the system is used efficiently, which should have a positive effect on the perceived benefits of the system when implemented (Terry et al., 2008). McAlearney, Robbins, Kowalczyk, Chisolm, and Song (2012) conducted a qualitative study to the role of training in a successful implementation of an EHR and concluded that training programs increase the likelihood of successful EHR implementations. They argued that effective training programs not only focus on technical approaches, but incorporate social and cultural factors.

A lack of quality training before the implementation will increase the likelihood of a failed implementation. As Littlejohns et al. (2003) found that insufficient recognition of the importance of training end users before introduction of the new system was a major factor in causing the implementation project of a EHR system in South Africa to fail. Reason was that the training that was offered mainly focused on how to work with the system but not why to use the system. Training should

show the benefits of the system to the users. The quality of the users training seems to plays a major role in the acceptance of information systems by users and therefore the success of the implementation.

The main goal of training is to increase the expertise of users when working with the HIS. Training can also be useful in showing users why the system is implemented and what the benefit are

IT Service quality

Meulendijks (2010) found that an adequate helpdesk was an important factor in the implementation process of a HIS. The quality of IT support is being measured as IT support's reliability, responsiveness, assurance and empathy (Pitt et al., 1995). The role of the helpdesk is to providing users with the technical support they need during the HIS implementation project (pre and post implementation).

Not many studies have been conducted which included service quality when evaluating a health information technology. Palm et al. (2006) found in an evaluation study of an implemented HIS that the support quality (including training quality) had a direct effect on the perceived usefulness, ease of use and overall satisfaction of users. A lack of or no adequate IT support will result in users being unable to obtain help and support they need, which will affect the use of the system and the satisfaction of users towards the system.

3.2.2 Psychological Ownership (of IT)

Psychological Ownership of IT (POIT) is defined as: "*the sense of ownership an individual feels for an IT/IS*" and reflects in terms of what the IT system does and how it is used (Barki, Paré, & Sicotte, 2008). This concept was found to be the mediating concept between user participation the two IT acceptance concepts perceived usefulness and perceived ease of use, which in turn influence system use (Barki et al., 2008). Paré et al. (2006) found in that through users' active involvement and participation, physicians feel they have a greater influence on the development process. The psychological ownership of the system was found to be a good predictor for user acceptance of the system among physicians (Paré et al., 2006).

Barki & Hartwick (1994) noted that "*because of their participation, users may perceive that they have had substantial influence on the development process and thereby develop feelings of ownership*" (p. 72). Some studies also argued that noticeable support of the management (Hsiao et al., 2011) and participation of users in the development and implementation process give users a sense of ownership (Kappelman & McLean, 1991; van der Meijden, Tange, Troost, & Hasman, 2001). Barki et al. (2008) states "*…active and meaningful participation of users in IS development and implementation process are likely to enhance their feeling of control, intimate knowledge and self-investing, which are the root of POIT*". However, these implementation responsibilities are normally given to small number of users. Two strategies were proposed by Barki & Hartwick (1994) to reach larger number of users are: "*assign additional development activities that lead to a sense of responsibility to different users and assign responsibility activities to user groups*". Champion users (key-users) can play a key-role in developing a sense of ownership with end-users.

The involvement of users in the implementation (including selection) can increase the feeling of ownership among users (Morton & Wiedenbeck, 2009). Lack of ownership could be a barrier to adoption of an EHR especially in top-down implementations (i.e. with little involvement of the users) when the system is basically laid out on users. Users may perceive the new EHR system as an external object they cannot perform influence on and is not relevant to them, and therefore no relate to it at all. User participation was found to increase users to feel more involved, which mediates with the success of the implementation. The users that were more engaged during an installation are more satisfied with the system (Kappelman & McLean, 1991). It was found that user participation with a HIS

implementation (measured as overall responsibility, hands-on activity, and communication) felt a stronger feeling of psychological ownership to the system (Barki et al., 2008; Paré et al., 2006). Also an adequate training and the quality of the IT service could increase the POIT of users.

RQ1: To what degree do user participation, training and IT service quality predict POIT?

3.2.3 System and information quality

System Performance

System quality can be defined as the technical quality of the information system itself (Delone & McLean, 2003). The system quality is measured as responsibility, reliability, and security of a system (Hsiao et al., 2011). Speed of the system is crucial of the usability of the system. Slow system response time may delay patient treatment and may be a reason for users to fall back on other systems (e.g. such as a paper forms) (Lee, 2008). A significant issue related to ease of use is therefore the a rapid system response time with limited system downtime (Doolan, 2002). A consequence of system failure is that users will not be able to access the patient records or other systems used in their work practices. Since the HIS is a system on which users rely heavily, users might be anxious about system failure (Croll, 2010). System reliability is a significant factor in adopting new clinical technology (Kirkley & Rewick, 2003). The system should be trustworthy and as complete as possible. System errors and missing functionalities will increase work-arounds by users. Another aspect of system quality is the user-interface (or design) of the system. The user interface of the system is needs to be clear, intuitive and easy to use (Guappone, Ash, & Sittig, 2008). Problems in the software design can increase the resistance towards the system (Scott et al., 2005).

Davis (1989) defines the perceived ease of use as "the degree to which a person believes that using a particular system is free of effort.", which is similar to the complexity dimension coined by Rogers (1995) in his diffusion of innovation theory. When systems are too difficult for users (i.e. not user friendly) or require more work due to high system complexity, then users may not accept the system or use it the way it is intended (McGinn et al., 2011). The perceived ease of use can be perceived as a system quality attribute, but since it also relates to the usage of the system it might also be considered as a user satisfaction attribute (van der Meijden et al., 2003). Sicotte et al. (2009) found in their study in which paper-based records was replaced by an electronic records system that ease of use was found to be the best scoring dimension.

A high quality of the system and information provided by the system will increase the user satisfaction, because the system will be more user friendly and effective in its use.

RQ2: To what degree do user participation, training, IT service quality and POIT predict System Quality?

Information quality

Information quality concerns with the quality of the input and output of the system, the quality of the information provided by the system (Delone & McLean, 2003). This can be the reliability, completeness, comprehensiveness and accuracy of the information (van der Meijden et al., 2003). Information is found to be of critical importance in the HIS system and the delivery of care. Some studies have found a stronger relationship between information quality and user satisfaction towards the system, than system quality (e.g. Hsiao et al. (2011)).

RQ3: To what degree do user participation, training, IT service quality and POIT predict Information Quality?

3.2.4 User satisfaction and intention to use

Professionals use a HIS (or other clinical system) a significant portion of time of their working day. Understanding the factors that influence the acceptance of a HIS will determine if a system is successfully implemented and if users are satisfied with the system (Delone & McLean, 2003). Acceptance and users satisfaction are two closely related, complex, and multi-faceted concepts. However, acceptance is conceptualized as the actual or intended usage of a system by users whereas the focus of user satisfaction is on the users' feelings towards the system. Unfortunately, there is a lack of a universal and commonly used definition for both concepts in the current body of research.

Lately, user satisfaction of implementation of HIS has received much attention in research (E Ammenwerth & De Keizer, 2005; van der Meijden et al., 2003), and found to be a complex concept and related to many failed EHR implementations (Buntin et al., 2011).

DeLone & McLean (1992) define user satisfaction as the users' response to the use of the information system. It is usually measured in dimensions of competence, satisfaction, and ease of use. Attributes of user satisfaction in healthcare are measured as satisfaction of work (Engström, Ph, & Scandurra, 2009), usage of the system (Palm et al., 2006; Palm, Dart, Dupuis, Leneveut, & Degoulet, 2010), user friendliness & usability of a system (Sittig, Kuperman, & Fiskio, 1999), and user attitudes towards the system (van der Meijden et al., 2003). Another measure (or precursor) of satisfaction was found to be user acceptance (Hsiao et al., 2011). These constructs or an overall satisfaction. Weir, Crockett, Gohlinghorst, & McCarthy (2000) found that a more task-oriented approach to satisfaction better predicted the system outcome or adoption. Aarts et al. (2004) found that users were unsatisfied with the system because of changes in their work practices due to a health IT implementation. This compatibility of the system is defined as "the degree to which an innovation is perceived as being consistent with existing values, needs, and past experiences of potential adopters" (Moore & Benbasat, 1991). Greiver, Barnsley, Glazier, Moineddin, & Harvey (2011) found that compatibility had a large influence in the success of the implementation of an Electronic Medical Record. This study defines the user satisfaction therefor as the compatibility of the HIS with the workflow of users, which better describes a task oriented satisfaction than overall user satisfaction.

In most studies the satisfaction level about the health information technology was found rather high. Jaspers, Peute, Lauteslager, & Bakker (2008) measured the user satisfaction as the usability of a new EMR in routine clinical use in a large academic hospital centre in the Netherlands to understand if the new (redesigned) EMR was an improvement of the earlier EMR. Despite some problems with the interface satisfaction, users were overall more satisfied with the new EMR and its improved system capabilities.

In order to achieve user satisfaction and acceptance of a HIS in a hospital setting, the HIS has to be designed specifically to meet the requirements of professionals. In addition, professionals should have access to high quality support. Adam Mahmood, Burn, Gemoets, & Jacquez (2000) found in a meta-analysis on user satisfaction in IT adoption literature that the key-factors influencing users satisfaction were user involvement in systems development, quality of the system, user experience, organizational support and user attitude toward the IS.

Weiner et al. (1999) found in an evaluation study of a new computer-based provider order entry (POE) system, that the quality of that particular system and the information was positively correlated with user satisfaction and increased the quality of patient care.

Acceptance was conceptualized by DeLone & McLean (1992) as the usage of the system. However in a context where the system is mandatory the system usage is less appropriate. They suggested intention to use instead, as an acceptance measure. Tung, Chang, & Chou (2008) studied the antecedents of

intention to use and found that the perceived ease of use and the usefulness of a system and information had a great positive influence on the intention to use. Furthermore Hartwick & Barki (1994) claimed that the effects of user participation on intention to use was mediated by the psychological concept of user involvement.

These findings show the importance of (1) user-centric implementation, (2) user involvement and psychological ownership, and (2) the perceived quality the system and information for the IT acceptance and user satisfaction.

RQ5: To what degree do POIT, System Quality and Information Quality predict user satisfaction?

RQ6: To what degree do POIT, System Quality and Information Quality predict intention to use?

3.2.5 Perceived Net benefit

Delone and McLean (2003) defines success as the net benefit on individual and organisation. This study focusses on the individual impact, which is the benefit from the users' perspective. Several studies have researched the benefits of a health information system, which are mainly benefits of quality work, efficiency and patient safety (van der Meijden et al., 2003). Quality of care can be defined as: "*doing the right thing at the right time in the right way to the right person and having the best possible results*". Patient safety is defined by the Institute of Medicine as: "*avoiding injuries to patients from the care that is intended to help them*" (Wolfe, 2001).

Chaudhry et al. (2006) performed a literature study about the impact of health information technology on quality, efficiency and cost of medical care. The authors demonstrated that the major benefits of health information technology to be an increased efficiency (i.e. decreased utilization of care) and better patient safety by improved guideline based care, enhanced surveillance and monitoring and, decreased medication errors. However, implementation of a new system can reduce productivity because of extra work due to the usability of the system (Scott et al., 2005).

Evaluation research of a HIS focusses most on patient safety, effectiveness, and efficiency (Menachemi & Collum, 2011). Many studies have evaluate the perceived benefits (or outcome) of health information systems implementations (Buntin et al., 2011). Although, many studies found a positive impact of a health information system on quality and safety, Black et al. (2011) argued there is a gap between the postulate and empirically demonstrated benefits. There was often none, or only a modest beneficial impact from health information systems implementations. This can mean that an HIS should not be seen as the solution for more efficient and better quality of care, but as a tool in achieving these goals.

Findings of a qualitative study of Fernando, Georgiou, Holdgate, and Westbrook (2009) showed that extra or burdensome data entry requirements of the introduction of a CPOE system has major negative effect on the emergency department of a major hospital, which may lead to unexpected adverse events. Same was found by an evaluation study of a clinical information system by Scott et al. (2005), where users reported reduced clinical productivity due to extra work and difficulty navigating through the system. The functionality of the newly implemented HIS should be compatible to the existing (clinical) work practices, and the system should be ease to work with. It is important to ensure high user satisfaction towards the system, which had a positive effect on the benefits and outcome of the HIS.

RQ7: To what degree do User Satisfaction and Intention to Use predict Perceived Net Benefit?

3.3 The conceptual framework

As mentioned earlier, Waal & Batenburg (2009) focused their evaluation on the system quality, and excluding the information quality and service quality (measured as the perceived usefulness and ease of use of the system) as other drivers for intention to use and user satisfaction. Their interest lie mostly in the perceived quality of work (e.g. job satisfaction) as the net benefit. The net benefit (and clinical outcomes) of a HIS will be most likely not be totally apparent by users just after the implementation. Therefore, the current study is focused on the satisfaction of users towards the implementation and the relation to their experiences and satisfaction towards using the HIS.

The framework of Waal & Batenburg (2009) is adapted firstly by reintroducing the perceived information quality and IT service quality as a facilitator for user satisfaction and system usage as in the D&M model. The system, information and IT service quality concepts are separate, but probably related concepts which are in this model classified under the HIS quality denominator for simplifying the model.

Secondly, where system quality was measured as satisfaction of using the system (i.e. usefulness and usability) it was perceived to more appropriate to rename this as user satisfaction (van der Meijden et al., 2003). The system quality than was measured as direct (but still subjective) quality measures of the screen and layout design, speed, system reliability and the learnability.

Finally in the context of the current HIS implementation where involvement of the users and education was important, the framework was extended by the factors end users training, management support, which together with the user participation determined the psychological ownership (i.e. feeling of responsibility to the system) as mediator for the perceived HIS quality concepts, attitude and user involvement. The adapted HIS implementation evaluation model is shown in Figure 7**Error! Reference source not found.**.

On the basis of the literature and the HIS implementation evaluation model the following propositions are proposed.

1. Adequate user training, users participation and support of management has a positive influence on the involvement (i.e. psychological ownership), and the quality of the his
2. The psychological ownership of users has a positive influence on the quality of the HIS, the involvement of the system in users' work, and their attitude towards the system.
3. The quality of the HIS and the users attitude have a positive influence on the usage and users satisfaction.
4. Usage of the HIS and the user satisfaction has a positive influence on the effect of the HIS on the work of users (i.e. net benefit).

Not included in the model are user characteristics (e.g. role, age and gender, previous HIS experience) and users expectations before the implementation, however, these may have an on influence the user acceptance and satisfaction.

