ELECTRONIC PATIENT RECORD:
WHAT MAKES CARE PROVIDERS USE IT?
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ELECTRONIC PATIENT RECORD: WHAT MAKES CARE PROVIDERS USE IT?

PROEFSCHRIFT

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te Arnhem
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PREFAE

My master thesis in 2003 was titled “What makes the doctor use the Electronic Patient Record?”, and that question is still one of the questions in the research that I present in this thesis. However, it is not the only one and the focus shifts from doctors to nurses and paramedical staff as well, and from Electronic Patient Records to information systems supporting care providers in their professional tasks. So the question should be rephrased to: What makes care providers use an information system, when providing care? The (summarized) answer I found in my master thesis was: When the system supports them in their tasks. And that answer does not need to be rephrased for this thesis, since it is still the kernel of the successful adoption of information systems by healthcare professionals. Of course there is more to say to that, then just the one answer. In this thesis I will present the motivation, the theoretical background, and results of my research, what I learned from it, and what others can learn from it. In order to increase the knowledge about successful adoption of information systems by healthcare professionals, and stimulate other researchers to continue to investigate the factors influencing adoption of innovations in healthcare, I will not only present the results of my research, but I will also present and discuss the methodology and tools that helped me gaining insight in the topic. But let me start at the beginning.

When I was a medical student in about 1982, it was one of my tasks to collect the patient record from the archives, in case of an unplanned admission of a patient that had previously visited the hospital. Collecting the patient record during the night meant: walking from the emergency room to the entrance hall, asking the porter for the key of the archive, walking downstairs to the basement, searching for the light switch, unlocking the door of the archive (shivering), walking along the rows of paper records searching for the correct date of birth and name. When I had found the right record, I had to select the record of the specialty and follow the previous procedure in reverse order. When I was lucky, it took me about 15 minutes to get the patient record, but often I returned without the right record, because the record was not there. More often than not, the only information the medical specialist had, was the information the patient could give and some medication boxes the patient had brought. But even when the admission was planned, the information was often incomplete and not the information the medical specialist desired. During the admission nurses kept their own patient record, which meant that they copied a lot of information from the medical record and it also meant writing many reports, and time-consuming team-meetings at the change of every shift to brief the colleagues of the next shift.

Even in that time the need to work more efficiently and the desire to professionalize evolved. Medical informatics developed and the first personal computers became
available (Bemmel & Musen, 1997). Many doctors, managers, and computer scientist expected computers to solve the information and record problem within 10 – 20 years, and when I started studying Business Information Technology in 2000, expectations were even higher, because of the potential of the internet. At that time the general opinion was that doctors resisted using computers and nurses did not dare using new technologies. This challenged me to investigate what factors influence the decision to make use of computers or not.

You can read the results of my investigation in this PhD thesis. Finishing this thesis does not mean the finishing my research on this topic. However, the thesis is a milestone for me, and a moment to look back at the past period. Doing a PhD is much more than just doing research and writing about it. It is a discovery tour in research, healthcare, information systems, but most of all in my own skills as a researcher. My travel companion in this journey was Ton Spil. Thank you, Ton, for your support, the discussions and most of all your faith that I would complete the trip. Robert Stegwee, your inspiration and endless experience in healthcare IS, helped me to keep on track and focused, thank you very much! Charles Willems, thank you for guarding the practical and educational relevance of my research. I also like to thank my colleagues of the University of Twente (IEBIS) and of Saxion (TiZW) for your interest, feedback and debate.

Most of all I like to thank my family: Wim, who shares my life for almost forty years now, thank you for your love and devotion, and Margot and Maarten, thank you for your support.

My research was not a linear process, like the care process, and like making quilts. Sometimes I followed the design, sometimes my strategy was: "Quilt as you go". However, the resulting dissertation is like a quilt, made of many patches, but united to a unique piece of work with some beauty, some usefulness, and some inspiration. Hopefully you experience these too when reading my dissertation.

Hengelo, December 2012

Margreet Michel-Verkerke

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CHAPTER 1  INTRODUCTION AND OVERVIEW

1.1.  INTRODUCTION

The care process is a very information-intensive process, where having the right information at the right moment and the right place is crucial for providing good care. The use of EPR's could support and facilitate these developments. However, the rate of adoption of information- and communication technology (ICT) in healthcare does not keep in pace with other developments in healthcare. Implementations of EPR's were not always successful (Walley and Davies, 2001), in contrast with implementation of medical technology like computer tomography (CT-scan) and magnetic resonance imaging (MRI). I wondered why. Why were EPR's not adopted faster and by far more care providers? What aspects influence adoption? That is why I started this research wondering: “What makes a healthcare professional use an information system, when providing care?” In this thesis I will present the motivation, the theoretical background, and results of my research, what I learned from it, and what others can learn from it. I will also present and discuss the USE IT-model, which is the methodology I applied and further developed in this research.

1.1.1 ELECTRONIC PATIENT RECORDS

About twenty years ago, Dutch general practitioners (GP's) started using personal computers for their patient administration and it took another decade for them to replace the green patient card by an electronic patient record (EPR). Although the paper patient record did have some strengths (Tange, 1997), EPR's offered a solution to overcome the weaknesses of paper patient records (see table 1.1) (Dick et al., 1997).

<table>
<thead>
<tr>
<th>Strengths of paper records</th>
<th>Weaknesses of paper records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Familiar to users: no new skills or behaviors needed to use it</td>
<td>Content: data is missing, illegible, inaccurate, excessive or redundant.</td>
</tr>
<tr>
<td>Portable to point of care.</td>
<td>Format: poor organization of data</td>
</tr>
<tr>
<td>Once in hand, no downtime occurs.</td>
<td>Availability: records are not in the place where needed, retrieving information is time-consuming</td>
</tr>
<tr>
<td>Flexibility in recording, also for subjective data.</td>
<td>No linkage or integration with other records</td>
</tr>
<tr>
<td>Can be browsed through, to scan for patterns or trends.</td>
<td>Above listed problems are worse for outpatient records.</td>
</tr>
</tbody>
</table>

Table 1.1. Strengths and weaknesses of paper patient records. Based on (Dick et al., 1997).

The advantages of using a computer for recording and reporting were legibility, ease of ordering, copying, storing and retrieval of information (Drazen et al., 1995). When computers became connected through networks and later the internet, an important
new functionality appeared: being able to exchange and share information with other care providers, even if they were in another location (Safran et al., 1999).

In the same period of time, the ideas about how to provide care altered: patients became more self-confident and wanted to be heard, care standards emerged, and collaborative care developed. The Chronic Care Model is an example of these developments (Wagner, 1998). Also control of healthcare costs became necessary. As soon as computers developed with increasing capacities and decreasing sizes, the potential for medical use was recognized. In 1997 the Dutch minister of Health initiated the national EPR-project (Masman et al., 2012).

Despite the enormous progress that is made, many healthcare professionals still experience problems, regarding patient information and patient records. The Dutch Health Inspection published a report describing the problems with information exchange in healthcare (IGZ, 2011). Although electronic message services are being developed, the possibilities to exchange information are still limited. E.g. when a patient is admitted to a nursing home the patient record has to be printed from the GP’s EPR, and selected data have to be entered manually in the EPR of the nursing home. Even if adequate systems are available they are not automatically adopted (Meijden et al., 2001). And labeling doctors resisting change or too stubborn to use computers is not only too simple, it is also not correct. The Dutch GP’s demonstrate this. They all use EPR’s for a long time now. So why are promising systems not used? Why are healthcare providers not satisfied with the system they use, despite their positive attitude, or why is the desired EPR not developed? When I write electronic patient record, I refer to the general concept of a computer patient record as defined by Gartner:

“A system that contains electronically maintained information about an individual’s health status and care. It focuses on tasks directly related to patient care, unlike other healthcare information systems that support providers’ and payers’ operational processes (which may, however, serve as source or feeder systems for the CPR). The CPR completely replaces the paper medical chart and thus must meet all clinical, legal and administrative requirements” (Gartner, 2012).

1.1.2 ADOPTION OF INFORMATION SYSTEMS

More challenging than investigating why EPR's are not adopted, is to find out why some systems are successful. Rogers defines adoption as: “the decision to make full use of an innovation as the best course of action available” (Rogers, 1995) p.21. In studying the success or failure of implementation of information systems I focused on the care professional as a (future) end-user of an electronic patient record (EPR). Rogers distinguishes five stage in the decision process to adopt an innovation: (1) Knowledge of the innovation, (2) Persuasion that the innovation is positive or not, (3) Decision to adopt or reject the innovation, (4) Implementation of the decision,
and (5) Confirmation, which means continuing or reconsidering adoption or rejection. Persuasion is influenced by perceived (a) relative advantage, (b) compatibility with values, experiences and needs of the individual, (c) complexity of the innovation, (d) trialability, and (e) observability of the results of the innovation (Rogers, 1995). Relative advantage, compatibility and observability match with the concept of perceived usefulness in the Technology Acceptance Model (TAM) of Venkatesh and Davis (Davis, 1989, Venkatesh and Davis, 2000, Venkatesh et al., 2003, Venkatesh and Bala, 2008). Complexity – mentioned by Rogers – is the opposite of Ease of use in the TAM. Perceived usefulness and Ease of use determine the Intention to use the innovation. The concept of Intention to use matches the Decision-stage in the innovation-decision process of Rogers. Also DeLone and McLean use the concept of Intention to use (DeLone and McLean, 2002). In their updated Information Systems Success Model (ISSM), DeLone and McLean categorize success factors into three categories: Information quality, System quality, and Service quality. These three categories influence both User satisfaction and Intention to use. The Use of an information system and User satisfaction are both enforced by the perceived Net benefits (DeLone and McLean, 2002). The kernel of the three models presented, is that an end-user will use an innovation or information system when he expects to experience some kind of advantage or benefit from it, and he will continue to use, when he actually experiences the benefits, and does not experience major obstacles. Continued use is defined as adoption. Based on TAM, ISSM, Rogers and other sources, Ton A.M. Spil, Roel W. Schuring and me, developed the USE IT-model in order to predict, explain and investigate the adoption of information systems in healthcare (Spil et al., 2006).

### 1.1.3 The USE IT-Model

The first version of the USE IT-model is created as a result of the evaluation of the introduction of an electronic prescription system for GP’s (Schuring and Spil, 2002). The USE IT-model integrates concepts of adoption (Rogers, 1995) and information systems success literature (DeLone and McLean, 2002, Davis, 1989, Venkatesh and Bala, 2008) in order to create a comprehensive and specific model to predict and evaluate the success of information systems. In the years that followed the USE IT-model is further developed until its publication in (Spil and Schuring, 2006b), which is the version I will present in this section. The USE IT-model presents two dimensions: the innovation-dimension and the domain-dimension. The innovation dimension has two constructs: the product, which refers to the innovation itself, e.g. the EPR, and the process, which refers to the process of development or implementation. Both product and process determine the success of the innovation (Saarinen and Sääksjärvi, 1992). Innovation is defined as: making a change in something established, especially by introducing new methods, ideas, or products (Oxford Dictionaries). The domain dimension refers to the social aspects in the user.
domain and the technical aspects in the IT domain. The two dimensions make four determinants for success: relevance, requirements, resistance and resources. The four determinants each are defined on two levels: the macro-level and the micro-level. The macro-level represents a more general perspective e.g., the organizational level. The micro-level refers to the individual user. For the resources determinant the macro-level concerns the material resources and the micro-level the immaterial resources. The USE IT-model dimensions and determinants are depicted in Fig. 1.1.

1.1.3.1. Relevance

Relevance is not to be confused with the degree to which the user considers outcomes as being positive. The set of outcome-dimensions that someone considers “positive” is larger than the set of outcome-dimensions that are relevant. Imagine a nurse, who basically considers the introduction of a computer decision support system, to support nurses in calculating and planning of infusions, as “positive”. This does not automatically imply that the IT-adoption is micro-relevant to her; it is only relevant if she is actually involved in preparing infusions for patients. Macro-relevance comprises economic, social, and functional improvements, as well as saving time and effort. An innovation is micro-relevant when it solves the here-and-now problems of the individual user in his working process (Spil et al., 2006). Relevance being defined in this way comprises perceived usefulness (Davis, 1989), relative advantage, high compatibility (Rogers, 1995), net benefits (DeLone and McLean, 2002), and job relevance (Chismar and Wiley-Patton, 2003), and results in task support satisfaction, which is a criterion for user satisfaction (Garrity and Sanders, 1998). In their study on the implementation of an Electronic Prescription System, Schuring and Spil found that lack of relevance was the major determinant that explained the failure of the implementation (Schuring and Spil, 2002).

1.1.3.2. Requirements

Macro-requirements comprise strategic general requirements and the chosen approach of the innovation process. At the micro-level, functional and performance requirements specify what the content of the innovation should be (Spil et al., 2006). E.g. the possibility to copy data from the patient history of a previous admission is a micro-requirement of a nurse. Usability is an element of the requirements determinant, as it resembles the question of how well users can use that functionality (Nielsen, 1993). Meeting the end-user’s functional requirements contributes to high interface satisfaction (Garrity and Sanders, 1998), and perceived ease of use, which is a prerequisite according to Davis (1989). Meeting the end-user’s performance requirements contributes to high information quality, and results in high system quality (DeLone and McLean, 2002).
<table>
<thead>
<tr>
<th>User Domain</th>
<th>Information Technology Domain</th>
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<tbody>
<tr>
<td><strong>Relevance</strong></td>
<td><strong>Requirements</strong></td>
</tr>
<tr>
<td>Macro-relevance</td>
<td>Definition: the degree to which the user needs are satisfied with the product quality of the innovation.</td>
</tr>
<tr>
<td>Definition: The degree to which the user expects that the IT-system will solve his problems or help to realize his actually relevant goals.</td>
<td>(co)determines: IT-diffusion</td>
</tr>
<tr>
<td>(co)determines: IT-diffusion</td>
<td>Macro-requirements</td>
</tr>
<tr>
<td>1. Economic improvements</td>
<td>Strategic general requirements and tactical approach is the degree in which the users agree with the objectives and methods used.</td>
</tr>
<tr>
<td>2. Social improvements</td>
<td>+ clear objectives, iterative approach, users involved</td>
</tr>
<tr>
<td>3. Functional improvements</td>
<td>- unclear communication, no participation, education</td>
</tr>
<tr>
<td>4. Saving of time and effort</td>
<td>Micro-requirements</td>
</tr>
<tr>
<td>Micro-relevance:</td>
<td>Functional and performance requirements specify what the content of the innovation should be.</td>
</tr>
<tr>
<td>Definition: The degree to which IT-use helps to solve the here-and-now problem of the user in his working process</td>
<td>+ timeliness, accurateness, ability to integrate, content fuzziness, non contract</td>
</tr>
<tr>
<td>1. Absolute value of relevance</td>
<td></td>
</tr>
<tr>
<td>2. Here and now value</td>
<td></td>
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<tr>
<td>3. Low initial costs</td>
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<td>4. Immediacy of reward</td>
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<td><strong>Resistance</strong></td>
<td><strong>Resources</strong></td>
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<td><strong>Macro-resistance</strong>&lt;br&gt;Definition: The degree to which the surroundings and locality negatively influence the users of IT&lt;br&gt;(co)determines: IT-diffusion&lt;br&gt;Generic sub-dimensions:&lt;br&gt;&lt;i&gt;Opportunity to change&lt;/i&gt; is the degree in which the users are forced to or allowed to change&lt;br&gt;+ budget available, clear objectives, top management support, social improvement&lt;br&gt;- decrease of autonomy, local effort for general gain, remaining old structures&lt;br&gt;&lt;i&gt;Ability to change&lt;/i&gt; is the change potential of the workers and the management&lt;br&gt;+ training, education, experience and enough resources&lt;br&gt;- constraints beyond the scope of the user that prevent him from using the IT&lt;br&gt;<strong>Micro-resistance</strong>&lt;br&gt;Definition: The degree to which IT-users themselves are opposing or postponing the IT-change&lt;br&gt;1. Parochial self-interest&lt;br&gt;2. Misunderstanding or lack of trust&lt;br&gt;3. Different assessments&lt;br&gt;4. Low tolerance of change</td>
<td><strong>Definition</strong>: The degree to which material and immaterial goods are available to design, operate and maintain the system.&lt;br&gt;(co)determines: IT-use&lt;br&gt;&lt;b&gt;Material&lt;/b&gt;&lt;br&gt;Generic sub-dimensions:&lt;br&gt;1. costs&lt;br&gt;2. hardware and software&lt;br&gt;3. user’s and designer’s time&lt;br&gt;&lt;b&gt;Immaterial&lt;/b&gt;&lt;br&gt;4. adaptability&lt;br&gt;5. capabilities&lt;br&gt;6. reliability</td>
</tr>
</tbody>
</table>

Fig. 1.1. The USE IT-model (Spil et al., 2006)

**1.1.3.3. Resources**

The main focus of the determinant resources is on the people and on the costs these people cause. Next to that the reliability (no unexpected downtime or errors) of the information technology and the information systems are considered. An example of an immaterial resource is the computer literacy of the end-user. Material resources refer to hardware, software and financial resources. Resources being defined in this way, refer to service and system quality (DeLone and McLean, 2002).
1.1.3.4. Resistance

Resistance was found to be the cumulative effect of not only lack of relevance, but also unfulfilled requirements, and inadequate resources (Schuring and Spil, 2001). Also lack of information, costs and implications explain resistance against the implementation of Electronic Health Records (EHR) by doctors (Hackl et al., 2011). Expectancy of reduced quality of work life satisfaction, high complexity and the lack of trialability can result in resistance (Garrity and Sanders, 1998, Rogers, 1995). Observability reduces resistance (Rogers, 1995). High perceived usefulness and ease of use prevent resistance (Bleich and Slack, 2010). In a more positive way resistance can be formulated as attitude to change.