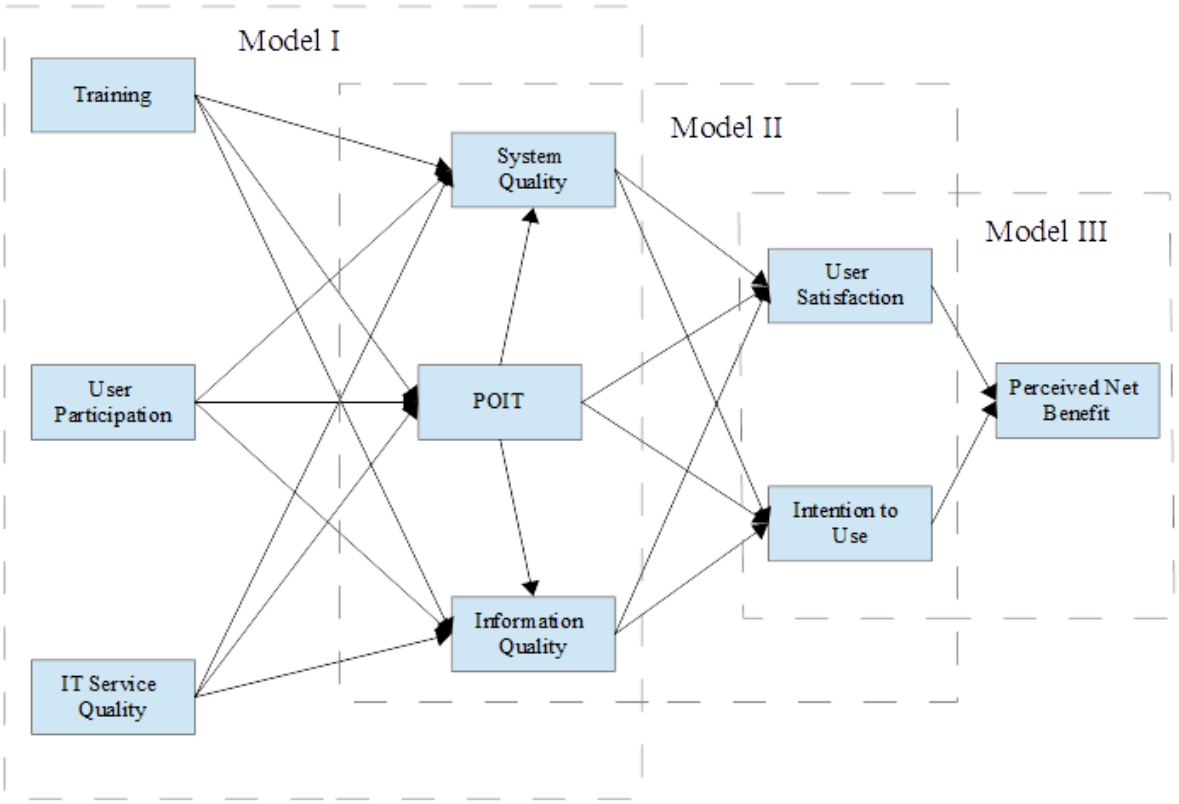

Figure 7. The HIS implementation success model for this study

3.4 Summary

The TRA and TPB models were developed specially to describe behavior and how it predicts outcome, many models were developed on these especially for adoption of technology and information system. Based on the TRA and TPB models, TAM focusses on how the users perceives to use the system and how it influences attitude of users and ultimately the acceptance and adoption. D&M model tries to evaluate when a system is a success by measuring the individual and organizational benefit of a system through key success factors. The IDT focuses on the diffusion of new technology by including users perception of improvement to the previous situation before the adoption.

These model all can be relevant for evaluating only the system, but note there are no implementation and organizational concepts examined in these models. The success of a HIS depends on a satisfactory implementation which involves users to integrate the new system into the complex organizational setting. Many adaptations are developed based on these models and studies to include these factors, (e.g. TAM2 and TAM3). Waal & Batenburg (2009) have adapted the D&M model to include involvement of users with the deployment of the innovation. This model has been adapted to the context and setting of the HIS implementation, by focusing more on the implementation process, the quality measures of the HIS and the user satisfaction. The alignment these dimensions will increase the likelihood of a successful implementation and acceptance of the HIS (Lau et al., 2011). User acceptance of an HIS is essential for a successful implementation and the involvement of users with the implementation is essential for the user acceptance.

A high user involvement in the implementation has been associated with a successful implementation of a complex HIS. Higher user participation (i.e. degree of influence) in the implementation (pre and post) process, management supports the implementation, and the more adequate the training may

increase the involvement of users which will increase the likelihood of a successful implementation. The involvement of users will increase the likelihood of a high quality system, better user satisfaction and usage of the system, and is influenced by their user participation, the support of the management and adequate user training before, during and after implementation.

The user satisfaction and rate of acceptance will increase over time by mainly two factors. The quality of the system and the information will increase as a result of improvements made to the system. These changes will be more successful when users participate in the change management process (post participation). Secondly as a result of improving efficacy with the HIS when the experience increases.

While the current study will not validate the theory based hypotheses, the evaluation model developed in this chapter will be applied to structure this research approach and to interpret the findings described in the Chapters 5 and 6.

4

Research Methods

Aim of this study was to identify important factors related to a successful implementation of a HIS in the UMC Utrecht, the Netherlands. An evaluation framework is constructed from previous evaluation and adoption literature to explain the satisfaction and acceptance of users.

This current evaluation study used a quantitative-qualitative follow-up mixed method design. In this design quantitative results were collected and followed up with focus group sessions to validate the results. The results of both methods are reported separately first and later integrated to get a more detailed picture of the implementation.

4.1 University Medical Centre (UMC) Utrecht

This study was performed in an academic hospital in the Netherlands, The University Medical Center Utrecht (UMCU). The UMCU is one of the largest public healthcare institutions in the Netherlands with more than 10.000 employees and more than a 1000 hospital beds including 12 divisions. The UMCU consists of three large department which were merged in 2000: the academic hospital (AZU), the Wilhelmina Children's Hospital (WKZ), and the faculty medicine (MFU). The mission statement of the UMC Utrecht is:

"The UMC Utrecht is a prominent, international university medical centre where knowledge about health, disease and care, for patient and society is created, tested, shared and applied."

The UMC Utrecht focusses on three key areas: patient care, research and education. In 2010 the UMC Utrecht started a new organization strategy named; Strategy 3.0, which focusses on three priority goals:

1. transpose innovation to improvements for the individual and the community;
2. change to multidisciplinary teams and care
3. dynamical interaction between hospital, patients and community.

This new strategy has impact on the hospital personal, care, research, and education. Part to achieve the Strategy 3.0 goals is the implementation of a new organization-wide integrated Hospital Information System: CS-EZIS from the vendor Chipsoft. In a strategy research Health ICT (translated: Zorg ICT) the UMC Utrecht concluded that the former hospital information system for the care processes were outdated. To assure continuity and desired innovations in the care process the former HIS needed to be replaced. The vision of the UMC Utrecht is to use ICT as enabler for high quality, safe and efficient care. This enabled the startup of the program Innovation Health ICT (translated: Vernieuwing Zorg ICT) with resulted in principles which the ICT had to meet:

- Care processes assist in the improvement of health quality and efficiency.

- By an integrated planning and ordering systems health professionals deliver better care (by reducing overhead tasks).
- Integrated, shared and coded medical records are essential for patient safety and research.
- Integrated care administration and billing improve management support information.
- One shared patient record, and access by patient to their own record is crucial for a strong competitiveness position.

4.1.1 HIS implementation at the UMC Utrecht

Issues with the replaced system

The old HIS was considered as legacy software which did not comply with current and future requirements. The old HIS consisted of many stand-alone systems, had low interoperability, and was found to be rigid to use. Issues with the old HS were:

- did not comply with current and future expectations and had a limited adaptability towards the current healthcare processes (system was nearly 30 years old)
- The supplier stopped the support of the system
- The ICT systems in the UMC Utrecht were fragmented and intertwined, which formed a potential risk for the information (service) continuation
- Health procedures and responsibilities were based on the legacy system and its limitations
- An increasingly number of patient care processes were insufficiently supported by CT.

These issues with the patient care processes reported by the users were mainly problems with:

- The patient information was presented unclear to the users, and it was frequently impossible to quickly access and retrieve the information needed.
- Transfer of patient and services was insufficiently supported by ICT
- Knowledge is not available everywhere which caused scheduling and patient logistics problems
- The absent of a central patient record meant information was stored at multiple records and places.
- Enter and retrieving patient data for clinical research was difficult
- Insufficient ICT support for daily care processes for example nurses
- Slow and unreliable system.

The new HIS

The acquisition of a new institute-wide integrated Hospital Information System started in 2009. The choice for a new HIS was a commercial and integrated "of the shelf" suite; CS-EZIS. CS-EZIS is a hospital information system that was designed to improve service delivery, outcome measures and operationally, through integration of medical information. The new HIS has functionalities regarding patient records, logistics of care and CPOE, patient administration, research and education, integration infrastructure, management information system, and patient portals. The implementation of the new HIS affected almost all employees involved in patient care, from the physician to the secretary.

For the service organisation, the new HIS is significantly different compared to the former HIS. The interoperability (/integrated) and less technically complexity of the new HIS has a direct impact on the way how the service organisation is organised. The alignment and collaboration between the service organisation and professionals is more important. This can be seen as a significant improvement and step forward.

A screenshot of the new HIS is shown in **Error! Reference source not found.**.

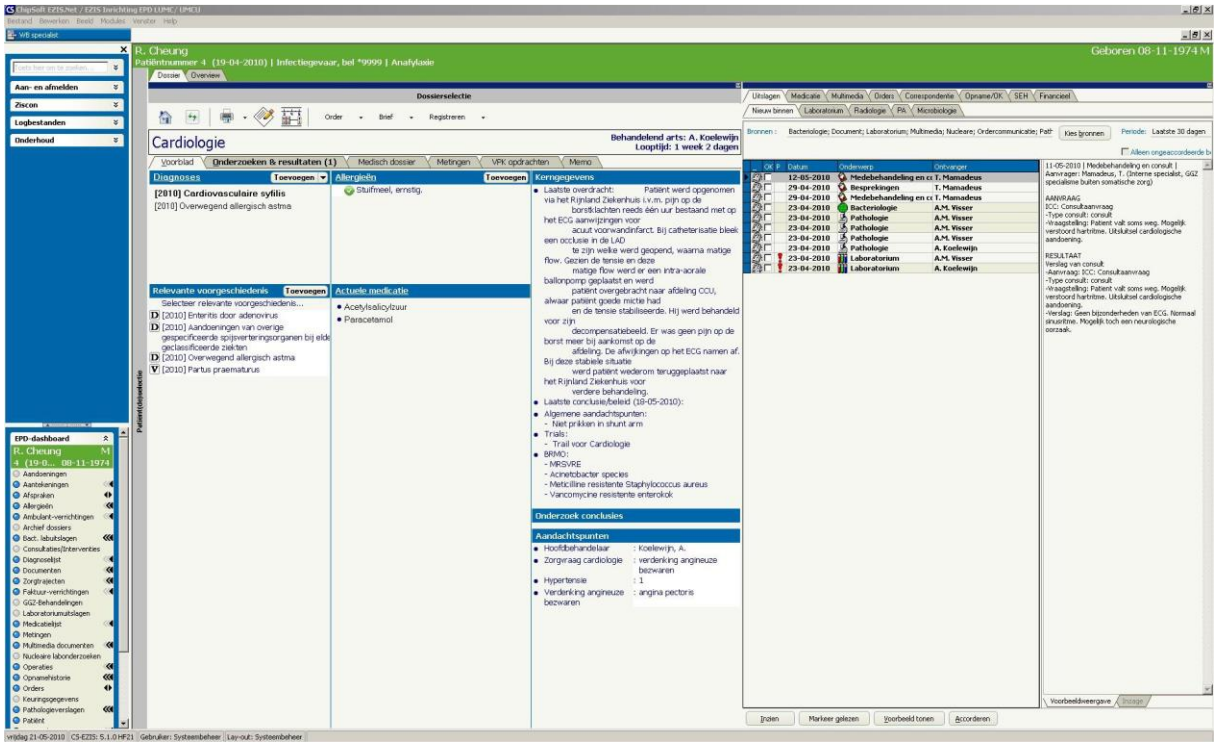

Figure 8. Screenshot of the new HIS

The implementation planning

The implementation phase of the new HIS took almost one and a half year, starting in February 2010 with the implementation deadline on June 10 2011. The implementation strategy for the new system was chosen to be a big-bang implementation with top-down management, and was in close cooperation with another (smaller) academic hospital in the Netherlands (LUMC). A top-down strategy was chosen above a bottom-up strategy, since the resistance of users for a new innovation can tends to slow down the implementation significantly. However, careful planning is essential in a big-bang implementation to ensure that the users are fully prepared for the transition, and knowing the risks (Anderson & Stafford, 2002).

The complete functionality of the old HIS had to be replaced by the new HIS, and the functionality towards the users had to be as good as or better. The implementation project consisted of the following phases:

1. **The analysis and design phase**: in this phases the workflow processes were developed to establish the information and user needs. Furthermore, project members were trained and test and acceptation plan was created.
2. **Interface development phase**: the interfaces and screen layout were developed and tested. The data of the old HIS was converted to the format for the new HIS.

3. **Test and education phase**: system tests and acceptation tests were performed, a test and production environment of the system was set up, and end-users were trained. At the end of this phase the system was going live by a big-bang.
4. **After care and change management**: in this phases after care and change management was conducted after the implementation.

The organisation of the implementation programme of the UMCU consisted of 64 project groups and around 600 project members. The project groups were focused around a specific (medical) function and clustered in functional domains. Furthermore, every division had a group and was self-responsible for its own communication to users about the implementation and the education of those users. The divisions were responsible:

- for the changes and design of the system to be compatible with the work processes.
- User acceptance testing of the systems' components
- Changing and designing processes
- Communication, education and after care of users

The communication from central management was general and factually, the divisions were responsible to translate this for their own situation of users.

User participation and training

The education of users was started three months before the implementation. The education consisted of training for trainers, e-learning environment and a practice environment. At the moment of introduction of the new HIS 24/7 support was proved for two weeks after. Champion users (i.e. key-users) were assigned to provide the training to users, have a pivotal role in the communication towards the users and as first point of contact for users with questions or problems. The key-users were highly involved in the development and implementation process.

When the new HIS went live on June 10th of 2011, about 6350 end-users attended a user training in performing tasks in the new system. These trainings were tailored to the work practices of the users' roles. Attending the training was compulsory for users working with the new HIS.

4.2 Mixed method design

In the current evaluation study it is useful to know how many users experience resistance, and how satisfied they are about the implementation and the system. However, it may be important to use qualitative methods to understand what the exact nature is of the resistance, issues with the implementation, and impact of the system on the work of the professionals. Therefore, for a balanced evaluation the use of a mixed-method design, the usage of both quantitative and qualitative methods, is required (Stoop & Berg, 2003).

According to Stoop and Berg (2003), qualitative research can be defined as that which gets to the what, why and how of a system and quantitative research as most suitable for establishing the size, extent or duration of certain phenomenon in a system.

Advantages of a mixed-method design is that a research is free to use all possible methods to address the research problem. But also because the research problem is being solved by using both numbers and words, they combine inductive and deductive thinking, and employ skills in recording and observing people's behaviour (Creswell & Clark, 2006). Combining the strengths of qualitative and quantitative research methods can lead to richer research results and a deeper insight. The richest results arise when

data from one method is used as input for the other (e.g. qualitative data can be used to make sense of obtained scores) (Stoop & Berg, 2003).

Drawbacks are that mixed-method design is difficult to set up, and takes time and resources to collect and analyse the quantitative and qualitative data (Creswell & Clark, 2006).