To investigate the USE IT-determinants the USE IT-interview model and the USE IT-questionnaire are developed (see Appendix I and II). These instruments are presented in the methodology section (1.3.).

1.1.4 RATIONALE OF THE STUDY

The theory about adoption of information systems is applied to healthcare to explain the (lack of) adoption. General theory is made more specific, and insight is gained about the factors that influence the adoption of EPR’s by healthcare professionals. Previous studies confirm the theories, but are not specific enough to identify the key factors in this context. Because of this the USE IT-model is developed. It is not only a theory but also provides methods like an interview model and a questionnaire.

1.1.5 OBJECTIVES OF THE STUDY

Each intervention to improve the information process in healthcare would be encouraged, since the quality of documentation, reporting, recording and information exchange is still an issue (IGZ, 2011, Voutilainen et al., 2004, Hansebø et al., 1999). Improving the information process refers to efficiency, effectiveness, quality (correct, complete, up-to-date), and availability. Implementing an EPR is an effective way to accomplish improvements (Ehrenberg and Ehnfors, 2001, Ammenwerth et al., 2011). However, seeing the potential is one thing, actually realizing the potential benefits is another. My research deals with the question what factors influence the bridging of this gap. I focus on electronic patient records (EPR’s) and on the adoption of EPR’s by healthcare professionals as an end-user. The second objective of the research is to further develop the USE IT-model and USE IT-methods, in order to discover whether the USE IT-model is a useful and usable tool to investigate the adoption of EPR’s in healthcare. This leads to the main research questions in this thesis:

1. What aspects determine the adoption of an Electronic Patient Record by healthcare professionals?
2. How should the USE IT-model be adjusted to predict or explain the adoption of Electronic Patient Records by healthcare professionals?

The four case studies (chapter 3 – 6) deal with the first research question. In chapter 7 and 8 focus on the second research question. In each study more detailed research questions are formulated.

1.2 METHODOLOGY

1.2.1 STUDY DESIGN

In this thesis I present four case studies (chapter 3, 4, 5 and 6), because “case studies are the preferred method when (a) “how” and “why” questions are being posed, (b) the investigator had little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context” (Yin, 2009) p. 2. See table 1.2 for an overview of the case studies.

The USE IT-model is the theoretical kernel of the methods used in all the presented research, except for chapter 2. The research design can vary in each case study, dependent on the objective, conditions and opportunities. Since the USE IT-model evolved during the research, the version presented in chapter 3 differs slightly from the USE IT-model presented in section 1.3 of this chapter. In the MS-case in chapter 3 a qualitative explorative design is chosen, applying USE IT-interviews (MS is multiple sclerosis, a progressive neurological disease). In the stroke case in chapter 4 a longitudinal qualitative design is applied to explain why the intended stroke integrated care information system is not realized. A longitudinal design is also chosen in the nursing home-case in chapter 5. In this case the qualitative USE IT-interviews are combined with a quantitative method: the USE IT-questionnaire. In the case of the evaluation of the nursing information system (NIS, i.e. an EPR for nurses) in a hospital (chapter 6), the combination of qualitative and quantitative methods is repeated. The results of the questionnaire in both cases is used to evaluate the construct validity of the USE IT-questionnaire. The results of all four cases are used to evaluate the USE IT-model in chapter 8. In this way a cycle of evaluation research and research method evaluation is created. The structure of most chapters follows the STARE-HI-structure which is recommended by the editors of several journals in the medical informatics field (Talmon et al., 2009).

One of the differences with other conventions about structuring research articles, is that the answers to study questions are not part of the results section, but included in the discussion section.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Context</th>
<th>Participants</th>
<th>Questionnaire response % (n)</th>
<th>Number of interviews</th>
</tr>
</thead>
</table>

24
Table 1.2. Overview of case studies

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Collaborative care for multiple sclerosis (MS)</th>
<th>Stroke Service</th>
<th>Nursing home, evaluation EPR</th>
<th>Hospital, evaluation NIS</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Nurses, medical staff, paramedical staff, patients</td>
<td>Nurses, medical staff, paramedical staff, project managers, vendor</td>
<td>Nurses, medical staff, paramedical staff</td>
<td>Nurses</td>
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<td>38% (129)</td>
<td>48% (93)</td>
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</table>

To measure the determinants the USE IT-interview model was applied. In this way an in-depth insight can be obtained in the nature and relevance of problems and solutions before implementation and this insight can be tested with the same tool during the evaluation of the implementation. The USE IT-interview method is applied in several researches (Michel-Verkerke et al., 2006) and proved to be a valuable tool with high validity, but bears the limitation of a qualitative method, regarding to reliability (Babbie, 1995). To overcome these limitations the USE IT-questionnaire is developed to measure the USE IT-determinants in a quantitative way and by that adding quantitative support for the qualitative findings. The USE IT-questionnaire is applied in the evaluation of an EPR in a nursing home (chapter 5) and with some modifications in the evaluation of a NIS in a hospital (chapter 6). The USE IT-questionnaire is mainly based on (Garrity and Sanders, 1998) and (Davis, 1989) and extended and adjusted in several studies. The main reason why a new questionnaire is developed, is that existing Information System Success – models do not provide a questionnaire (e.g. (Delone and McLean, 2003)), or the questionnaire is not specific or detailed enough (e.g. (Venkatesh and Davis, 2000), (Venkatesh and Bala, 2008)) to result in specific recommendations for improvement.

1.3 RESULTS

Before presenting the results of my case studies, I present an overview of the situation in the Netherlands in respect to Electronic Patient Records in chapter 2. In 2002 we presented our EPR-orientation-model for success of Electronic Patient Records (EPR's). The Electronic Patient Record is seen as a way to improve the information process, and make healthcare more efficient and effective. But this has been the case for more than two decades. In The Netherlands the last decade many initiatives lead to the implementation of EPR’s within care organizations, but also regional infrastructures for information- and network services are realized. The law to realize a national EPR is rejected by the Dutch Senate, however.
The EPR-orientation-model characterizes EPR's according to the orientation of its origine: administration, medical technology and care process. To be successful an EPR must cross the borders of its original orientation and intersect with all three orientations. The EPR-developments in the last decade in the Netherlands are described in relation to the orientations. This leads to the extension of the model with external relations and the enlargement of the intersection between the administration orientation and care process orientation. The four criteria for a successful EPR from the end-user viewpoint are updated to five criteria. In order to be successful an EPR must:

1. Be micro-relevant to the end-users;
2. Provide complete and integrated patient data;
3. Be available and accessible anywhere and anytime;
4. Contain active elements, like alerts, decision support and workflow management;
5. Register data necessary for quality and finance, without extra effort for the care providers.

1.3.1 Case Studies

In chapter 3 and 4 I present two case studies concerning pre-evaluations in a collaborative care setting. In both cases the desire for an EPR originates from the care process orientation. The main expected benefit is to be able to share patient information cross-organizational and cross-functional throughout the entire care process in order to realize continuity of care. From the case concerning care for patients suffering from multiple sclerosis (MS) in chapter 3 can be learnt that you have to organize the collaboration first, before you can develop and implement an information system. The major issues that emerged from this case study were: (a) MS-care is only micro-relevant for a few care providers, (b) informal communication dominated, and (c) only informal collaboration occurred. The lack of relevance of MS for care providers is illustrated by the incidence and prevalence of MS in the Netherlands, which was estimated at resp. 1800 and 14.400 MS-patients in 2007. In the same year 215 people died of MS (RIVM). This means that – on average – a GP encounters only one or two MS-patients in his practice and diagnoses a new MS-patient once every five years. Because of the low micro-relevance of MS-care, we advised a low-profile solution to improve the continuity of MS-care. We advised to formalize the collaboration by introducing a MS-protocol, a coordinator to manage the collaboration, and the development of a patient relation management (PRM) system. The latter contains elements of a workflow management, one of the active elements of the fourth criterion for creating a successful EPR. ICT can support the process of collaboration, but the development stages of the IS and the care process should be in balance. When the information system is far ahead of the care process, the advanced functions will not be used. This was also confirmed in the NIS-case,
which demonstrated that only those functions that were necessary or clearly supportive, were used (chapter 6). The information also needs to differ in relation to the stage of the development of the collaboration. In the MS-case the care providers wanted to know where the patient ‘was’ in the healthcare chain, and which care providers also were involved with the patient, in order to know what treatments the patient had received and in order to know who the care providers could contact for information.