4.3 Quantitative design (survey)

The quantitative aspect of the study is a longitudinal, cross-sectional and self-administered survey study with three measurements in time, with questions based on the evaluation model. Two measurement were already conducted. A baseline measurement (t_0) in May 2011 before the HIS implementation, which focused on the satisfaction of users towards of the replaced HIS, and the expectations of CS-EZIS. The second measurement (t_1) was conducted a half year after the implementation of the new HIS from November 2011 (t1). This first follow-up measurement focused on the satisfaction of the implementation and acceptance and first experiences of users with the new HIS. A third measurement, the second follow-up, was taken in May 2012 (t2), a year after the big-bang implementation, and a month after the roll-out of a new release of the HIS.

The baseline measurement evaluated the user satisfaction with the former HIS and expectations with the new HIS. The two follow-up measurement evaluated the satisfaction of the new HIS. For every measurement two versions of the survey were distributed, a comprehensive version for the key-users and a shortened version for the end-users.

4.3.1 Population and sample

The population of interest are employees of the UMC Utrecht of all disciplines. All respondents were invited for the user training and should have had the training. Although the training was mandatory, some users probably did not attend the training. A sample was accessed through the CS-EZIS training schedule databases for end-users and key-users. These databases contained the e-mail addresses of 2579 end-users and 266 key-users to which a hyperlink with the survey was distributed by e-mail. A description of the respondents to the surveys are presented in Chapter 5.

4.3.2 Questionnaire development

Large part of the survey tool used in the current study was originally developed and validated by Waal and Batenburg (2009). The adapted survey tool was tailored to the current setting and context; a new HIS implementation in an academic hospital in The Netherlands. Some items were changed or added to the existing survey tool. As mentioned before key-users and end-users had different surveys every measurement. But there were also discrepancies between the surveys every measurement, due to change in setting, time and length of survey.

Most question are asked as theorems via a four-point Likert scale with responses the responses (1) “strongly disagree”, (2) “disagree”, (3) “agree” and (4) “strongly agree”. Some system quality items, are asked via a seven-point Likert scale.

The seven-point items of the perceived system quality concept where transformed to a 4-point likert scale by the following formula (where A is the new item, and B is the old one):

$$A = 0.5B + 0.5$$

Most items in the questionnaires were questioned as a positive statement. Items that were questioned in a negative form were reverse transformed before computing the concepts. Scales or constructs were calculated by the mean of all cases of the items in the scale.

Next the development of the concepts are described. Appendix B consists of the items of the scales.

Perceived Net Benefit (NET): The perceived net benefit of the system is being defined as the effect on the work of the system. This concept was measured by four items from the Perceived Usefulness scale from the Technology Acceptance Model (Davis, 1993) and own items.

User Satisfaction (US): Where Waal and Batenburg (2009) measured user satisfaction as the satisfaction of the information quality and the IT service quality. The current study measured user satisfaction by the concept of compatibility. Compatibility was measured by six items from the classic compatibility scale by Moore & Benbasat (1991) and the work-with-computer scale from Tijdens, K. and Steijn, B. (2002).

Intention to use and Usage (USE): The intention to use is measured by one item, i.e. "If the system was not mandatory, I would still use it". This concept was suggested as one of the first by (Seddon & Kiew, 1996). The actual usage of the HIS was measured by percentage of hours using the HIS per week over the total work hours per week.

Perceived System Quality (SQ): The system quality concept was measured by the system capabilities, learnability, and user-interface. The items were adapted from Questionnaire for User Interaction Satisfaction (QUIS), a tool developed by the University of Maryland (Sittig et al., 1999). An item about system errors was added. Furthermore, like Waal and Batenburg (2009) usability was measured by six items from a (Dutch) questionnaire developed by Tijdens, K. and Steijn, B. (2002), and the complexity scale of Ronald & Howell (1991) adapted from the Diffusion of Innovations theory discussed in the previous chapter.

Perceived Information Quality were adapted from Shaw, DeLone, and Niederman (2002).

Psychological Ownership: To measure the Psychological Ownership scale five items from Paré, Sicotte, & Jacques (2006) were used.

User participation (PAR): User Participation with a HIS implementation changes over time. Pre-implementation the user participation is mostly concerned with the development of the system, during the implementation with the implementation process itself and after with the participation changing and improving the system. User participation is being measured by four items, based on the Degree of Influence scale developed by Lynch and Gregor (2004), and the User Participation scale of Wixom and Watson (2001). Within the pre-participation context with the focus on the implementation process and in the post-participation context on change management.

End-user training (EUT): these items were self-developed.

IT Service Quality: a 3 item scale was adapted from Shaw, DeLone, and Niederman (2002).

4.3.3 Survey administration

The current evaluation study was approved by the board of directors of the UMC Utrecht and permitted access to the medical staff for the study. The surveys were created and e-mailed by Survey Monkey (http://www.surveymonkey.com) to the key-user and end-users.

E-mail addresses were administered from the training schedule list. From the training schedule list a random selection was made for participants only knowing their e-mail address and division of working.

In the two follow-up questionnaires (t1 and t2) nine pharmacists and ten managers were added to the participants' lists. See for the response rate **Error! Reference source not found.** in Chapter 5.

The three surveys each ranged for four weeks.

- The baseline measurement ($t_{0)}$ conducted a month before the implementation of CS-EZIs from May 2011 till June 2011;
- First follow-up measurement ($t_{1)}$ was conducted half a year after the big bang implementation of CS-EZIS, from November 2011 till December 2011;
- Second follow-up ($t_{2)}$ was conducted a year after the big bang implementation and a month after the rollout of the new release of CS-EZIS (CS-EZIS 5.2) from May 2011 till June 2011.

Each measurement three reminders were sent by email to non-respondents. The first follow-up reminder was send by e-mail seven days after the start of the survey. The second follow-up reminder was send after day 14 and a final reminder was emailed after day 21.

4.3.4 Data treatment and statistical analysis

The data from the surveys was transferred from Survey Monkey to a SPSS data file for data manipulation and statistical analysis. For this study only the data from the end-user survey for the second and third measurement were used. Furthermore, only data from physicians, nurses and administrative staff was used for analysis. Uncomplete responses were dismissed from the analysis.

The research model constructed in Chapter 3 was divided in three models and analysed individually by OLS regression analysis. These models are labelled 'Model I', 'Model II', and 'Model III'. Finally the full model was tested by a hierarchical regression analysis. The data was analysed with SPSS 20.0.

Questionnaire development

The internal consistency of the concepts within the theoretical framework were assessed by the Cranach's alpha reliability coefficient. A coefficient close or above the conventional level of .70 was considered acceptable. Furthermore, a PSA one-factor analysis was performed for every concept. The following section presents the results from the validity and reliability analysis.

4.4 Qualitative design (Focus group)

Focus groups are particularly suited for collecting information on people's attitudes and experiences, "how they think and why they think that way", within a particular context (Kaplan & Maxwell, 2005). Following the surveys and based on the survey results, two focus groups were conducted about the implementation of the new HIS. These focus group sessions were split up in a session for key-users and one for end-users. The focus group sessions were conducted in July 2011, and each session lasted approximately one and a half hours and was chaired by two researcher. No compensation was offered to participants attending the group.

A semi-structured guide based on the results from the quantitative study was used for the focus group sessions. In each sessions participants discussed in-depth their about their attitude and experiences on statements constructed from the survey results. These statements were structured to the developed framework in Chapter 3, and each factor from the framework was discussed in the focus group sessions. Statements for the key-users differed from the end-user statement.

One of the focus group leaders introduced a topic by presenting a statement to the focus group participants following four questions:

1. was the statement understood and recognized by the participants?
2. did participants agree with the statement?
3. what were the bottlenecks and issues with the statement? And,
4. how could these issues have been resolved (lessons learned)?.

The focus group leaders encouraged participants to talk to each other and guided the discussion. The interviews were audio-taped with a verbal consent of the participants.

Participants for the focus groups were primarily recruited through the division managers (13 divisions) in academic hospital, by asking them to bring forward at least two interested key-users and end users who were trained and worked with new HIS and had work experience with the replaced HIS. This initially did not result in sufficient participants, so the users who were brought forward by division managers were asked to bring forward colleagues themselves. For the key-user focus group seven key-users participated, consisted of an information manager, a pharmacist assistant, medical secretary, application manager. For the end-user focus group five participants were willing to partake, and consisted of an outpatient nurse, a doctor, paramedical, doctor's assistant, and a medical secretary.

The focus groups were transcribed by NVivo 8.0 and quotes were coded according to the factors from the proposed evaluation framework for analysis.

5

Results of Quantitative Data

The main purpose of this research was to evaluate a theoretically-bases model of HIS success to predict HIS implementation success from a user centric perspective. This study evaluated the effects of implementation context variables (user participation, training, and IT support quality) on the perception of users towards the system and their feeling of involvement and on the effects on user satisfaction and their intention to use the system. Finally, the effects of latter two variable were evaluated on the HIS success outcome (perceived net benefit). This chapter will describe the results from this study by the proposed hypothesis derived from the literature study and the proposed conceptual model.

5.1 Sample statistics

As mentioned three measurements were performed among users of the HIS. The context of this study focused on the satisfaction of users with the new HIS and their experiences with the implementation process, therefor only respondents were used who participated in the last two measurements. The sample size for this study was 375 respondents who had fully answered both of the last two surveys, and were physicians, nurses or administrative staff.

Descriptive data on the end-users' education function and division over the three measurements are presented in Table 2 and average age of the end-users in Table 3. The majority of the users were female with an average of 69% in all the measurements and 32% of the end-users were male. A majority of the users had an academic education 56% or a higher education 28%. Physicians were the largest group of the sample followed by nurses and administrative staff. The average age of all the survey participants who responded was 43 years. Female respondents, with an average of 41 years, were slightly younger than the male respondents, which average around 46 years.

Table 2. gender, education, function, and division distribution for end-users

	%	(n)
Gender		
Female	64%	(240)
Male	36%	(135)
Education		
Secondary education	4.8%	(18)
Secondary professional	10.9%	(41)
Higher professional	28%	(105)
University education	56.3%	(211)
Role/function		
Physician	55.5%	(208)
Nurse	31.2%	(117)
Administrative staff	13.3%	(50)

Table 3. average age of end-users

	Mean	(SD)
All end-users	42.70	(11.22)
Female	40.99	(11)
Male	45.75	(11)

5.2 Descriptive results

Table, presents the mean and standard deviations of the constructs for each discipline and the total. The reliability analysis of the constructs indicated a Cronbach's alpha almost all higher than 0.7, which confirmed the reliability of the scales. Only for POIT the calculated Cronbach's alpha was just below the threshold (0.68). However, one can argue that this is an insignificantly difference. All the scales are therefore confirmed as reliable constructs (see Table 4).

An ANOVA analysis reveals that physicians were overall significantly less satisfied with the implementation compared to nurses and administrative staff. They were less satisfied with their participation, training quality, IT service quality, and had less feelings of ownership towards the system than nurses and/or administrative staff. They also perceived the system to be of a lower quality, had less intention to use the system, reported to have a lower user satisfaction and perceived less benefit of the system compared to both nurses and administrative staff. Nurses and administrative staff showed on almost no factors a significant difference, expect for their perception of training. Administrative staff was significantly less satisfied with the training quality given compared to nurses, but no significant difference was found between physicians and administrative staff.

Table 4. Scale properties

			Physicians		Nurses		Administrative staff		Total	
			N=208		*N=117*		*N=50*		*N=375*	
Scales	Cronbach's α	Items	M (SD)		M (SD)		M (SD)		M (SD)	
Perceived Net Benefit	0,84	3	2,38	0,66	2,65	0,52	2,79	0,46	2,52	0,61
User Satisfaction	0,83	4	2,35	0,59	2,74	0,36	2,81	0,37	2,53	0,54
Intention to use	-	1	2,51	0,77	2,78	0,60	2,86	0,61	2,64	0,72
Information Quality	0,71	3	2,70	0,52	2,83	0,33	2,86	0,36	2,76	0,45
System Quality	0,88	11	2,24	0,44	2,59	0,32	2,62	0,34	2,40	0,43
Psychological Ownership of IT	0,68	5	2,22	0,44	2,37	0,44	2,52	0,49	2,30	0,46
IT Support Quality	0,76	6	2,67	0,48	2,91	0,38	2,78	0,48	2,76	0,46
Training	0,74	3	2,32	0,55	2,66	0,40	2,45	0,44	2,45	0,51
Participation	0,77	7	2,47	0,47	2,75	0,35	2,68	0,45	2,58	0,45

5.3 Regression Analysis

Multiple regression analysis were performed to test the three decomposed parts of the constructed HIS implementation success model. These parts were labelled 'Model I', 'Model II' and 'Model III'. The distribution patterns were normal by histogram and P-P plot for all the data used to test these models. No outliers were detected (Appendix C). Also a correlation analysis was performed which showed no high correlations between the variables (r = < .09). For all three OLS regression models VIF-factors were computed for each predictor in the regression model. These VIF factors in none of the three models exceeded a value of 5. These results indicated no potential problem of multicollinearity. Presented next are the result of the regression analysis performed.

5.3.1 To what degree do the service quality (Par, train, ITQ) factors predict Psychological Ownership of IT (POIT)

A multiple regression analysis was performed to assess to what degree factors specifically concerning the service quality during the implementation of a HIS (IT support quality, user participation, training) predicted the Psychological Ownership of IT (POIT). A Pearson product correlation analysis revealed relationships between POIT and IT service quality (r = .24, p <.001), user participation (r = .50, p <.001) and training (r = .34, p <.001).

There was a significant relationship between POIT and the predictors (F (3, 371) = 43.4, p < .001). A medium coefficient of determination (R2) was found at 0.249 for the regression analysis. The only variable that significantly predicts POIT was user participation. Training and IT support quality were not found to be directly influencing POIT (Figure 9).

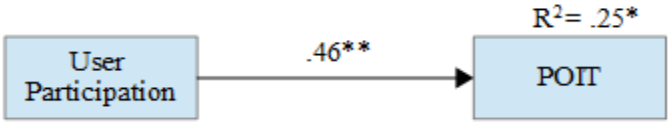

Figure 9. Model I Multiple Regression Analysis. Dependent variable: Psychological Ownership of IT (POIT)

5.3.2 To what degree do service quality factors, and POIT predict System Quality?

A multiple regression analysis was performed to assess to what degree factors specifically concerning the service quality during the implementation of a HIS (IT support quality, user participation, training), Psychological Ownership of IT (POIT) predicted the perceived System Quality. A Pearson product correlation analysis revealed significant relationships between System Quality and POIT (r = .35, p <.001), IT service quality (r = .47, p <.001), user participation (r = .56, p <.001) and training (r = .57, p <.001).

Statistically significant predictors of System Quality were Use Participation, Training and IT Service Quality. The model accounted for 43% of the variance in System Quality. ANOVA results indicated a good degree of prediction of System Quality (F (4, 370) = 68.38, p < .001). Only POIT was not found to significantly predict System Quality (Figure 10).