In the stroke service (chapter 4) the collaboration was better organized, resulting in an increased number of thrombolyses, and in an improved patient flow after 10 years. The stroke care process appeared to be a linear process, with cross-organizational transfers of patients and information. Each care provider knew where the patient was in the care process and everyone knew whom to contact with. However, the information flow could still be improved. Care providers wanted to receive the necessary information ‘automatically’. The chronic phase of stroke care is not covered by the stroke service. Also a national care protocol for stroke, that covers the entire care process, is not available. This makes that stroke care does not meet the criteria for integrated care. Although the incidence and prevalence of stroke is much higher than of MS (resp. 45.000 and 226.000), the micro-relevance was still low for primary care. A dedicated stroke integrated care information system is therefore not relevant for most care providers. The first criterion for a successful EPR, presented in chapter 2, fails for stroke care. A general electronic transfer information system for exchange of patient data probably is relevant to the care providers in stroke care.

The nursing home case in chapter 5 demonstrated that micro-relevance is not the same for nurses, paramedical staff and medical staff. In the first phase of the research the doctors used the EPR, but were not satisfied with the system, except for the availability of information. The EPR was designed for nurses and did not support the doctors very well doing their tasks. Because of a merger most doctors left the organization after the first phase of the research. Four years later the new doctors appreciated the EPR for its possibilities, although the system still did not support them in all their medical tasks. These findings demonstrate that when the requirements of a specific user group are not met, the micro-relevance is low for them. The doctors in the first phase used the EPR, because they had no alternative, but did not really adopt the system. This confirms that use is not the same as adoption, and mandatory use is no guarantee for adoption. The nursing home-case also demonstrated that when the micro-relevance was high, and the information needs were met, which was the case for nurses and paramedical staff, the EPR was successfully adopted. In this case study the value of a combined qualitative and quantitative design was demonstrated, since the questionnaire quantified the dissatisfaction of the doctors, and the interviews revealed the reasons. The EPR in
the nursing home met the first three criteria we presented in chapter 2, of which availability and accessibility were appreciated most.

The hospital case in chapter 6 was an example of a successful implementation of a Nursing Information System. In this case it became clear that only those functions that were micro-relevant, were used. Information quality was more micro-relevant than relieving time-pressure. The attributes of information quality became clear: the nurses expect complete, correct, up-to-date and accessible patient information. The information quality of the NIS was satisfactory, but needed to be improved. A very important finding was that information quality depends on the users and is not a system attribute, since the system does not produce information, but only presents information entered by the end-users. This creates a controversy, because the information entered by a nurse is mainly used by a colleague, and the information retrieved is entered by a colleague. The effort of entering information is not directly rewarded. This aspect was not found in information quality literature. Also this case confirmed the first three criteria for a successful EPR with the emphasis on the requirement of complete and integrated data.

1.3.2 USE IT-MODEL

In all four cases the applied methodology was based on the USE IT-model, and in all four cases USE IT-interviews were conducted. In the two evaluation studies in chapter 5 and 6, the USE IT-questionnaire is also applied. In chapter 7 the results of both cases are combined and a factor analysis is performed to evaluate those sections of the USE IT-questionnaire measuring Support of providing care, Ease of use and Support of use, which were the questionnaire sections that were similar in both cases. The purpose of the factor analysis was to examine the construct validity, i.e. to identify what factors were actually measured and how these factors relate to the USE IT-determinants. The factor analysis resulted in six factors. The section ‘Support of providing care’ measured two factors measuring relevance: (a) task support, which is a part of micro-relevance and (b) collaboration, which is an element of macro-relevance. The section ‘Support of providing care’ also measured two factors of micro-requirements: (c) compatibility, (d) accessibility. The section ‘Ease of use’ measured another two factors of micro-requirements: (e) interface satisfaction and (f) learnability. The sections of the questionnaire measuring the adequacy of resources and technical support did not combine into factors. This study clarified the construct validity of the investigated sections of the USE IT-questionnaire and supports the further specification of the USE IT-determinants (Chapter 8).

1.4 DISCUSSION
1.4.1 What aspects determine the adoption of an Electronic Patient Record by healthcare professionals?

From the presented case studies can be learnt that the system must be micro-relevant to the end-user. Micro-relevance includes task support, quality of care, and patient satisfaction. The structure of an EPR should support the way of working, e.g. the care plan is central for nurses in a nursing home EPR, but for doctors the medical and medication history is crucial, and in an integrated care information system, the structure is based on the care protocol. On the other hand the structure of the EPR should not be too rigid, nor limiting the professional autonomy or obstruct individual treatment of patients.

To be micro-relevant to end-users, an information system has to fulfill requirements, which can be categorized as: information quality, accessibility (anywhere, anytime), compatibility, interface satisfaction, and interoperability. To achieve a high information quality the patient data need to be complete, correct, and up-to-date. In realizing this, two dilemma’s evolve: first, the quality of the retrieved data depends on the data entry of the end-users. Very often end-users do not retrieve the data they entered themselves, but data entered by colleagues. This means that a doctor or nurse is not rewarded directly for the effort of accurate data entry. In order to stimulate accurate patient data entry, the EPR should be designed in such a way that entering data is easy and easily incorporated in the working process, and the end-user experiences benefits directly. The second dilemma that arises is the large amount of data. How can a healthcare professional recognize patient data that are urgent and really matter, and which data can be browsed through later. How can a healthcare professional find the specific data needed in a specific situation? To solve this dilemma, it is necessary to design the interface of an EPR in such a way that personalization is possible and navigation is made easy.

The investigated EPR’s did not contain active elements. It is to be expected when the EPR works well and satisfies the information needs of the end-user, the desire for more task support in order to further improve the quality, effectiveness and efficiency will emerge. When end-users are satisfied with their second generation EPR, the wish to make the next step to a third generation EPR (Handler and Hieb, 2007) or a EPR at stage 4 of the US EMR adoption model (HiMSS, 2011) will arise. Active elements like decision support for medication (Electronic Prescription System) and workflow management (based on care standards or clinical pathways) are being implemented in many EPR’s in the Netherlands. In order to meet the micro-requirements, adequate resources need to be available. When they are and the end-user does not perceive negative consequences, resistance will be very low or absent.
1.4.2 How should the USE IT-model be adjusted to predict or explain the adoption of Electronic Patient Records by healthcare professionals?

The USE IT-model provided a good theoretical base for the case studies. All case studies together contributed to the evaluation of the USE IT-model, which leads to the more consistent and specified USE IT-adoption-model. The results of the four presented case studies are combined with another six case studies – not part of this thesis – in order to evaluate the USE IT-model in chapter 8. The definitions and dimensions of the determinants are revised based on the results of the studies, and hypotheses about the relations between the determinants are formulated. When we developed the USE IT-model we assumed the determinants to be related and we expected relevance to be the dominant factor. However, we did not know the nature of the relations between relevance, requirements, resistance and resources. After conducting the case studies presented in this thesis, the USE IT-model was evaluated and hypotheses were developed about the relations between the determinants. Research learned that relevance is the most influential determinant of the four. This is to be expected, since perceived usefulness which is an element of relevance, is also found to be the most significant factor in the adoption of IS or IT in healthcare (Chau and Hu, 2002a). Requirements is the second most important determinant. Relevance and requirements deal with the content of the innovation. Sufficient resources are a prerequisite for a successful implementation, resulting in adoption by the end-user. Resistance has a reason, and is the result of low scores on the other determinants. The relative importance of the determinants is depicted in the font size in figure 1.2.

From the research I hypothesize that the determinants in the USE IT-model are related as shown in figure 1.2. Since the research is predominantly performed in a qualitative way, the relations cannot be confirmed by statistical tests. Relevance is the most important determinant. The relevance determines the requirements for the system. The requirements determine what resources are needed. Adequate resources are a prerequisite to build a system that meets the requirements. And a system that meets the end-user’s requirements helps to realize the expected benefits and makes the system relevant to the end-user. Genuine resistance hardly exists. Resistance can be explained by lacking expected relevance or (fear of) inadequate resources. Solving both diminishes resistance. It is not clear whether meeting requirements has a direct influence on resistance (dotted arrow), or whether the effect is through relevance and resources.
The evaluation of the USE IT-model lead to the following adaptations (see chapter 8 for more details):

1. Macro- and micro-level are defined in a more consistent way as resp. organizational or group level and individual level. The distinction between macro- and micro-level are added to the resources determinant.
2. The approach for implementation is positioned as an element of the resistance determinant and moved from the requirements determinant, because the implementation approach is part of the innovation process and not of the innovation product.
3. In the relevance determinant the dimensions are formulated in terms of quality, effectiveness, efficiency and task support.
4. In the requirements determinant the product quality is specified at both levels.

The new version is renamed to the USE IT-adoption-model, because it intends to predict or explain adoption of information systems, which is more focused than information systems success.

1.4.3 STRENGTHS AND WEAKNESSES

The variety in cases makes generalization for healthcare possible, but the number of cases is still limited and more research is necessary. Until now, the application of the USE IT-model in researches is limited to the developers, which bears the risk of bias. However, the USE IT-adoption-model combines the social context of the user with the technical context of the information system, which is necessary to
understand adoption of technology. Performing pre-evaluations provides information about what helps to make information systems being adopted, and how rejection can be prevented. The longitudinal design of the case studies in chapter 4 and 6, made it possible to reflect on earlier results in the same case. The combination of qualitative and quantitative design in the case studies in chapter 5 and 6 gave a richer result than when only one method was applied. Qualitative results help to explain and interpret quantitative findings and quantitative results help to justify the importance of qualitative findings.

1.4.4 RESULTS IN RELATION TO OTHER STUDIES

The importance of micro-relevance is confirmed by Bleich & Slack who explain that EPR will be enthusiastic accepted, if it “is easy to use and helpful to doctors, nurses, and other clinicians in the care of their patients” (Bleich and Slack, 2010). In order to be micro-relevant to the end-user the EPR must support him when providing care. Beuscart-Zéphir et al. emphasize the necessity of a thorough analysis of the end-user's process before developing an EPR (Beuscart-Zephir et al., 2001). In both the MS-case and the stroke service case micro-relevance was too low to successfully implement an integrated care information system. However it is worthwhile to search for a solution like the e-transfer system or PRM, in order to improve the quality of care in these cases, because Featherstone and Keen found that in diabetes care, an integrated electronic health record supports the integration of care (Featherstone and Keen, 2012). Genuine or intrinsic resistance, i.e. resistance without a reason was not found in this research. Also Dent & Goldberg demonstrated that the mental model of resistance to change is a misinterpretation of Lewin's work (Dent and Goldberg, 1999). According to Ammenwerth et al. the introduction of a NIS contributes to the improvement of the quality of information processing (Ammenwerth et al., 2011).

The USE IT-adoption-model is based on a large body of knowledge, including the ideas of Rogers (Rogers, 1995), TAM (Venkatesh and Bala, 2008, Davis, 1989) and ISSM (DeLone and McLean, 2002), and combines social and technological factors, as well as innovation process and innovation product factors. Yusof et al. added the organizational context to ISSM in the human-organization-technology fit (HOT-fit)-framework (Yusof et al., 2008), but does not provide instruments or indicators to test the framework. Ammenwerth et al. created the HIS-monitor which combines quality criteria to the steps in the individual care process (Ammenwerth et al., 2007). The detailed HIS-monitor is focused on the information and system quality of the hospital information system. Compared to the questionnaire to investigate the TAM, the USE IT-adoption-model provides more specific results, which can be used to increase adoption in a specific case.

1.4.5 MEANING AND GENERALIZATION OF THE STUDY
This research provides insight in the factors influencing the adoption of EPR’s by healthcare professionals, an update of the theoretical model to predict or explain adoption of information systems, and the instruments to investigate adoption of information systems. Although the research only included Dutch cases, the variety in cases and research designs was large: collaborative care – including primary care, nursing home, hospital, and nurses, doctors, and paramedical staff were included. The research designs varied from pre-evaluations and post-evaluations, to qualitative and quantitative research, and the combination of both, longitudinal designs and methodology evaluation. The combination of applying mixed methods and the inclusion of a large part of the population makes the internal validity in each case high. The findings in each case enforced results in other cases or provided additional insights. This makes it very likely that the results can be applied to healthcare professionals in general, at least in healthcare settings comparable to the Netherlands.

Although the USE IT-model is applied in healthcare settings only in this research, it is based on general innovation- adoption theory and information systems-success theory, and is likely to be applicable in other sectors too.

1.4.6 Unanswered and New Questions

Research provides answers to questions, but also evokes many new questions. New questions about the adoption of EPR’s are:

- How can the dilemma of data entry by the care providers be resolved?
- Will the general e-transfer system be adopted in stroke care and will this also be a solution for the lack of relevance in MS-care?

To answer the first question a redesign has to take place. To answer both questions an implementation, followed by an evaluation using the USE IT-model should be performed.

I presented the USE IT-adoption-model with the interview-model and questionnaire, in order to increase the knowledge about successful adoption of information systems by healthcare professionals, and stimulate other researchers to continue to investigate the factors influencing adoption of innovations in healthcare. Questions that need to be investigated are:

- Is the USE IT-adoption-model valid in other sectors than healthcare?
- Are the lists of dimensions of each determinant complete?
- Do the interview-model and questionnaire need adjustment?
- Can we justify the relations between the four USE IT-determinants?
Application of the USE IT-adoption-model with interviews and questionnaire in new case studies in- and outside healthcare are needed to clarify these topics. To justify the relations between the USE IT-determinants a quantitative study of sufficient size is necessary, in order to perform a statistical analysis of the model.

1.5 CONCLUSION

The research presented in this thesis illustrates that information systems, such as EPR’s can be successfully adopted by healthcare professionals, as long as the system is micro-relevant to the end-user. Resistance is the result of lacking resources and micro-requirements not met. The thesis also presents methods to analyze what the USE IT-determinants at the micro-level include for specific users in specific cases. However, adoption is not a dichotomous phenomenon, but a process, as Rogers depicted in the innovation-decision-process: adoption can be continued or not, as well as rejection (Rogers, 1995). Adopters are critical users: they are enthusiastic and want to use the system for all their tasks, and they express ideas about how to make the system even better. This explains why the scores on general satisfaction items are higher than on specific items (chapter 5 and 6). Adoption is not only a rational phenomenon, but also an emotional one: the system becomes yours, and you want to use it and improve it, and make an effort to realize maximum benefits.

Not only users can change their mind, the care process constantly develops and changes, as was demonstrated in the longitudinal researches (chapter 4, 5). We can neither foresee how society and government will develop as we saw in the development of the Dutch national EPR (chapter 2), but some challenges are clear: the growth of healthcare costs and the growth of healthcare ‘consumption’ has to be stopped, since the relative number of young people in the population will diminish. Since healthcare is an information-intensive industry, information systems must be and can be applied to make healthcare more efficient and more effective, and on the same time increase the quality of care and patient satisfaction. These macro-level objectives can only be achieved when the system satisfies the requirements and relevance at the micro-level of the end-user.

1.6 STRUCTURE OF THE THESIS

The thesis is composed of this introduction chapter and another seven articles, of which three articles are published, one is resubmitted after minor revisions and the remaining three articles are or will be submitted to a conference and two journals. For your convenience the thesis is divided in four parts. See table 1.3 for the structure and state of publications, more details are given at the start of each chapter.
<table>
<thead>
<tr>
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<th>Electronic Health Records in the Netherlands, Luctor et Emergo: what emerged after a decade of struggle?</th>
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<td><strong>Case studies</strong></td>
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<tr>
<td>Chapter 3</td>
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<tr>
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<td>Information and communication technology support for stroke care: The relevance dilemma</td>
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<tr>
<td>Chapter 5</td>
<td>Evaluation of an Electronic Patient Record in a nursing home: One size fits all?</td>
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<td>Chapter 6</td>
<td>Information quality of a Nursing Information System depends on the nurses: A combined quantitative and qualitative evaluation</td>
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<td>Chapter 7</td>
<td>Evaluation of the USE IT-questionnaire for evaluation of the adoption of Electronic Patient Records by healthcare professionals</td>
<td>Published</td>
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<tr>
<td>Chapter 8</td>
<td>The USE IT-adoption mode to predict and evaluate adoption of Information and Communication Technology in healthcare</td>
<td>Submitted</td>
</tr>
<tr>
<td><strong>Part IV</strong></td>
<td><strong>References and appendices</strong></td>
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Table 1.3. Structure of the thesis
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<td></td>
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<tr>
<td>Appendix I</td>
<td>USE IT-interview model</td>
</tr>
<tr>
<td>Appendix II</td>
<td>USE IT - questionnaire</td>
</tr>
<tr>
<td>Summary</td>
<td></td>
</tr>
<tr>
<td>Samenvatting (Dutch)</td>
<td></td>
</tr>
<tr>
<td>Biography</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


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MICHEL-VERKERKE, M. B. 2012a. Evaluation of the USE IT-questionnaire for evaluation of the adoption of Electronic Patient Records by healthcare professionals. Methods of Information in Medicine, accepted for publication.