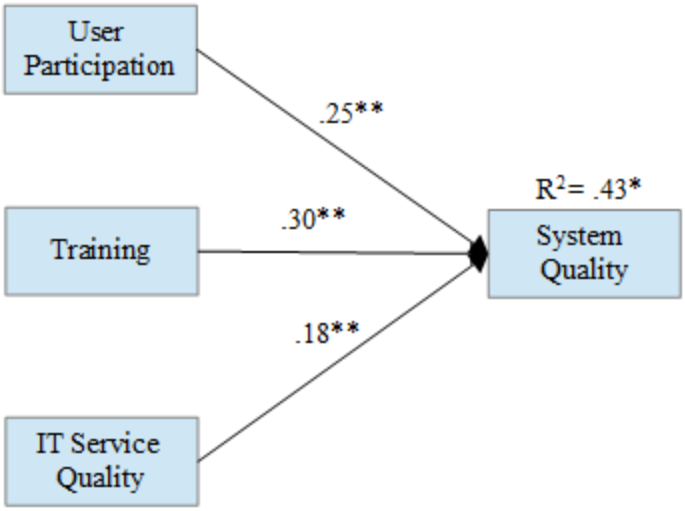

Figure 10. Model I Multiple Regression Analysis. Dependent variable: System Quality

5.3.3 To what degree do service quality factors, and POIT predict Information Quality?

Another multiple regression analysis was performed to assess to what degree factors specifically concerning the service quality during the implementation of a HIS (IT support quality, user participation, training), Psychological Ownership of IT (POIT) predicted the perceived Information Quality. A Pearson product correlation analysis revealed significant relationships between System Quality and POIT (r = .20, p <.001), IT service quality (r = .34, p <.001), user participation (r = .41, p <.001) and training (r = .39, p <.001).

Statistically significant predictors of System Quality were Use Participation, Training and IT Service Quality. The model accounted for 21% of the variance in Information Quality. ANOVA results indicated a good degree of prediction of System Quality (F (4, 370) = 24.95, p < .001). Only POIT was not found to significantly predict Information Quality (Figure 11).

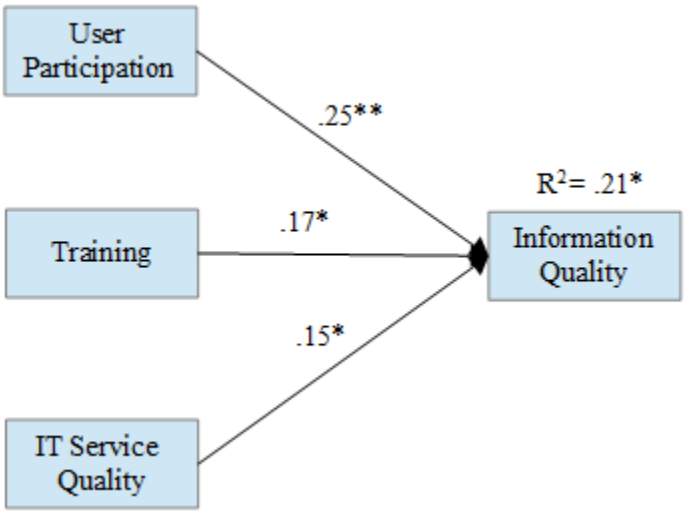

Figure 11. Model I Multiple Regression Analysis. Dependent variable: Information Quality

5.3.4 To what degree do POIT, System Quality and Information Quality predict user satisfaction?

A multiple regression analysis was performed to assess to what degree Psychological Ownership of IT (POIT), Information Quality and System quality predicted the User Satisfaction. A Pearson product correlation analysis revealed significant relationships between User Satisfaction and POIT (r = .42, p <.001), Information Quality (r = .46, p <.001) and System Quality (r = .75, p <.001).

Statistically significant predictors of User Satisfaction were System Quality, POIT and Information Quality. The model accounted for 60% of the variance in User Satisfaction. ANOVA results indicated a good degree of prediction of System Quality (F (3, 371) = 184.58, p < .001) (Figure 12).

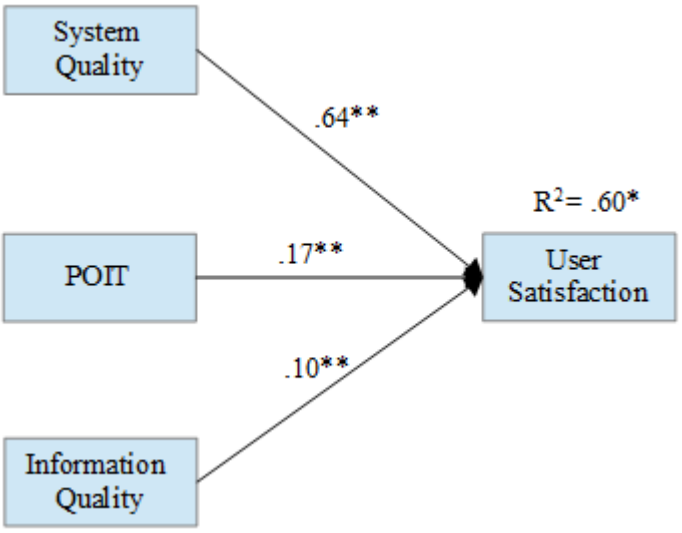

Figure 12. Model II Multiple Regression Analysis. Dependent variable: User Satisfaction

5.3.5 To what degree do POIT, System Quality and Information Quality predict Intention to Use?

A multiple regression analysis was performed to assess to what degree Psychological Ownership of IT (POIT), Information Quality and System quality predicted the Intention to Use. A Pearson product correlation analysis revealed significant relationships between Intention to Use and POIT (r = .40, p <.001), Information Quality (r = .28, p <.001) and System Quality (r = .57, p <.001).

Statistically significant predictors of Intention to Use were System Quality and POIT. The model accounted for 37% of the variance in Intention to Use. ANOVA results indicated a good degree of prediction of System Quality (F (3, 371) = 71.85, p < .001). Information Quality was found not to be significantly predict Intention to Use (Figure 13).

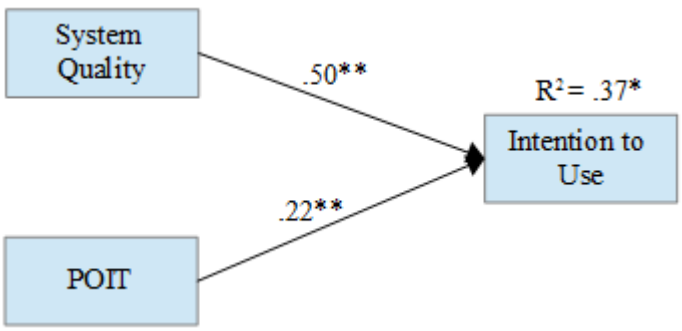

Figure 13. Model II Multiple Regression Analysis. Dependent variable: Intention to Use

5.3.6 To what degree do User Satisfaction and Intention to Use predict the Perceived Net Benefit?

A multiple regression analysis was performed to assess to what degree User Satisfaction and Intention to Use predicted Perceived Net Benefit. A Pearson product correlation analysis revealed significant relationships between Perceived Net Benefit and Intention to Use (r = .56, p <.001), and User Satisfaction (r = .71, p <.001).

Statistically significant predictors of Perceived Net Benefit were both User Satisfaction and Intention to Use. The model accounted for 53% of the variance in Perceived Net Benefit. ANOVA results indicated a good degree of prediction of System Quality (F (3, 371) = 71.85, p < .001) (Figure 14).

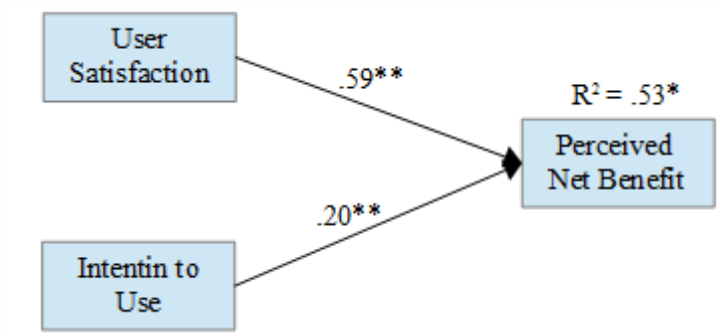

Figure 14. Model III Multiple Regression Analysis. Dependent variable: Perceived Net Benefit

5.3.7 Model Fit

The model was tested using a hierarchical multiple regression analysis. The dependent variable was Net Benefit. Firstly entered were User satisfaction and Intention to use, followed by System quality, information quality and POIT, and finally the service quality variables. User Satisfaction and Intention to use accounted for 52.5% ($p < .001$) of the variance at the first step. When System Quality, Information Quality and POIT were entered as an un-hypostasized effect of Perceived Net Benefit, at the second block of the model, only POIT was found to be significant and accounted for 54.4% (R2 change = .019, $p = .002$) of the variance. A small but significant increase. At the third step the service quality factors were added which resulted in no significant change of the variance (Figure 15).

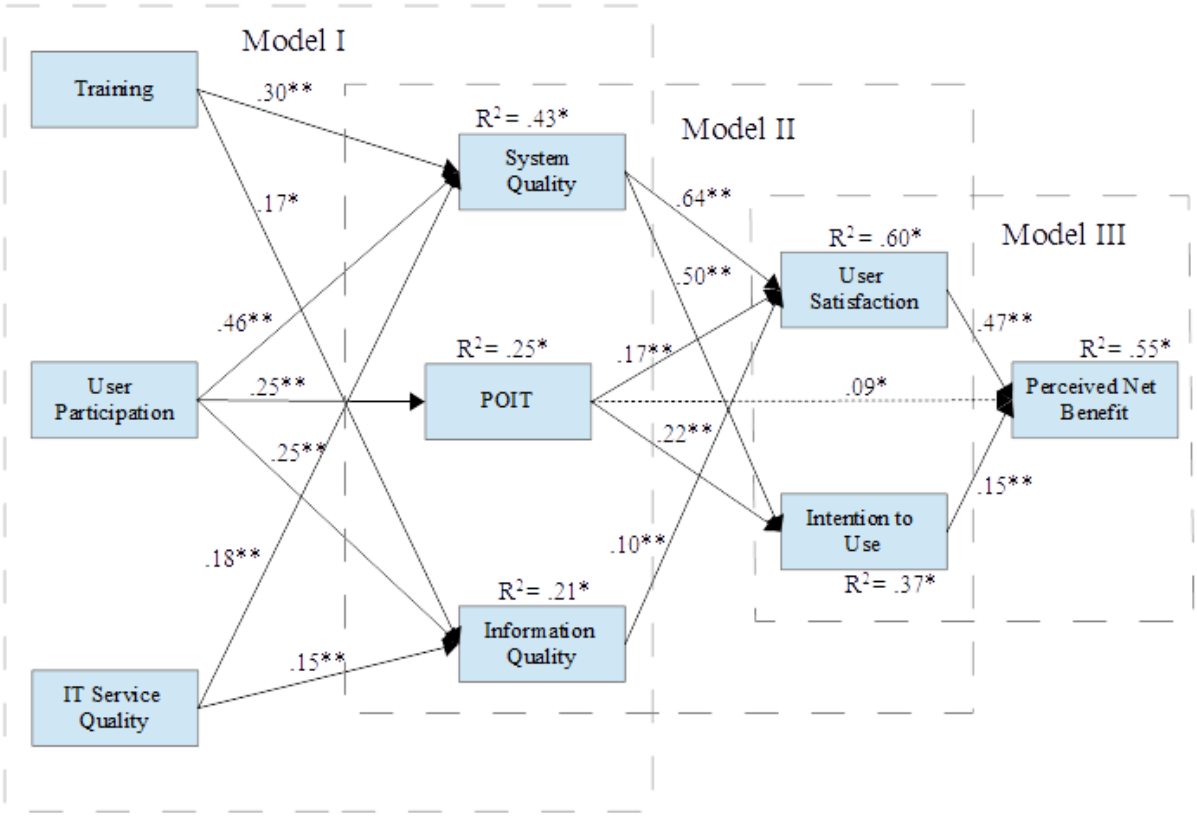

Figure 15. HIS implementation evaluation model

6

Results of Qualitative Data

Two focus groups were conducted (one with only key-users and one with only end-users) to get an in-depth insight in implementation of a new HIS. The focus groups structure was based on results from the survey and presented as statements to the participants (see Appendix C). These participants were asked if they recognized these results, what their experiences were, and how to improve the implementation.

Objective of the focus groups was to identify the barriers and facilitators of the implementation, and to map the antecedents of a successful implementation. Several themes associated with the first 1.5 years of the HIS implementation emerged from the focus groups and were categorized according to the concepts in the theoretical model.

The following sections summarize the focus group results for every concept of the HIS implementation evaluation model. These results do not chronologically follow the focus group discussion semi-structured design. The discussions in the focus groups primarily focused on the bottlenecks that participants perceived during the implementation of the new HIS. This does not imply that the participants were not satisfied with the implementation. However, this was primarily a result of the design of the focus groups, which had the goal of mapping the bottlenecks and best practises of the HIS implementation. The next section will present the results of these focus groups according to the concepts of the evaluation model.

6.1 Effects on work practices, care and safety.

The primary objectives of introducing a new HIS was to improve quality of care, patient safety and operational efficiency. The results from the survey showed that the perceived benefits of the new HIS were relatively low. The users were asked to how they perceived the benefits of the new HIS on the patient safety and their work practice.

When participants were confronted with the results of the survey on the net benefit, one participant from the key-user focus group was surprised about the number of key-users in the survey (70%) that reported to experience a positive impact on their work from the new HIS. This was perceived as a low score, because the key-users were highly involved with the design and implementation.

> *When I see that 70%, so say very rough two-thirds, meaning that one third think it just is not [not happy with effect at work]. And I think actually a shockingly large number. And then we talk about key users. People who are above average in question happen to that EZIS*

However, the participants mentioned the new HIS had impact on patient safety, privacy and security, the quality of their work and efficiency.

6.1.1 Effects on Patient care and safety

Some participants agreed with the statement that the new HIS improved the patient safety as a result of improved information quality and compatibility with the work practices. This improvement of the information quality, as in more accurate and complete patient records, was facilitated by improved interoperability and integration in the new HIS. For example, an administrative staff among the participants mentioned that the registration of patient information and checking of personal identification number (BSN number) when administrating a reduced the change of error (e.g. prescribing wrong medicine).

> *I think you can understand by good patient safety, that everyone should be able to register everything in the system. So the consultations of the specialists who are registered, the medication was recorded. So everyone say but also insightful ...*
>
> *What to ourselves it is noticeable that it is enrolling patients and precisely control the BSN [number] that you are sure you're dealing with the right patient. That's just for us a very big advantage.*

On the other hand, some participants perceived a negative impact on the patient safety as a result of the implementation of the new HIS, caused by poor system quality and the complexity of the system. The issues with system quality were unresolved errors in the information system (mainly related to system design) and incompleteness (i.e. the absence of important functionalities) of the new HIS. These issues increased the risk of subscribing or administering wrong medication to patients. Furthermore, a physician mentioned that the many checklists and needed actions (e.g. clicks) increased the complexity of working with the system which potentially could cause human errors.

> *Yes, I must honestly say that the patient did not improve by ECIS has been taking the medication. That was for us [in old situation] much more ideal really. And especially with the children has considerably decreased. The children knew the dosage [ECIS] not. And they cannot count on milliliters. Same with capsule preparation eg. That's what we all are self-filtering and self-monitor when it should be delivered because it will never come back in ECIS. So I think it's in all overseer certainly not become safer.*
>
> *What disappoints me is also the amount of checkboxes you need to tick. What I think can encourage errors, as it's just too much ... And I think this actually increases changes of mistakes, instead of making the system more secure.*

Participants complained about the lack of IT support to resolve the technical issues. Users were therefore strongly encouraged to report potential risky situations due to technical issues to a central alert system (i.e. MIP), to create an urgency for these technical issues. The participants acknowledged many of these alerts were made related to the implementation of the new HIS.