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## APPENDIX I. THE USE IT – INTERVIEW PROTOCOL

Only the main questions are listed. Additional questions to further explore given answers are not listed.

<table>
<thead>
<tr>
<th>Primary process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What care do you provide?</td>
</tr>
<tr>
<td>How do you act at your tasks?</td>
</tr>
<tr>
<td>2. What other tasks do you have apart from providing care?</td>
</tr>
<tr>
<td>How much time or energy do these tasks take from you?</td>
</tr>
<tr>
<td>3. What exceptions or disturbances make that this kind of care or the coordination of this care fails?</td>
</tr>
<tr>
<td>4. Do you use a care protocol or medical guideline for the care you provide?</td>
</tr>
<tr>
<td>5. Who refers patients to you?</td>
</tr>
<tr>
<td>6. To whom do you refer patients?</td>
</tr>
<tr>
<td>7. What other care providers or institutions are simultaneously involved with the care for your patients?</td>
</tr>
<tr>
<td>8. How do you experience the cooperation with other care providers in respect to the providing of the care?</td>
</tr>
<tr>
<td>9. With what care providers should you cooperate (more)?</td>
</tr>
<tr>
<td>10. What do you find important in the contact with other care providers?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. What information about the patient do you need to perform your job properly?</td>
</tr>
<tr>
<td>What information do you receive from whom?</td>
</tr>
<tr>
<td>What form does this information have?</td>
</tr>
<tr>
<td>12. Does this information suffice?</td>
</tr>
<tr>
<td>13. What information do you generate yourself when providing care?</td>
</tr>
<tr>
<td>What information do you give to whom?</td>
</tr>
<tr>
<td>14. How do you appreciate the quality of the proposed (or implemented) innovation?</td>
</tr>
<tr>
<td>15. Were the right end-users involved with making or selecting this innovation?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. What do you experience, <strong>for you personally</strong>, as important in your daily work when you look at the care you provide?</td>
</tr>
<tr>
<td>17. What aspects in the ability to provide care, do you experience as a bottleneck or problem?</td>
</tr>
<tr>
<td>18. Do you know proposals for improvement, concerning these patients, for which you would do your utmost?</td>
</tr>
<tr>
<td>19. How important are these proposed improvements in the chain of care in relation to other possibilities to improve aspects of your job?</td>
</tr>
<tr>
<td>20. In what way could the use of ICT matter to you?</td>
</tr>
<tr>
<td>21. What aspect of your job would you miss, if it would be removed?</td>
</tr>
<tr>
<td>22. How important are your tasks for these patients, <strong>for you</strong>, in comparison with your tasks for other patients?</td>
</tr>
<tr>
<td>Resources</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>23. What ICT-facilities do you have at your disposal at your workplace?</td>
</tr>
<tr>
<td>24. What of these ICT-facilities do you use when providing care?</td>
</tr>
<tr>
<td>25. Is the technical support sufficient to guarantee the quality of the system?</td>
</tr>
<tr>
<td>26. Do you think you will have support to implement changes?</td>
</tr>
<tr>
<td>Resistance</td>
</tr>
<tr>
<td>27. To what extent are you convinced that the use of ICT is necessary to improve the providing of care?</td>
</tr>
<tr>
<td>28. Do you experience obstacles when implementing innovations?</td>
</tr>
<tr>
<td>29. How much time and energy do you think you can find to implement the changes that will occur when introducing innovations and ICT in this kind of care?</td>
</tr>
<tr>
<td>30. Do your colleagues or managers stimulate you to participate in changes?</td>
</tr>
<tr>
<td>31. Can you name other innovation-projects this organization is working on?</td>
</tr>
</tbody>
</table>
# APPENDIX II. USE IT-QUESTIONNAIRE

1. **General questions**

   Department:

   Function:

   Age:

   When did you start using the Electronic Patient Record? (month, year)

2. **Computer use and skills**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Never</th>
<th>Now and then</th>
<th>Weekly</th>
<th>Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>How often do you use a computer in your work?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Do you have a computer at home?</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Does this computer have an internet connection?</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>How often do you use your computer at home?</td>
<td>Never</td>
<td>Now and then</td>
<td>Weekly</td>
<td>Daily</td>
</tr>
<tr>
<td>5</td>
<td>Please mark how often you use the computerprogram's below (at home or at work)</td>
<td>Never</td>
<td>Now and then</td>
<td>Weekly</td>
<td>Daily</td>
</tr>
<tr>
<td>6</td>
<td>E-mail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Internet explorer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>electronic calendar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Word</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Excel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Games</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Paint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Notepad</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please mark the keys which you know of and which you are able to use.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Function-key, escape, tab, end, delete, enter, cursor, Num lock, Caps lock, shift, ctrl, numeric keys, insert, home.</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Please mark the computer-terms of which you know the meaning.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>URL, www, browsing, domain, intranet, extranet, internet, document, file, account, hyperlink, return, space, indents, hack, virus, spam, directory.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please mark the computer-functions you are able to use.
17. Scrolling, open a window, minimize a window, close a window, cut, paste, copy, create a new folder, move a folder, delete a folder, empty dustbin, open a new document, type a text, save a document, save a document at a diskette, open a saved document, move a saved document, delete a document, print a document, insert a table in a document, insert a picture in a document, log on, create a favorite.

3. Use of the Electronic Patient Record (EPR)

<table>
<thead>
<tr>
<th>How often do you use the part of the electronic patient record mentioned below?</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Rarely or never</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. Tab Ward</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Tab History</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Copy data from previous record (when present)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Open a guideline from tab anamnesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. etcetera</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Tab measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Enter blood pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. etcetera</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The questions depend on the structure of the specific EPR.

4. Objectives of the Electronic Patient Record

<table>
<thead>
<tr>
<th>I use the patient data entered by me, for my own professional acting</th>
<th>agree O O O O O disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>27. The patient data entered by me, are used by colleagues or other care providers, for their acting</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>28. The patient data entered by me, function as an order to other care providers (e.g. doctor, nurses)</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>29. The patient data entered by me, are used for financial process like declaration</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>30. The electronic recording of patient data, is also meant for the patient to account for my acting</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>31. The electronic recording of patient data, is also meant to be able to account for my acting legally</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>32. The electronic recording of patient data, is also meant for other care providers to account for my acting</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>33. The electronic recording of patient data, is also meant to adhere to legal or other obligations</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>34. The electronic recording of patient data, is also meant</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>35.</td>
<td>The electronic recording of patient data give me insight in the quality of care providing</td>
</tr>
<tr>
<td>36.</td>
<td>The electronic recording of patient data give me insight in the efficiency of care providing (no waste of time or materials)</td>
</tr>
<tr>
<td>37.</td>
<td>The electronic recording of patient data give me insight in the effectiveness of care providing (the care has the intended effect or result)</td>
</tr>
<tr>
<td>38.</td>
<td>The electronic recording of patient data are used by the organization for the conduct of business</td>
</tr>
<tr>
<td>39.</td>
<td>I use the electronic recording of patient data to evaluate my own acting</td>
</tr>
<tr>
<td>40.</td>
<td>The electronic recording of patient data are used for evaluation and assessment among colleagues</td>
</tr>
</tbody>
</table>

5. Support of providing care 1

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>41.</td>
<td>The EPR quickly gives me a first impression, even when I do not know the patient</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42.</td>
<td>The EPR quickly gives me a complete view on the patient, even when I do not know the patient</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.</td>
<td>The EPR quickly gives me insight in the necessary care needed (planned activities), even when I do not know the patient</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44.</td>
<td>The EPR quickly gives me an overview of care activities carried out, even when I do not know the patient</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45.</td>
<td>The EPR quickly gives me insight in results to accomplish by providing care, even when I do not know the patient</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46.</td>
<td>Care activities are carried out as described in the EPR</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47.</td>
<td>Everyone enters data and reports in the same way</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48.</td>
<td>Reports are kept regularly and up-to-date.</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49.</td>
<td>Oral and written reports do not contain conflicting information</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.</td>
<td>Patient data are not entered in the record of another patient</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.</td>
<td>I enter appointments and orders from the doctor’s round immediately in the EPR</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52.</td>
<td>I enter change of care or interventions, immediately in the EPR</td>
<td>agree 0 0 0 0 disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6. Support of providing care