However, some of the issues were related to the system quality, participants from the end-user focus group stated that the patient safety is mostly influenced by human (their own) action rather than a system. The accuracy of patient data is depend of the person entering it in the record. This risk of error making could be significantly decreased by user training.

6.1.2 Effects on privacy and security

Participants further mentioned an improvement of the patient privacy and security as a result of the implementation of the new HIS. Whereas, most (medical) information in the old HIS was open to the whole organisation, in the new HIS this is much more restricted. Users are authorised by role and division what they can and cannot access. Although this improved the privacy protection of the patient, some participant mentioned that it was generally unknown for users to what information the other department is allowed access to. This causes confusion and irritations in multidisciplinary meeting. Most users still had the open authority perspective about the information restrictions from the old HIS. Making more clear who has which restrictions and access to certain information, to all users will save much frustrations.

6.1.3 Effects on quality and efficiency of work practices

The increase of information benefits the quality of information and therefor the quality of the users' work practices and the patient safety. Participants mentioned the transfer from a low integrated (and partly paper-bases) system to an organisation wide integrated electronic based record supported their work practices and had a positive effect on the efficiency and quality of their work practices. Examples of improvements mentioned were, better and faster registration, more accurate information, less redundancy, less double entering of information, and better communication between colleagues.

However, several participants perceive no benefits, or mentioned even a decrease in efficiency, as a result of the increase of information that can be put into and pull out of the system. They argue the complexity of the new HIS had a negative impact on the efficiency. Some participants mentioned the lack of automation of their work practices by the system as a barrier. They perceived less compatibility with their work.

> *But you see a shift of work. And I have always said, we are not automated, we have been digitalized. And that's a whole other story. So it's not faster than before ... Management did expect that; like, just wait as the CS-ECIS is so much faster and requires less personnel.*

> *... Completing the automatic or digital record takes more time ... it also invites you to fill in a lot of boxes and to register. But some boxes you are allowed to check, you do not need to fill in. And it is quite difficult to skip a checkbox. There is some quality improvement, but it takes more time.*

Participants conclude that with adequate training, users can be educated how to use the system more efficient.

6.2 User Satisfaction with the implementation

A majority of the participants were satisfied with the implementation of the HIS, and mentioned users had invested a lot of time and energy in the implementation. The participants believed that users were motivated and enthusiastic towards the big-bang implementation (on 10 June 2011).

> *I must say, what we have achieved in this short time, I do think an achievement [others comply with this statement]. For we now of course talk a lot about negative things. But when I look at where we went live with it and what is possible with the system, when you see how many people have worked and how many hours have invested in it. It is also an achievement.*

Unfortunately, this enthusiasm with the users had decreased after the implementation. According to a focus group participant due to certain critical errors and missing functionalities became clear in CS-EZIS after working with the system in practice. According to a participants some system errors were unavoidable, because not all scenarios could be captured pre-implementation. However, a major factor for less resistance among users was adequate IT service giving support with the issues and problems of users.

Another participant agreed and mentioned that in the first weeks after the implementation, small problems were resolved adequately, which had a positive effect on the user satisfaction towards CS-EZIS and the implementation. However, the bigger and more difficult bottlenecks in the system (e.g. physician codes) were not solved by IT support after some time which caused for a decrease in user satisfaction levels.

Furthermore, a participant stated that certain problems arose due to inexperience of the users with new HIS, caused by the transition to a new system and inadequate training. The participants were satisfied with the 24/7 standby support of the IT service in the two weeks after the implementation. This took some of the workload off the key-users.

One participant argued that perhaps some problems with the new HIS could have been resolved postponing the implementation deadline, until the system was complete. Delivering a quality system should be the priority, not achieving implementation deadlines and not exceeding the budget which was the perception of some participants. Another participant responded that the strict deadline created pressure, which helped to achieve certain goals. The question raised if with a less strict deadline the same pace and necessity would be maintained. Perhaps by postponing there is a risk that the build-up enthusiasm and involvement level would decline.

> *... More opted for finance and whatever the cost to achieve the deadline, instead of truly substantive to implement a good system, at that moment. Also in it I like, if we had not done this then we still had nothing now. That is the other side of it.*

6.2.1 From user resistance to system acceptance

Both key-users and end-users participants of the focus groups perceived a resistance early before the implementation among users to use the system. Main reasons given for this perceived resistance were a low expectations, low satisfactory due to system errors, and anxiety because of novelty of the system. However, a participant stated that the level of resistance towards the new system reduced over time as issues with the system are being resolved and users became more experienced working with the system.

> *... There is [one year after introduction] also much resistance gone. Because in the beginning there was quite a bit of resistance to EZIS. Because you had to give up the familiarity, it was all new, and it still was not working. You also get used to the system making your resistance also reducing. Everyone is working on it now, and we understand the system better now ...*

In overall the participants of the key-users focus group were satisfied with the implementation of the new HIS in the hospital, as a result of participation an involvement of users. A key-users mentioned:

> *... But that they were generally pleased about the introduction I can also imagine when you see how much time and energy we have put into it in advance and lived toward the June 10th. And the fact that it takes just on June 11, more or less. Yes I think it has nevertheless given a kick ....*

6.2.2 Expectations in relation to satisfaction

Some participations of the focus-groups mentioning that users were anxious about the technical part of the system before the implementation, but had high expectations improvement of efficiency, quality of the system and an improved accessibility of patient records and information.

> *... I think the expectations were high. Users have dreaded the technical part actually. But that the content [of the system] would be better, it would be more efficient, and that you could at all times look into the records, that would be great.*

Though, end-users seemed to have less positive expectation about the new system, and a participant from the end-user focus group expressed his expectations as "hope" for that the system would be more efficient. This statement of 'hope' instead of expectations implied the need for a better system among the end-users.

The expectations of users influence the satisfaction towards the HIS. When the expectations of users about the system turn to be false, and are not confirmed, it has a negative influence on the satisfaction of the users.

> *... Some things promised are currently not yet realized what does not benefit the satisfaction of EZIS.*

Furthermore, the users' expectations and overall satisfaction were according to the participants mainly facilitated by previous experience with electronic records, quality of the training, user involvement with the implementation, support of management, IT support, and perceived usefulness of the system.

6.2.3 Previous experience with electronic HIS

Some participants mentioned that to the experience with electronic records before the implementation versus mainly paper based records in their working practice was related to the satisfaction and expectations of users. Users who already used electronic records, were more satisfied with the old HIS and were probably felt more resistance towards using the system and about the benefits of the system.

A key-user participant from the pathology department which previously worked mainly with paper based systems agreed, but argued that changes in workflow impact the user satisfaction towards the new system. Changing from paper to an integrated electronic HIS had more impact on work practices than when users already worked with an electronic HIS before the implementation. Users were more anxious about the changes in their work practices and responsibilities due to the implementation of the new electronic system. However, the participant mentioned, when users saw the benefits of the new HIS their anxiety towards the system disappeared, which positively influenced the satisfaction.

6.3 User satisfaction (usefulness) and usage

The quantitative survey results showed that users were more positive about the usefulness of the new HIS, but less about the ease of use, compared with the old HIS. Participants of the focus groups were also asked to explain their perceived experiences and satisfaction of using the new HIS. The themes that emerged from the focus group discussions were about the compatibility and changes with users' work practices and the complexity of the system.

6.3.1 Compatibility and Change in work practice

The majority of the focus group participants mentioned a change of their responsibilities as a result of the implementation of the new HIS, and had mixed feelings about the compatibility of the new HIS. Users reported the changes were negative on one aspect, but could be positive on another.

> *On the one hand the shift of responsibilities, which also goes to the other side. On the other hand, you see that people have more responsibilities, and on the other hand you also get things back again.*

Most positive about the compatibility were the participants from the administrative staff. A medical secretary who participated the focus group mentioned that the new HIS was highly compatible with several of their work practices, like registering and managing patient information in the system.

> *... on a number of areas [EZIS] was better to work with, such as enrolling patients and thus control of the name and address information. That is really for us a very important improvement.*

In contrast, several participants (mainly physicians) reported a more negative feeling about the compatibility with their work practices. They perceived an increase in workload due to a shift in responsibilities from the medical secretary to the physician. Physicians, for example, had to create their own letters after the implementation of the new HIS, where before the implementation this was responsibility of their secretaries. These changes in work practices might be a cause why physicians are less satisfied with the system.

> *I notice that we [doctors] are increasingly typing OK reports manually. Or we have standard lists where everything is filled in and where to change things themselves. But then again, before than you dictated it and then was getting ready in a few minutes, and now you are there spending more time with. And then you had also checked it again though, I must say [in old situation] and now.*

However, the new HIS was perceived as more useful according to the participants because of the high interoperability of the system (integration of information and systems). In their experience, the implementation of the new HIS had a positive effect on the quality of their work practices but non or negative effect on the efficiency due to incompatibility with some work processes. A participant expressed this paradox as following.

> *... That the new HIS only had digitized the needed information, but not automated their work practices.*

6.3.2 Changes in contact with patients

Participants worried about the changes in the patient-professional relation when using the new HIS, and were anxious about the patients' reactions. However, they felt that most patients' reactions were neutral or even positive towards the new HIS. Patients were well informed by posters, and even sometimes helped physicians with navigating in the system.

But participants felt that the interaction with their patients (e.g. during consults) had changed after the implementation of the electronic records. They perceived the relation and interaction to be less personal due to the presence of a computer screen for the clinician. Changing the setup of the outpatient clinic so patients are able to watch on the screen with the physician for example, would be an improvement to increase patient participation during consult.

6.3.3 System Usage

As a result of the implementation of the new HIS, usage of paper-based records decreased significantly. The digitalization of information improved the efficiency. While the majority of the hospital had implemented and utilized the new HIS, participants of the focus groups agreed some departments still used paper records and their own system (e.g. radiology). However, they mentioned that these departments would like to switch to the new HIS, due to the decrease of paper-based record use and improved interoperability.

6.4 System and Information quality

Some themes related to the quality or performance of the system were discussed in the focus groups. Participants had mention how the system and information quality influenced the perceived user satisfaction and benefit of the system. Overall, participants were positive about the quality of the information which improved due to better system interoperability, and the speed of the system. However, several issues were mentioned related system errors, incompleteness, and the system layout design.

6.4.1 Complexity and Ease of use

The participants recognized the relative low satisfaction with the ease of use of the system due to its high complexity, and inflexibility, as reported in the quantitative survey results. The problems mentioned by the participants were mainly with the design of the screens, navigation, the handling of the system, and the lack of personalizing the system to their needs.

As a result of the complexity of the system, participants mentioned that that not all the capabilities of the system are utilized, which results in lower user satisfaction (usefulness) and positive effect of CS-EZIS on the work practices.

> *Because it is little intuitive. That is one of the criticisms of EZIS. I find it difficult, if you do not know where to look, it's hard to find your way.*
>
> *You become so overwhelmed by all these tabs, you might actually be able to make personal settings.*

> *One factor is time with us at the clinic. We just really notice that fewer patients are consulted. Because a consultation really just takes more time. We are digitized, but of course he is not automated. It's all become digital, but we must be performed a lot more action.*

The perceived ease of use of the system is affected by the experience with the system and the users' anxiety working with the HIS. A participants mentioned the lack of knowledge of basic computer skills such as typing. Also, another participant mentioned that just after the implementation users were anxious to make mistakes when working with the new system. Overtime users will become more skilled working with the new system and

6.4.2 System (design) error and incompleteness

The results from the qualitative survey showed that many users perceived that the new HIS had many errors, even a year after the implementation. The subject of errors in the system and missing of important functionalities (i.e. incomplete system) was also reoccurring topic in the focus groups. The perceived lack of these important functionalities and the lack of solving these system errors in the new HIS, had according to some participants a negative effect on the patient safety. Furthermore, a participant mentioned that the system errors and system incompleteness became more apparent over time and experience using the system. The perceived system errors had a negative effect on the satisfaction of users towards the system.

Participants mentioned several errors, which were mostly errors in the system design, and mostly related to patient medication.

- A pharmacist for example mentioned in the key-user focus group that the new HIS was missing a functionality to measure medication doses for a children.
- A nurse mentioned that information about prescribed medication was not visible anymore after the medication stopped.

6.4.3 System speed

Participants perceived the system as being sometimes slow in use when multiple connection with external system were being made, especially after the new release of the HIS. This had according to the participants a negative effect on the patient satisfaction and decreased the efficiency of their work practices. Participants experienced system stalls when having many connections with external systems, when opening scanned documents, or when opening large records. The long waiting time or restarting the system due to the stalls caused irritation with the users. One participant mentioned it could cause a negative image with patients.

However, participants were satisfied with the improvement of system speed compared to the old HIS. This was a major improvement according to the participants, which showed how important the speed of the system is for users. Participants mention that the response time of the old HIS was very long and stalled more than the new HIS. One participant rationalized the issues with the speed of the new HIS as

> *You also get used to the fact that it [with EZIS] faster.*

6.4.4 Screen and Layout design

Another issues which was discussed by participants were with the layout of the system screen and how certain information was presented. Some participants perceived that information was not presented clearly to the user.

- For example, a nurse mentioned that it was almost not visible which patient record was selected in a list for administering medication.
- Another example from a participant was that the lists of consults records presented on the screen were becoming too lengthy and unclear over time. These issues decreased the patient safety, and the perceived ease of use of the system.

The unclear screen layout increased system complexity which decreased perceived ease of use. The complex screen layout also was reported to have a negative impact on patient safety, because it could increase errors.

6.4.5 System interoperability and integration

The interoperability of the new HIS was found to be improved compared to the replaced system. Different systems and information are currently accessible through a single system for the whole hospital, which is perceived to impact the quality and efficiency benefits of the users work practices.

Users mentioned that the interoperability improved the accessibility and availability of information, efficiency as a result of working from one system, and less redundant entering of information.

However, several participants mentioned the lack of interoperability with some important external systems (e.g. order management system and radiology information system). The lack of interoperability with some systems could cause delays in care processes, and more risk for medical errors, since users have to work with two different systems (even back to paper) and redundant information. . For example, some participants mentioned a lack of integration with the CPOE system and the new HIS. Orders were easier with paper than digitally according to a participant, but was inefficient and more separable for errors.

6.4.6 Improved information quality

The information from the new HIS was found to be of better quality (more relevant and accurate) compared to the old system. Participants mentions that the new HIS invited (or required) the practitioner to record more patient information into the system. Also the high interoperability of the new HIS has increased the quality of the information. The information was found to be better accessible in the new HIS for users compared with the old HIS. The improved quality of information had a positive impact on user satisfaction, the quality of work and the patient safety.

6.5 IT support with the implementation

IT support is responsible for the development, implementation and service support of the new HIS. A common theme with the participants from the focus groups was about the quality of IT support related to the implementation and resolving users' issues. Participants were satisfied with the availability of the

first line support during and short after the implementation. However, participants were unsatisfied with IT support on the handling of users' needs and reported issues, communication and leadership from IT support and the support from the vendor.

These issues resulted in users being unsatisfied with the IT service quality. A low service quality had negative impact on their perception of the system quality and their user satisfaction.

6.5.1 Availability of support in early implementation phase

A facilitator for a successful implementation was the first line IT support in the early implementation phase. Participants were positive about the availability (i.e. on the work floor) of the support during and short after the implementation. In this period small issues were fixed quickly. However, the complex issues were not being solved and kept unfixed.

6.5.2 Lack of adequate technical support

A common issues during the implementation mentioned by the participants was the lack of a adequate IT support in system development, and after the implementation. IT support is amongst other things, responsible for supporting users with technical issues and the change management (improvements) of the system.

Participants reported issues with the IT support as a lack of leadership and clear organisation. Calls and issues disappeared from lists without notice, which caused users to spend much time and resources inquiring these issues. Participants felt it took them much time and energy to make their issues and needs a priority for IT support and to get them implemented. They complain about the indecisiveness of the IT support to solve the technical issues, which in some cases caused a risk for the patient safety (e.g. issues with medication system). They strongly felt that IT support does not realize the urgency of some of these issues, and take them seriously.

> *But you must be very careful that your list of calls that you have standing out. Because they throw it all away. Frequently, we find that all our calls that we have open are gone from the system, and we must be notified again.*

> *Officially they suppose [helpdesk] to report that it has been dealt with, but that does not happen. They just disappear from the list. So we are now looking 1x a month after everything back to check that everything is still on it. If you're not going to nag the call will become out of the picture.*

6.5.3 Communication and user involvement with technical support

A lack of adequate communication and planning from IT support was mentioned as a bottleneck in the implementation. This led to low user involvement, uncertainty with users and spending unnecessary time and energy.

Participants felt they were informed too late about the impact of changes and updates and not enough involved as users. Several participants stated this resulted in not being able to find enough resources and time to help with the implementation or test the change in the system adequately.

> *So now we've had so EZIS 5.2 and next year there will be a new version. What I really miss is that as a decentralized functional administrator never too early am aware of the changes. Which we also already could start testing and see what kind of impact does it have on your department.*

However, a participant was positive about the latest developments of the IT support where an effort was made to involve users (in this case physicians) in improving the system. Users could give their needs and requirements to technicians face to face.

6.5.4 Expectations of technical support

Furthermore, several participants mentioned that the feedback from IT support on their made calls was very late or even totally absent. They felt that their calls or requests were pushed into the organisation by IT support, where they disappeared. This resulted key-users to keep track of their made requests and questions which required unnecessary time and energy. The participant expected a quick and adequate response from the IT support, so they knew what to expect and were not left in uncertainty. IT support was setting unfulfilled expectations. Promises to resolve the system issues were not being confirmed according to several participants. This had a negative influence on the satisfaction after the implementation. A participant of the end-user focus group perceived this in a similar way.

> *There are mountains of gold promise, even though last year when we mentioned our problems. It was nevertheless said they are working on. And we are a year later and we still have hope. And we work absolutely inefficient in some areas.*

A participant felt the reasons for the inadequate IT support is probably the lack of recourses (e.g. manpower) of IT, and the narrow view IT support with issues.

6.5.5 Lack of adequate support from the Vendor

The participants of the focus groups related many issues with the system quality and the IT support quality to the vendor of the new HIS. They had a negative feeling towards the role the vendor played in the implementation process. Several issues with the vendor were brought forward in the focus group with the key-users.

The participants felt that the vendor benefitted too much from the implementation without returning any recognition or reward. A participant explained that the vendor befitted from the implementation too much, by developing a quality system for academic hospitals using the experiences of the users, without getting recognition from the vendor.

The vendor's attitude towards the users' needs and requirements was rigid according to some participants, who mentioned a number of issues related to the role of the CS-EZIS vendor in the implementation process, which explained this rigid attitude.

They believed that certain user needs and system functionalities were difficult to realize in the new HIS, because the system was originally developed for general hospitals. Participants explained, an academic hospital is a completely different, more complex organisation with different needs and requirements. According to the participant, was the vendor not willing to develop a (framework of the) system which is specifically designed for the academic hospital perspective, which caused many request from users not being realized. Instead, so the participants mentioned, the vendor required the UMC Utrecht to adapt

to working with CS-EZIS, instead of CS-EZIS adapting to the processes in the UMC Utrecht. However, this had negative consequences for the quality of work and satisfaction of users.

6.6 Training and education

Training and education were hypothesised as an important factor for a successful implementation of a HIS. The quantitative results of the survey show that a many users were not satisfied with the quality of the training. Training appeared to be an important topic in the focus-groups since it was one of the key themes in the focus groups discussions. Participants gave their views on how, and why a high quality user training was important in a HIS implementation, and what the issues were they experienced.

6.6.1 Training as facilitator for system satisfaction

Several key-user participants mentioned that the training and education of users facilitated the HIS implementation and user satisfaction. Especially the testing (and playing) in the test-environment contributes to the adoption of the HIS according to the key-user participants. High quality training would increase the perceived system and information quality and decreases the resistance of users.

> *... If you look at the previous period [pre-deployment], so in May and June [2011], when all end users are trained. That could have make them enthusiasm for the system.*
>
> *By our management team had made it compulsory training. [...] But if you training very well, that may solve a lot of problems and eliminate resistance.*
>
> *The processes are not always well equipped, but a very large part of the problems arise because there is simply not enough skilled. Not knowing what is where ...*

6.6.2 Insight in impact and benefit of the new HIS

The participants of the end-user focus-group agreed with the view that training and education facilitated the user satisfaction about the system. It would doing so by giving the users insight in the impact, the use, and expected benefits of the system. However, end-user participants complained that the training was of inadequate quality and that they had insufficient opportunity to train in the test environment of CS-EZIS.

> *I think it is a pity that the sandbox for instance was not accessible for more people sooner. Just to see what the system is ... because just before going live many people had seen nothing, and were thus difficult to form an expectation.*

6.6.3 Quality of the training

The training of users was not of adequate quality according to the participants. They mentioned that the content of the training sessions were forgotten easily by the users. The participants perceived the content of the training to be generic and the groups were too diverse. Departments and roles have different ways of work practices and specific questions about CS-EZIS. Participants rather saw the user training to be more task and role specific, combined with practice examples (e.g. cases). As a

result a participant mentioned that physicians used the system differently, and probably not as intended.

The lack of training in a test environment meant that users learned more from the system when using it in daily practice. Using the system in a test environment or daily practices was according to end-user participants the best way to lean the system.

Another issues reported by several participants was with the quality of the online instruction manual of the new HIS, which was unclear and difficult to navigate. A smart help function in the system itself would have been much more useful and easier a participants mentioned.

Extra tips and tricks evening were organised to provided extra training and examples of real life problems with the HIS. The participants stated that users in general perceived they were experts with the HIS, however the focus group participants mentioned that the tips and tricks lessons showed users still had much to learn.

6.6.4 Training by the key-users

The key-user participants (in particular) expected the training material to be delivered ready made by the CS-EZIS project. However, they reported that in many cases they had to develop their own training. An advantage that was mentioned on this, was that training would be more specific for a certain department or role, however since a large part of the training is the same for the divisions (over the whole organisation) and therefore double work developing that part. Better coordination about the training material towards the key-users was needed according to the participants.

6.7 User participation and involvement

A user centric (e.g. user involvement) development and implementation of an information system is proposed to be crucial for a successful implementation.

The participants acknowledged that more user involvement with the development and implementation process of the new HIS would might lead to higher acceptance and satisfaction. Involved users have more insight and understanding why certain needs and requirements are not being implemented in CS-EZIS, and can transfer their enthusiasm to others.

It is practically impossible to involve all users in the implementation of such a complex HIS in a complex organisation as a large academic hospital, therefor key-users were assigned to support development of the system, and the end-users during the implementation. Not all users can participate equally in the implementation process. The key-user provided support to users, helped to develop the new HIS, and to communicate and excite users about the implementation. This would than lead to a higher feeling of ownership towards the system, more participation in the implementation process and ultimately higher satisfaction level towards the new HIS.

Users were overall satisfied with the assigned key-users and their functioning. Enthusiastic key-users with a positive attitude towards the system had, according to the focus group participants, a positive effect on the satisfaction of other users. Key-users were in that sense perceived as a role model. That key-users were found to be in general more satisfied with the implementation of the new HIS was explained by the participants that they were highly involved and participated more with the implementation. However, an unsatisfied key-users could have a negative influence on the other users.

There's just a lot of time and energy put in, in my opinion. And the people who propagated who were also enthusiastic. And I think that also contributed to positive expectations.

Now these [key-users] were often much involved in the design of the system, so they went there for real and were more satisfied.

We had a couple of doctors who were really positive [against CS-ECIS]. They were also involved in the development. That influences then I think in one way or another, on how they perceive the system. And how it get transferred to colleagues.

Participants mentioned different facilitators and barriers for the involvement of users in the implementation.

6.7.1 Facilitators and barriers for user involvement

Participants mentioned several facilitators for user participation. The most important facilitators were:

- (Hands-on) user participation increased the feeling of personal involvement towards the implementation.
- Psychological Ownership is higher in the healthcare domain compared with other domains, which could result in higher user involvement.
- High quality training and education shows the benefit of the system and has a positive effect on the feeling of involvement.

Mentioned barriers that had a negative influence on the users involvement

- Failure of fulfilling promises made (by IT support) does not confirm the users' expectations, which induces demotivation to be involved in the implementation.
- When user needs and requirements are not being met in the system, and users have to develop own work around.
- The little time that IT support is able to invest in users issues.
- Low feeling little control over the implementation and decisions.
- Participant's felt the management is more focused on meeting the implementation deadline with lowest costs, instead of developing a high quality and complete system.
- Changes in users work practices, which is more uniformed over the whole organization, makes that certain system (i.e. forms) are being obsolete, which were developed specially for and by a department.
- A negative attitude towards the system makes users feel less ownership towards the system.

6.7.2 How can the involvement of users be improved?

- Participants were asked directly how the feeling of involvement and hands-on participation of users to with the implementation could be improved. The level of psychological ownership with the key-users towards CS-EZIS could be increased according to the participants by several interventions mentioned in the table below.

- Improving the form, speed and quality of communication, which would increase the willingness of users to take in the information. This would increase the involvement and participation towards CS-EZIS implementation.
- More adequate and clearer feedback from the IT support to calls of problems and needs. For example, by informing key-users their call is on the to-do list.
- Increasing involvement by better understanding how the project organization is organized.
- Involvement should be more stimulated and rewarded, according to a participant. The management did not realize how much effort the implementation of CS-EZIS has taken for the users

6.8 Conclusions from the focus groups

We can conclude from the focus group discussions that participants (and most users) were overall satisfied with the implementation of the new HIS. The satisfaction of users is influenced by a complex set of factors related to a HIS implementation.

The focus group discussions result in observations which can give a deeper insight and understanding in how users perceived the implementation. From the results the flowing general observations can be made. These observations consist of barriers and facilities of the HIS implementation and can explain the relation between different factors in the HIS implementation (i.e. proposed evaluation model). In the following section the observations made in the focus group sessions will be integrated with the results of the quantitative results and the theory. After, lessons leant and best practices for a successful HIS implementation will be generalized.

7
Discussion and conclusion

Many health IT implementation were found to fail due to technical, organizational and individual factors (Rahimi & Vimarlund, 2007). Evaluating for these which specific factors are important in an implementation and how could give early warning signs, and best practices for future health IT implementation (Kappelman et al., 2006). The primary aim of this study therefor was to predict which factors were related to a successful HIS implementation, and how.

A mixed method research approach was used to evaluate the implementation of a HIS in in the context of a large Dutch academic hospital. Mixed method research integrates quantitative and qualitative approaches to produce a more complete evaluation. From the theory of IS implementation research a model of HIS implementation success was developed based on the evaluation model adapted from Waal & Batenburg (2009), which incorporates implementation factors to the IS success model of Delone and McLean. In this model it was proposed that the perceived net benefit of users was directly related to user satisfaction and their intention to use the system. Next, it was hypothesized that these two concepts in turn would be predicted by the quality of the system & information and the psychological ownership (i.e. feeling of involvement). Finally, the service quality factors related to implementation (i.e. training, participation and IT service quality) were proposed to predict the system quality and information quality and the again the psychological ownership. In addition, because psychological ownership was the main focus of this study it was proposed that physiological ownership would also predict system and information quality.

The results from this evaluation study showed that users were overall satisfied with the implementation of the new HIS, and that a successful implementation is influenced by a complex set of factors. The results from the quantitative study (i.e. focus groups) suggest what the bottlenecks and the lessons learned were from the implementation.

7.1 Service Quality

From the qualitative findings it appeared that users found the service quality factors important for HIS implementation success. The quantitative results found that training, user participation, and IT Service Support predicted the perceived System Quality and Information Quality. Prior HIS implementation research have found similar the importance of these factors in the system success (Ludwick & Doucette, 2009; Sellitto & Carbone, 2007). Palm et al. (2010) found in an empirical evaluation study of a Clinical Information System implementation a direct positive effect of service quality on the perceived ease of use among users.

The focus group participants mentioned several issues with the user training before the implementation. Main issues reported were that the structure of the training was too general, and most users had no access to the test environment. A high quality training, specifically designed for a certain task or role, and

showing users the impact and usefulness of the system, influences the user satisfaction and acceptance of the system. Which ultimately ensures a greater likelihood for a successful implementation of the HIS. This is consistent with other research which state that an effective training program must move beyond the technical approaches and focus on social and cultural factors to make a difference in implementation success (McAlearney et al., 2012). Clinicians are more likely to resist the system when they do not perceive, or have not experienced, the benefits of the change (Lee et al., 2005; Lorenzi, Riley & Mantel, 1990).

A central theme in the focus groups were bottlenecks which could be traced back to the quality of IT support. However, the survey results found that users were relatively satisfied with the IT quality, some issues mentioned. Participants felt the IT support did not see the urgency in their problems, neglected to give feedback on user calls, there was a lack of leadership, perceived resistance of the systems vendor towards users problems, and promises made by IT support that were not honored. These issues had negative effect on the users' satisfaction and expectations towards the system. The quantitative results were validated by participant stating that the quality of service and IT support was strongly related to the quality of the system and information. The quality of the service helps for a better alignment between the system and the users' needs and requirements, especially for system improvements post-implementation.

When users participate and have an influence in the design and implementation process of the HIS, they will more likely be satisfied with the quality of the information, the system and the perceived ease of use of the system. Training was found to be a more effective implementation strategy component for system success, when the system is technical complex and task interdependence are high (Sharma & Yetton, 2007). With adequate training users will perceive the system less complex and easier to use. The IT support will further help users with difficulties and issues they have when working with the system (Lee & Smith, 2012).

Participation was found to directly predict Psychological Ownership. The quantitative results related to participation showed that users perceived they were not much involvement with the implementation and the effort made to include users' needs and requirements. This probably resulted in the low psychological ownership over the new HIS, as was also found by a study of Barki & Hartwick (1994). These findings are consistent with the findings of (Paré et al., 2006), who stated that "individuals are thought to develop feelings of ownership of an object when they have control over the system, associate with the system and put a lot of time and effort into the system", which was also mentioned by participants of the focus groups conducted in this study. Training and IT service quality were not found to be significant predictors of POIT. Although these are important factors in successful implementation, these factors are merely as a support when using the system, and don't give users actual influence on the design of the user interface and implementation processes.