<table>
<thead>
<tr>
<th></th>
<th>With the EPR I can perform my tasks faster</th>
<th>agree 0 0 0 0 0 disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.</td>
<td>With the EPR I can perform my tasks better.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>54.</td>
<td>Thanks to the EPR the care process passes smoothly.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>55.</td>
<td>Thanks to the EPR I can spend more time on direct care.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>56.</td>
<td>With the EPR I can perform my tasks easier.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>57.</td>
<td>I think the EPR useful and useable in my job.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>58.</td>
<td>I would not want to work without the EPR anymore.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>59.</td>
<td>The EPR precisely provides me the information I need.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>60.</td>
<td>The EPR precisely offers the functionality I need.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>61.</td>
<td>The EPR does not have any superfluous functionality.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>62.</td>
<td>The EPR contains all information I need.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>63.</td>
<td>The EPR contains all functionality I need.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>64.</td>
<td>The EPR does not contain superfluous information.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>65.</td>
<td>In the EPR I can enter all information, I want to lay down.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>66.</td>
<td>Anytime I need specific information, I can see all the information.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>67.</td>
<td>Anytime I need specific functionality, I can use all that functionality</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>68.</td>
<td>Anywhere I need specific information I have access to all that information.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>69.</td>
<td>Anywhere I need specific functionality, I can use all that functionality</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>70.</td>
<td>The EPR support collaboration of disciplines better than a paper record does.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>71.</td>
<td>By using the EPR I have a better insight in care provided by other disciplines than by using a paper record</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>72.</td>
<td>Using the EPR raises the quality of patient data recording.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>73.</td>
<td>The advantages of using an EPR compensate for the disadvantages amply.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>74.</td>
<td>Using the EPR has many advantages compared to using a paper record.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
</tbody>
</table>

### 7. Ease of use

<table>
<thead>
<tr>
<th></th>
<th>Finding data is faster in the EPR than in a paper record</th>
<th>agree 0 0 0 0 0 disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.</td>
<td>Entering data is faster in the EPR than in a paper record</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>76.</td>
<td>The EPR saves time, because much data are filled out automatically</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>77.</td>
<td>The arrangement of windows comply with the way I work</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>78.</td>
<td>I can find the right window quickly</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>79.</td>
<td>I can read the information well.</td>
<td>agree 0 0 0 0 0 disagree</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Agree 1 2 3 4 5</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>81.</td>
<td>I consider the arrangement of windows logically</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>82.</td>
<td>I appreciate the lay-out and use of colors of the windows</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>83.</td>
<td>It is easy to enter data in the right way</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>84.</td>
<td>It is easy to retrieve data</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>85.</td>
<td>Data are presented in exactly the way I need</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>86.</td>
<td>I can enter data in exactly the way I consider necessary.</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>87.</td>
<td>You become automatically skillful in using the EPR</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>88.</td>
<td>Little or no training is needed to start using the EPR</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>89.</td>
<td>It is immediately clear what a certain function / window / button means</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>90.</td>
<td>It is immediately clear how a certain function / button must be used</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>8.</td>
<td>Support of use</td>
<td></td>
</tr>
<tr>
<td>91.</td>
<td>When I have a question about the EPR, my colleagues can help me</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>92.</td>
<td>When I have a question about the EPR, I know whom to call</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>93.</td>
<td>When I have a question about the EPR, it will be handled right by the application manager</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>94.</td>
<td>During the EPR-training I have learned enough to use the EPR</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>95.</td>
<td>I have a need for a repetition of the electronic patient-record training</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>96.</td>
<td>I have a need for a follow-up of the electronic patient-record training</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>97.</td>
<td>The computer(s) I use, rarely give an error</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>9.</td>
<td>Professional autonomy</td>
<td></td>
</tr>
<tr>
<td>98.</td>
<td>An undesirable effect of the use of an EPR is, that others have more insight in my professional acting</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>99.</td>
<td>Because others can read the patient data entered by me, I am more careful in recording data</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>100.</td>
<td>Because others can read the patient date entered by me, I record more data</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>101.</td>
<td>Because others can read the patient date entered by me, I record less data</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>102.</td>
<td>I decide myself whether I use the Electronic Patient Record or not</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>103.</td>
<td>I use the EPR because the organization/fellowship/my colleagues demand that I use it</td>
<td>agree O O O O O disagree</td>
</tr>
<tr>
<td>104.</td>
<td>I use the EPR and a paper patient record</td>
<td>agree O O O O disagree</td>
</tr>
<tr>
<td>105.</td>
<td>If you would want to, I could decide to use the EPR no longer</td>
<td>agree O O O O disagree</td>
</tr>
<tr>
<td>106.</td>
<td>I continue to use the EPR, because I invested a lot of time</td>
<td>agree O O O O disagree</td>
</tr>
<tr>
<td>107.</td>
<td>I continue to use the EPR, because I invested a lot of money</td>
<td>agree O O O O disagree</td>
</tr>
<tr>
<td>108.</td>
<td>I continue to use the EPR, because I am satisfied with it</td>
<td>agree O O O O disagree</td>
</tr>
</tbody>
</table>

10. Open questions

| 109. | For which functions or in what situation do you use a paper record (e.g. correspondence)? |
| 110. | In what situation do you print data and what data do you print? |
| 111. | What advantages do you experience using an EPR? |
| 112. | What disadvantages do you experience using an EPR? |
| 113. | What functions of the EPR do you consider most useful? |
| 114. | What functions of the EPR do you consider less useful? |
| 115. | What functions do you miss in the EPR? |
| 116. | What advantages do you experience using a paper record? |
| 117. | What disadvantages do you experience using a paper record? |
SUMMARY

Despite the enormous progress that is made, many healthcare professionals still experience problems, regarding patient information and patient records (see chapter 2). Why are promising systems not used? Why are healthcare providers not satisfied with the system they use, despite their positive attitude? But even more challenging is to find out why some systems are successful. In my research I studied two successful implementations to discover what characteristics of the EPR and what characteristics of the users lead to a successful adoption of the EPR by the care professionals (chapter 5 and 6). A large body of knowledge regarding success and failure of innovations and information systems exists, e.g. the standard work of Everett M. Rogers about the diffusion of innovations (Rogers, 1995), the work of Visnawath Venkatesh and Fred D. Davis about the acceptance of technology (Davis, 1989, Venkatesh and Davis, 2000, Venkatesh et al., 2003, Venkatesh and Bala, 2008), and the work of William H. DeLone and Ephraim R. McLean about the categories of factors for success of information systems (DeLone and McLean, 2002). Based on this knowledge base, Ton A.M. Spil, Roel W. Schuring and me, developed the USE IT-model in order to predict, explain and investigate the adoption of information systems in healthcare (Spil et al., 2006). However, the application of this knowledge in practice is a challenge and especially when this practice is healthcare. This leads to the main research questions in this thesis:

1. What aspects determine the adoption of an Electronic Patient Record by healthcare professionals?
2. How should the USE IT-model be adjusted to predict or explain the adoption of Electronic Patient Records by healthcare professionals?

The four case studies (chapter 3 – 6) deal with the first research question. In chapter 7 and 8 focus on the second research question. In each study more detailed research questions are formulated.

METHODOLOGY

In this thesis I present four case studies (chapter 3, 4, 5 and 6), because “case studies are the preferred method when (a) “how” and “why” questions are being posed, (b) the investigator had little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context” (Yin, 2009). The USE IT-model is the theoretical kernel of the methods used in all the presented research, except for chapter 2. The research design can vary in each case study, dependent on the objective, conditions and opportunities. In the MS-case in chapter 3 a qualitative explorative design is chosen, applying USE IT-interviews (MS is multiple sclerosis, a progressive neurological disease). In the stroke case in chapter 4 a longitudinal qualitative design is applied to explain why the intended stroke integrated care
information system is not realized. A longitudinal design is also chosen in the nursing home case in chapter 5. In this case the qualitative USE IT-interviews are combined with a quantitative method: the USE IT-questionnaire. In the case of the evaluation of the nursing information system (NIS, i.e. an EPR for nurses) in a hospital in chapter 6 the combination of qualitative and quantitative methods is repeated. The results of these cases is used to evaluate the USE IT-model in chapter 8. In this way a cycle of evaluation research and research method evaluation is created. In each case study the methodology is described. In chapter 7 the USE IT-questionnaire is introduced, and in an extensive description of the USE IT-model can be found in chapter 8. The interview model can be found in appendix I. The structure of most chapters follows the STARE-HI-structure which is recommended by the editors of several journals in the medical informatics field (Talmon et al., 2009).