These results confirm the importance of service quality during the implementation for the success of a system.

7.2 Psychological Ownership of IT

It was proposed that POIT would have a positive effect on system quality and information, and on user satisfaction and intention to use. Psychological Ownership of IT was found to only significantly predict user satisfaction and intention to use and not the quality of the system and information. This was partly contradictory with the findings of Barki et al. (2008) and another study by Morton & Wiedenbeck (2009), who found that POIT was an antecedent of the perceived ease of use, which is somewhat similar to system quality used in the current study. However Morton & Wiedenbeck (2009) did find that user

involvement had a positive influence on the attitude of users, which was consistent with the relation between POIT and user satisfaction. Hartwick & Barki (1994) found that the psychological concept of user involvement was had a positive influence on the acceptance of a system. Furthermore, the quantitative results also showed that POIT predicted the perceived net benefit. These findings were somewhat confirmed by Barki et al. (2008) who found that POIT strongly was positively related to perceived usefulness.

The participants of the focus groups validated these results by stating that user involvement and participation in the implementation, resulted in more enthusiastic users and higher satisfaction.

Participants mentioned three barriers for the level of psychological ownership among users: (1) having little influence in changes and development of the new HIS, (2) losing of the ownership and responsibility of the previous "proprietary system" because of uniformity (whole organization with the same system), and (3) lack of support towards the system by some key-users who did not want to propagate the system.

Drivers for more involved the participants mentioned were the highly involved nature of persons in the healthcare, participation and intensive training. However, participants mentioned that lack of technical support, support of the management in the implementation, not conforming to users' expectations, compatibility issues of the system and losing of ownership of self-made system decreased the feeling of involvement. A full model hierarchical regression model with the perceived net benefit as dependent variable found that POIT was related to the net benefit, where participation was not. From this we can suggest that POIT could be a mediating factor between the actual participation of users during implementation and their perceived net benefit of the HIS. Other studies also found POIT to be a mediating factor between participation and system success (Barki et al., 2008; Hartwick & Barki, 1994). The current research has found that the effect of user participation on POIT is a user centric design principle.

7.3 System and Information Quality

The dependent variables of the second model of our framework were user satisfaction and intention to use. The quality of the system and information were both found to predict the user satisfaction. This is consistent with findings by Weiner et al. (1999) which showed that the quality of the system and information positively correlated to the users satisfaction. The quantitative results also showed that only the quality of the system predicted the intention to use. A high quality system and clear and proper information can allow users to do their work more efficient.

The participations of the focus groups mentioned some issues with the completeness and clearness of the new HIS. Also did participants found the new HIS more difficult to learn compared the old HIS. Users report there are many errors in the new HIS, which increases over time. The information quality of the old HIS was perceived relatively high and did not change after the implementation. The improved interoperability and system speed of the new HIS resulted according to the participants in better compatibility with work practices and improved accuracy and accessibility of the information. The implementation of the new HIS did change some work practices for some users, although some were found to be positive, others negative. Furthermore, the new HIS was perceived as complex and difficult to work with, as a result of unintuitive screen layout and inflexibility of the system. It was expected though by participants that with more experience of using the system and better training, users would find the system easier to work.

7.4 User satisfaction and Intention to Use

The third model of our conceptual HIS success framework proposed that user satisfaction and intention to use predicted the perceived net benefit of the new HIS. The quantitative results showed that both user satisfaction and intention to uses positively influenced the perceived net benefit of the new HIS. Greiver, Barnsley, Glazier, Moineddin, & Harvey (2011) found that compatibility had a large influence in the success of the implementation of an Electronic Medical Record. This study defines the user satisfaction therefor as the compatibility of the HIS with the workflow of users, which better describes a task oriented satisfaction than overall user satisfaction. Another study by Lee et al. (1996) on a physician order entry system showed similar results where. This study showed that user satisfaction was positively correlated to the perceived effects on productivity, and system features that were mostly used were also rated by as more useful.

Participants from the focus groups mention that the automation of certain administrative work processes increased compatibility and efficiency, whereas it made other tasks (e.g. checklists) more difficult to perform due to the high complexity of the system and therefore less efficient. User satisfaction will probably increase as users gain more experience working with the system, use it more often (Jaspers et al., 2008). This experience will be gained, according to the participations over time, but also through training. Training insures that all the functions of the system will be used as was intended, and therefore more efficiently.

7.5 Perceived Net benefit

The participants of the focus groups confirmed this by expressing mixed feeling about the benefits of the new HIS on efficiency, quality of work and patient safety. Some mentioned an improvement in more accurate registration and monitoring of patients, but others (e.g. pharmacist) that the implementation of new HIS decreased the patient safety. Weiner et al. (1999) argued that the net benefit of a system is a subjective construct which differs between users groups and study context, which means the outcomes of a HIS implementation are difficult to measure.

However, these perceptions about the net benefit, were according to the participants, to be influenced by the quality of the system, information and the satisfaction of using the system. The perceived improvement in efficiency, patient safety and quality of work were a result of higher interoperability, improved information quality, better compatibility with work practices and less paper-based records. Although the perceived system complexity, compatibility issues, an incomplete system and many system errors had a negative effect on their perceived benefits. There was a perception that the benefit of the system would improve over time, as more system error were resolved and the system became more routinized for users.

7.6 Lessons learnt

The following is a list of lessons learnt or recommendations for increasing the likelihood of a successful implementation of a HIS.

- **Improving IT support and system quality**: managing the issues and problems of users and providing them with adequate and fast feedback will increase the user satisfaction towards the implementation and acceptance of the system. Problems in the system design will likely increase the resistance of users to accept the system (Scott et al., 2005).

- **Software vendor needs to be involved in the implementation**: The role of the vendor in the implementation and IT service was a common theme in the focus group discussions. The vendor plays an significant role in a HIS implementation (Meulendijks, 2010). The supplier strongly influences the end-product outcome and its success. However, many healthcare organizations does not have an optimal relationship with their supplier (Meulendijks, 2010). A positive attitude of users towards the vendor will increase the satisfaction of the IT service quality. The vendor should be more visible in the implementation process and communicate more with the users about its role.
- **Adequate user training**: to educate users about the usefulness and benefits of the system, and to insure users are able to work properly with the complex HIS, which increases efficiency and quality of care. Training and education should be tailored to the users role and specific tasks, continues also after the implementation of the HIS. The training should be designed to improve the perception of the HIS compatibility with the users work practices and emphasize the benefits of the system.
- **Assign key-users to support the end-users:** enthusiastic key-users about the implementation of HIS have a positive influence on the enthusiasm and attitude of end-users towards the implementation. End-users valued the support of key-users. These key-users act as initiators for users system acceptance.
- **Involve users in the implementation and increase their psychological ownership (also after the implementation):** to achieve a high quality system and user friendly user-interfaces. Participation of users in the implementation process will improve their involvement. To increase their psychological ownership:
    - Communicate with users on the right time, and give them specific tailor made information.
    - Adequate, quick and clear feedback from IT support on users problems and requests
    - Inform and involve users more about the project organisation
    - Stimulate and reward involvement of users in the implementation.

  The phase after the going live of the HIS may seem less intensive in comparison with the pre-implementation phase planning. However, the post-implementation phase is equally important for the success of an HIS implementation. For users to be satisfied and accept the system after the implementation, the changes and improvements to the system needs to satisfy the users' needs. The participation, involvement, training and support of users after the implementation is vital for ensuring better user satisfaction with the system.
  Paré et al. (2006) found that champion users reported higher feeling of ownership towards the new system. Also they perceived the system to be more useful, easier to use and had a more positive attitude. Champion users generally more involved in the implementation process compared to other users, which causes a higher feeling of ownership with these champion users.
- **Pay great attention to a the usability and compatibility with users' work practise of the system**

7.7 Research contribution

This evaluation study of the implementation of the new HIS found that users were overall satisfied with the implementation. These findings show that the involvement and participation of users in the implementation process, user training and IT support quality play in important role in the quality and the acceptance of the HIS.

This study is one of the few studies that uses that a longitudinal and mixed research approach for evaluating an implementation of a HIS. This give a more comprehensive understanding of the barriers and facilitators during an implementation. Through this study a better understanding is achieved of the role of the implementation factors on system quality, information quality and IT service quality, and their role on user satisfaction and net benefit.

7.8 Limitations and future research

The mixed method approach of this study managed to provide a deeper insight in to bottlenecks and issues related to a HIS implementation in a large academic hospital. A possible limitation was the selection bias of clinical and administrative staff as participants in this evaluation study. Findings from this one-site evaluation study may be not generalizable to other hospitals implementing a HIS. However, a large sample size was used with users from many different departments of the academic hospital.

Another limitations is that the results from this study may be influenced by selection bias. It was unclear what the reasons were for participation who choose to drop out completely or not to complete all three surveys. It could have been that the satisfaction of users towards the system played a role in the decision to drop out. Furthermore, a full longitudinal analysis could only be performed for key-users.

Many different user groups used and from different divisions. The implementation communication and planning slightly differ for the different division in the academic hospital. Look for differences between divisions.

Despite the limitations, the longitudinal mixed method approach was found to be well suited to evaluate the implementation of a HIS at a large academic hospital in depth and over time adding strength to the findings. However, further research should focus on the impact of the benefits of the new HIS, the effect on the clinical behavior and patient outcomes. This HIS evaluation study was based on the overall users' satisfaction and available theory, because of the large diversity of the users. For further evaluation of the HIS it is important to evaluate the problem areas more specific. Also a more Task-oriented approach should be applied to find the success and outcome of the system on a specific level. A study by Weir et al. (2000) found that an overall satisfaction construct did not correlated with the adoption of a health IT system. Instead they found that the effectiveness of specific tasks better predicted the likelihood of system success and less resistance from users to adopt the system.

Finally, this study validated the proposed model by a multiple regression analysis method. For a more comprehensive validation more extensive analysis methods like Structural Equation Modeling (SEM) could be used. A model could also include other factors concerning implementation such as user characteristics or more from a management view such as management support, project management of financial costs. Different constructed models and theories could be adapted and extend each other to come to a clear understanding of health IT implementation.

7.9 Conclusion

The objective of this study was to determine which factors influenced system success during implementation from a user's perspective. A conceptual model based on the research of Waal & Batenburg (2009) was developed. This model was validated by several multiple regression analysis and focus groups were performed to get more detail about the users experiences of the system and the implementation process.

From this evaluation study several conclusions can be drawn. A successful implementation suggest to influence the likelihood of system acceptance by users and system success. From these results we can conclude the importance of a high service quality and participation during implementation for the success of a system, however the quantitative results showed no direct relationship. The results suggest that the service quality during the implementation increases the satisfaction, acceptance of the system by users and their feeling of involvement, which will increase the likelihood of system success. The feeling of involvement by users (psychological ownership) was a key concept in increasing the likelihood of system success. Not only was it found to be a driver for user satisfaction and intention to use it also increased the perceived outcome of the system (net benefit). Letting users extensively participate in the implementation was found to increase this feeling of involvement or ownership. The proposed evaluation model seems like a good predictor of HIS implementation success.

Another conclusion form this study is an implementation of a health information system should not only be evaluated on their success factors, but just as important, also the barriers of a successful implementation. These evaluations should include qualitative research methods and have a longitudinal design to get a detailed view of bottlenecks for short term interventions in the implementation process and the best practices for future IT implementations.

In final conclusion, the results from this study emphasize the importance of the social-technical approach of implementing an organizational wide HIS. Adequate change management and a user centric design of the system where users are involved in the implementation process can increase the likelihood of the system success. Lessons that were identified (and important factors) in this evaluation study have the potential to be used as a guide for managers and decision makers who are engaged in the implementation of health information technology.

Despite the strengths of this evaluation study, it is difficult to define a general list of success and or failure factors for a HIS implementation, due to the unpredictability of complex HISs and the hospital as a health service organization. However, certain insights can be outlined for the successful HIS implementation evaluated in the current study (Berg, 2001). This study has contributed to the health IT research by proposing a valid model to evaluate a HIS from a users' perspective and providing best practices for managers implementing a HIS.

8

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A

Focus group statements

Key-users

1. De verwachtingen voor CS-EZIS onder de key-users waren hoog gespannen. Rond de 80% was het eens dat CS-EZIS sneller, efficiënter zou zijn en meer zou bijdragen aan kwaliteit van werk en patiëntveiligheid.
    - Waarom waren de verwachtingen volgens u zo hoog gespannen?
    - Waarom waren volgens u de verwachtingen voor de gebruiksvriendelijkheid van CS-EZIS het laagst?
2. Bijna 70% van de key-users gaf aan dat het management duidelijk had gecommuniceerd waarom over te stappen naar CS-EZIS en wat de impact zou zijn.
3. Meer dan de helft van de key-users (65%) geeft aan dat CS-EZIS meer bijdraagt aan de patiëntveiligheid dan Mirador.
    - Hoe is de patiëntveiligheid door invoering van CS-EZIS verbeterd?
    - Wat kan in CS-EZIS nog verbeterd worden voor betere patiëntveiligheid?
    - Welke veranderingen ziet u in de relatie van professional en patiënt door invoering CS-EZIS?
4. 50% van de key-users vond dat Mirador aansloot bij de werkzaamheden, tegenover 70% bij CS-EZIS.
    - Hoe is uw manier van werken veranderd door CS-EZIS?
    - Wat is volgens u de reden dat CS-EZIS minder aansluit bij de werkzaamheden?
5. 70% van de key-users gaven aan dat CS-EZIS een positief effect heeft op de kwaliteit en bijna 60% op de controle van de werkzaamheden? Opmerkelijk is dat deze scores bijna gelijk waren voor Mirador.
    - Waarom denk u dat Mirador en CS-EZIS bijna gelijk scoren op het effect voor kwaliteit en controle op de werkzaamheden.
    - Hoe heeft CS-EZIS een positief effect op de kwaliteit en controle van de werkzaamheden?
6. 80% van de key-users vond dat ze voldoende op de hoogte werden gehouden van de vorderingen, en meer dan 70% vond dat ze voldoende bij de invoering werden betrokken. Hoewel maar 45% van de key-users een gevoel van eigenaarschap heeft naar CS-EZIS toe.

7. Een half jaar na invoering vond 60% van de key-users dat er geprobeerd was de wensen en eisen van hun (en van collega's) te verwerken in CS-EZIS.
8. Over het algemeen waren key-users tevreden over de invoering van CS-EZIS. Toch gaf ruim 50% aan dat een week na invoering nog niet alles verliep als normaal.
9. De key-users gaven aan tevreden te zijn over de IT ondersteuning bij CS-EZIS. Vond u dit ook?
10. Bijna 80% van de key-users gaven aan na de invoering van CS-EZIS vaak dezelfde vragen te krijgen.
11. Bijna 60% van de gebruikers vond een jaar na de invoering de werkinstructies voor CS-EZIS moeilijk te vinden, en 45% vind deze niet duidelijk.

End-users

1. De verwachtingen voor CS-EZIS onder de gebruikers waren hoog gespannen. Rond de 80% was het eens dat CS-EZIS sneller, efficiënter zou zijn en meer zou bijdragen aan kwaliteit van werk.
    - Waarom waren de verwachtingen volgens u zo hoog gespannen?
    - Waarom waren volgens u de verwachtingen voor de gebruiksvriendelijkheid het laagst?
2. Het merendeel van de gebruikers vond dat ze voldoende geïnformeerd werden over invoering van CS-EZIS en over de updates.
    - Wat waren de knelpunten in de communicatie?
    - Hoe zou dit verbeterd kunnen worden?
3. Meer dan de helft van de gebruikers vond een jaar na invoering dat CS-EZIS bijdraagt aan de patiënt veiligheid.
    - Hoe is de patiëntveiligheid door invoering van CS-EZIS verbeterd?
    - Wat kan in CS-EZIS nog verbeterd worden voor betere patiëntveiligheid?
    - Welke veranderingen ziet u in de relatie van professional en patiënt door invoering CS-EZIS?
4. Een half jaar na invoering van CS-EZIS vond de helft van de gebruikers dat CS-EZIS een positief effect heeft op de kwaliteit en controle van de werkzaamheden.
    - Hoe zijn uw werkzaamheden door CS-EZIS veranderd?
    - Hoe kan CS-EZIS volgens u nog meer de kwaliteit en controle op uw werkzaamheden verbeteren?
5. Voor invoering van CS-EZIS gaf de helft van de gebruikers aan naast Mirador een papieren dossier te gebruiken. Met invoering van CS-EZIS is dit aanzienlijk verminderd.
    - Hoe vaak wordt nog een papieren dossier gebruikt en waarvoor?
6. Driekwart van de gebruikers gaf aan dat CS-EZIS gemakkelijk te gebruiken was. Meer dan de helft van de gebruikers vond CS-EZIS wel moeilijker dan Mirador.
    - Op welke punten is CS-EZIS moeilijker in gebruik vergeleken met Mirador?
    - Wat maakt CS-EZIS makkelijker in gebruik?

- Wat kan er volgens u verbeterd worden aan de gebruiksvriendelijkheid van CS-EZIS

7. Iets meer dan de helft van de gebruikers vond dat men voldoende betrokken werd bij de invoering en updates van CS-EZIS.
    - Hoe had volgens u (het gevoel van) betrokkenheid van gebruikers vergroot kunnen worden?
8. Over het algemeen vonden gebruikers dat de invoering van CS-EZIS soepel verliep. Toch gaf de helft aan dat een week na invoering nog niet alles verliep als normaal en patiënten last hadden van de invoering.
    - Wat waren de knelpunten voor uw werkzaamheden die u (en uw collega's) tegenkwam na de invoering?
    - Waardoor hadden patiënten last van de invoering?
    - Heeft u ideeën hoe deze knelpunten hadden kunnen worden voorkomen?
9. Het merendeel van de gebruikers gaf aan tevreden te zijn over de IT ondersteuning bij CS-EZIS.
    - Wat waren de knelpunten met de IT ondersteuning?
    - Hoe had dit verbeterd kunnen worden?
10. Meer dan de helft van de gebruikers gaf aan tevreden te zijn over de kwaliteit van de CS-EZIS trainingen. Over de CS-EZIS instructies was men minder tevreden.
    - Wat waren de knelpunten in de trainingen en de instructies voor CS-EZIS?
    - Hoe had dit verbeterd kunnen worden?

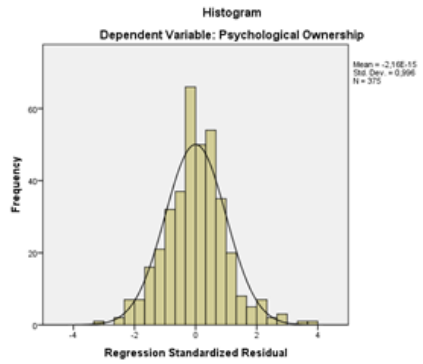
B
Questionnaire

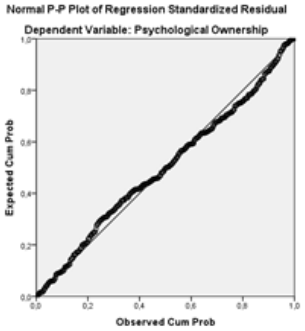
Perceivce Net Benefit	Door het gebruik van Mirador/CS-EZIS verbetert de kwaliteit van het werk dat ik doe.
	Door het gebruik van Mirador/CS-EZIS heb ik meer controle over mijn werk.
	Ik vind dat CS-EZIS bijdraagt aan patiëntveiligheid
Intentional Use	Als het CS-EZIS systeem niet verplicht was, zou ik het toch gebruiken
User Satisfaction	Het gebruik van CS-EZIS sluit aan bij alle aspecten van mijn werk
	Het gebruik van CS-EZIS sluit aan bij de manier waarop ik wil werken
	CS-EZIS vind ik ondersteunend bij mijn werkzaamheden
	Het werken met CSEZIS komt logisch op mij over
System Quality	Mirador/CS-EZIS logisch in het gebruik
	Het gebruik van Mirador/CS-EZIS vergt teveel handelingen
	CS-EZIS is makkelijk te gebruiken
	CS-EZIS vind ik logisch opgebouwd
	Het verbeteren van onjuist ingevoerde gegevens in CS-EZIS is gemakkelijk
	De indeling van informatie op het scherm is [Onlogisch/Logisch]
	Hulpberichten op het scherm in CS-EZIS zijn [Niet behulpzaam/Behulpzaam]
	~~Snelheid van CS-EZIS is [Langzaam/Snel]~~
	Er zitten nog veel fouten in CS-EZIS
	CS-EZIS is gemakkelijk te leren
	Mirador/CS-EZIS is betrouwbaar
	~~Mirador/CS-EZIS is compleet~~
	Mirador/CS-EZIS is duidelijk
IT Service Quality	Als ik een probleem heb met CS-EZIS, weet ik met wie ik contact op moet nemen
	De snelheid waarmee een hulpverzoek door de IT wordt afgehandeld is goed
	De kwaliteit van de reactie op een hulpverzoek is goed
Information Quality	De informatie die door CS-EZIS wordt geleverd is relevant
	De informatie die door CS-EZIS wordt geleverd is volledig
	De informatie die door CS-EZIS wordt geleverd is betrouwbaar
Psychological Ownership of IT	Ik zie mezelf als een professional in het gebruik van CS-EZIS
	Ik heb CS-EZIS zo ingesteld dat het handig is bij mijn werkzaamheden
	Ik heb persoonlijk veel tijd geïnvesteerd in het helpen invoeren en verbeteren van CS-EZIS
	Ik heb een gevoel van eigenaarschap naar de invoering en verbetering van CS-EZIS toe
	Als ik erover nadenk, zie ik een deel van mijn ideeën/eisen terug in CS-EZIS
IT Service Quality	Als ik een probleem heb met CS-EZIS, weet ik met wie ik contact op moet nemen
	De snelheid waarmee een hulpverzoek door de IT wordt afgehandeld is goed
	De kwaliteit van de reactie op een hulpverzoek is goed

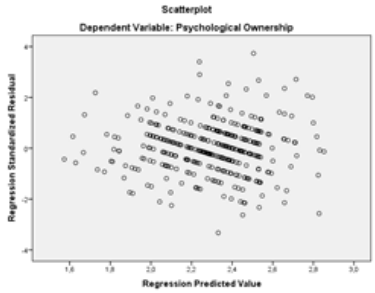
Participation	Ik ben vooraf voldoende geinformeerd over CS-EZIS
	Ik wist wat de invoering van CS-EZIS voor mijn werk voor gevolgen zou hebben
	Bij de ontwikkeling van CS-EZIS werd ik steeds op de hoogte gehouden van de vorderingen
	Ik werd voldoende betrokken bij de invoering van CS-EZIS
	Ik werd steeds op de hoogte gehouden van nieuwe wijzigingen aan CS-EZIS
	Ik werd voldoende betrokken bij de wijzigingen aan CS-EZIS
	Er is geprobeerd de wensen van mij en mijn collega's te verwerken in de wijzigingen aan CS-EZIS
Training	De kwaliteit van de training die ik ter voorbereiding op CS-EZIS heb gekregen was goed
	De instructies voor het werken met CS-EZIS zijn gemakkelijk te vinden
	De instructies voor het werken met CS-EZIS zijn duidelijk

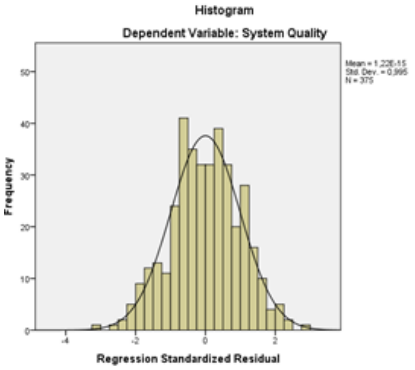
C

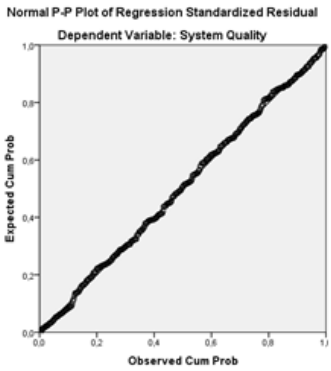
Regression Diagnosis Check

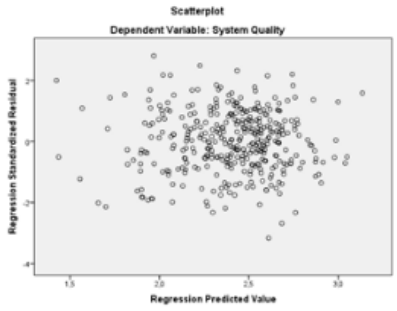


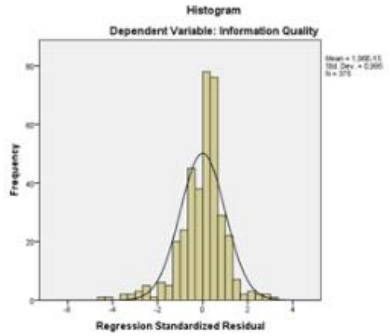


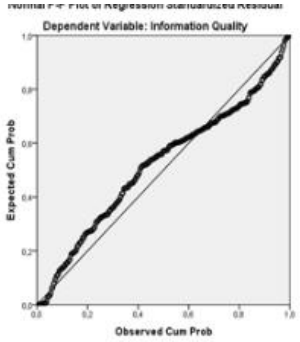









Histogram
Dependent Variable: Information Quality
Frequency
Regression Standardized Residual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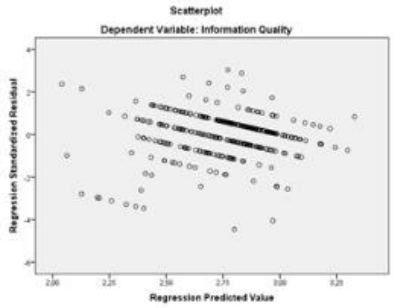
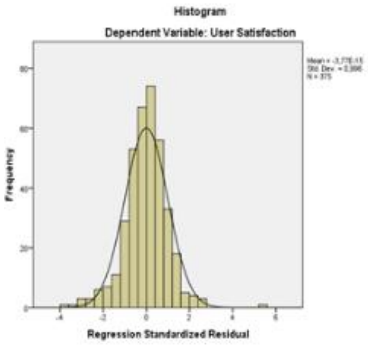
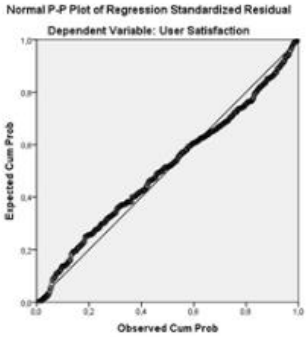
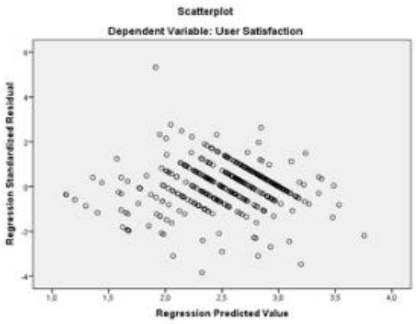
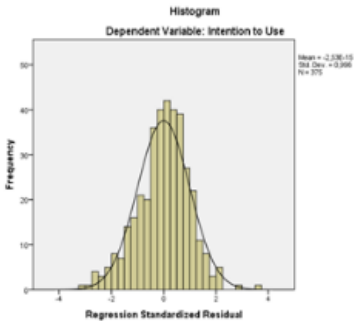
Expected Cum Prob
Observed Cum Prob

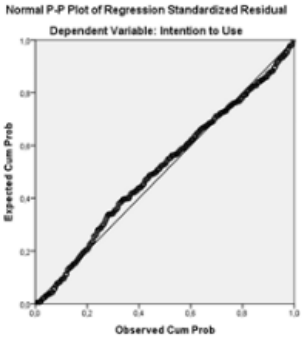

Scatterplot
Dependent Variable: Information Quality
Regression Standardized Residual
Regression Predicted Value

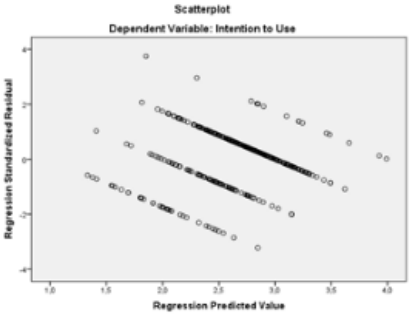

Histogram
Dependent Variable: User Satisfaction
Frequency
Regression Standardized Residual

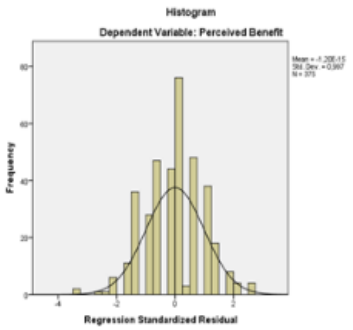

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: User Satisfaction
Expected Cum Prob
Observed Cum Prob

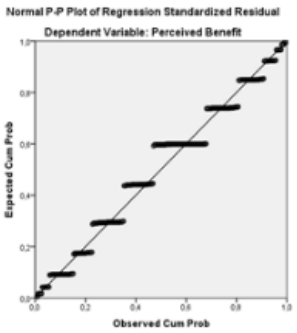

Scatterplot
Dependent Variable: User Satisfaction
Regression Standardized Residual
Regression Predicted Value

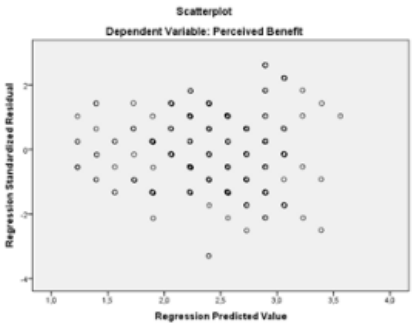

Histogram
Dependent Variable: Intention to Use
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Intention to Use
Expected Cum Prob
Observed Cum Prob


Scatterplot
Dependent Variable: Intention to Use
Regression Standardized Residual
Regression Predicted Value


Histogram
Dependent Variable: Perceived Benefit
Frequency
Regression Standardized Residual


Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Perceived Benefit
Expected Cum Prob
Observed Cum Prob


Scatterplot
Dependent Variable: Perceived Benefit
Regression Standardized Residual
Regression Predicted Value