RESULTS

Before presenting the results of my case studies, I present an overview of the situation in the Netherlands in respect to Electronic Patient Records in chapter 2. In 2002 we presented our EPR-orientation-model for success of Electronic Patient Records (EPR's). The Electronic Patient Record is seen as a way to improve the information process, and make healthcare more efficient and effective. But this has been the case for more than two decades. In The Netherlands the last decade many initiatives lead to the implementation of EPR's within care organizations, but also regional infrastructures for information- and network services are realized. The law to realize a national EPR is rejected by the Dutch Senate, however.

The EPR-orientation-model characterizes EPR's in three orientations: administration, medical technology and care process. The developments in the last decade in the Netherlands are described in relation to the orientations. This leads to the extension of the model with external relations and the enlargement of the intersection between the administration orientation and care process orientation. The four criteria for a successful EPR from the end-user viewpoint are updated to five criteria. In order to be successful an EPR must:

1. Be micro-relevant to the end-users;
2. Provide complete and integrated patient data;
3. Be available and accessible anywhere and anytime;
4. Contain active elements, like alerts, decision support and workflow management;
5. Register data necessary for quality and finance, without extra effort for the care providers.
In chapter 3 and 4 I presented two case studies concerning pre-evaluations in a collaborative care setting. From the MS-case in chapter 3 can be learnt that you have to organize the collaboration first, before you can develop and implement an information system. The major issues that emerged from this case study were:

1. MS-care is only micro-relevant for a few care providers,
2. Informal communication dominated, and
3. Only informal collaboration occurred.

We advised to formalize the collaboration by introducing a MS-protocol, a coordinator to manage the collaboration, and the development of a patient relation management (PRM) system. The latter contains elements of a workflow management, one of the active elements of the fourth criterion for creating a successful EPR. ICT can support the process of collaboration, but the development stages of the IS and the care process should be in balance. When the information system is far ahead of the care process, the advanced functions will not be used. The NIS-case also demonstrated that only those functions that were necessary or clearly supportive were used (chapter 6). The information needs also differ in relation to the stage of the development of the collaboration. In the MS-case the care providers wanted to know where the patient ‘was’ in the healthcare chain, and which care providers also were involved with the patient, in order to know what treatments the patient had received and in order to know who the care providers could contact for information.

In the stroke service (chapter 4) the collaboration was better organized, each care provider knew where the patient was in the care process and they knew whom to contact, but the care providers wanted to receive the information ‘automatically’. Although the prevalence of stroke is much higher than of MS, the micro-relevance was still low for primary care. A dedicated stroke integrated care information system is therefore not relevant for most care providers. The first criterion for a successful EPR, presented in chapter 2, fails for stroke care. A general electronic transfer information system for exchange of patient data probably is relevant to the care providers in stroke care.

After these two cases, the USE IT-questionnaire is applied in the evaluation of an EPR in a nursing home (chapter 5) and with some modifications in the evaluation of a NIS in a hospital (chapter 6), because in an evaluation you not only want opinions, but you also want to be able to quantify results, in order to be able to measure adoption. The nursing home case in chapter 5 demonstrated that micro-relevance is not the same for nurses, paramedical staff and medical staff. It also confirmed that use is not the same as adoption, and mandatory use is no guarantee for adoption. In the first phase the doctors used the EPR, but were not satisfied with the system, accept for the availability of information. Four years later the doctors appreciated
the EPR for its possibilities, although the system still did not support them in their medical tasks. In this case study the value of a combined qualitative and quantitative design was demonstrated, since the questionnaire quantified the dissatisfaction of the doctors, and the interviews revealed the reasons. The nursing home-case also demonstrated that when the micro-relevance was high, and the information needs were met, which was the case for nurses and paramedical staff, the EPR was successfully adopted. The EPR in the nursing home met the first three criteria presented in chapter 2.

The hospital case in chapter 6 was an example of a successful implementation of a Nursing Information System. In this case it became clear that only those functions that were micro-relevant, were used. Information quality was more micro-relevant than relieving time pressure. The attributes of information quality became clear: the nurses expect complete, correct, up-to-date and accessible patient information. A very important finding was that information quality depends on the users and is not a system attribute, since the system does not produce information, but only presents information entered by the end-users. This aspect was not found in information quality literature. Also this case confirmed the first three criteria for a successful EPR.

In chapter 7 the results of the two cases in chapter 5 and 6 are combined and a factor analysis is performed to evaluate that part of the USE IT-questionnaire that was similar in both cases. The factor analysis result in four factors measuring micro-relevance: (a) task support, (b) compatibility, (c) collaboration and (d) accessibility, and in two factors measuring micro-requirements: (a) interface satisfaction and (b) learnability.

**DISCUSSION**

*What aspects determine the adoption of an Electronic Patient Record by healthcare professionals?*

From the presented case studies can be learnt that the system must be micro-relevant to the end-user. Micro-relevance includes task support, effective care, efficient care, and patient satisfaction. To achieve this, an information system has to fulfill requirements, which can be categorized as: Information quality, accessibility (anywhere, anytime), compatibility, interface satisfaction, and interoperability. In order to meet the micro-requirements, adequate resources need to be available. When they are and the end-user does not perceive negative consequences, resistance will be very low or absent (chapter 8).

*How should the USE IT-model be adjusted to predict or explain the adoption of Electronic Patient Records by healthcare professionals?*
The USE IT-model provided a good theoretical base for the case studies. Compared to the Technology Acceptance Model (Venkatesh and Bala, 2008) and the Information Systems Success Model (DeLone and McLean, 2002), the USE IT-adoption-model provides more specific results, which can be used to improve adoption in a specific case. All case studies together contributed to the evaluation of the USE IT-model, which lead to the more consistent and specified USE IT-adoption-model. Research learned that relevance is the most influential determinant of the four. This is to be expected, since perceived usefulness which is an element of relevance, is also found to be the most significant factor in the adoption of IS or IT in healthcare (Chau and Hu, 2002a). Requirements is the second most important determinant. Relevance and requirements deal with the content of the innovation. Sufficient resources are a prerequisite for a successful implementation, resulting in adoption by the end-user. Resistance has a reason, and is the result of low scores on the other determinants. Hypotheses were developed about the relations between the determinants. Since the research is predominantly performed in a qualitative way, the relations cannot be confirmed by statistical tests.

**STRENGTHS AND WEAKNESSES**

The USE IT-model combines social context of the user with the technical context of the information system, which is necessary to understand adoption of technology. Performing pre-evaluations provide information about what helps to make implementation successful, and how failure can be prevented. The longitudinal design of the case studies in chapter 4 and 6, made it possible to reflect on earlier results in the same case. The combination of qualitative and quantitative design in the case studies in chapter 5 and 6 gave a richer result than when only one method was applied. Qualitative results help to explain and interpret quantitative findings and quantitative results help to just the importance of qualitative findings. The variety in cases makes generalization for healthcare possible, but the number of cases is still limited and more research is necessary. Until now, the application of the USE IT-model is limited to the researches performed by the developers and their students, which bears the risk of bias.

**UNANSWERED AND NEW QUESTIONS**

Research provides answers to questions, but also evokes many new questions. Is the USE IT-adoption-model valid in other sectors than healthcare? Are the lists of dimensions of each determinant complete? Do the interview-model and questionnaire need adjustment? How can the dilemma of data entry by the care providers be resolved? We presume relations between the four USE IT-determinants, but will we be able to justify these relations? Will the general e-transfer system be adopted in stroke care, and will this also be a solution for the lack of relevance in MS-care?
CONCLUSION

The research presented in this thesis demonstrates that information systems, such as EPR’s can be successfully implemented, as long as the system is micro-relevant to the end-user. The thesis also presents methods to analyze what micro-relevance includes for specific users in specific cases. However, adoption is not a dichotomous phenomenon, but a process, as Rogers depicted in the innovation-decision-process: adoption can be continued or not, as well as rejection (Rogers, 1995) p. 162. Not only users can change their mind, the care process constantly develops and changes, as was demonstrated in the longitudinal researches (chapter 4, 5). We can neither foresee how society and government will develop as we saw in the development of the Dutch national EPR (chapter 2).
S AMENVATTING (DUTCH)

Ondanks de enorme vooruitgang die is geboekt, ervaren veel professionals in de gezondheidszorg nog problemen als het gaat om patiëntinformatie en patiëntendossiers (zie hoofdstuk 2). Waarom worden veelbelovende systemen niet gebruikt? Waarom zijn zorgverleners niet tevreden met het system dat ze gebruiken, ondanks hun positieve houding? Maar een nog grotere uitdaging is uit te zoeken waarom sommige systemen wel succesvol zijn. In mijn onderzoek heb ik twee succesvolle implementaties onderzocht om te ontdekken welke kenmerken van een EPD en welke kenmerken van de gebruikers leiden tot een succesvolle adoptie van het EPD door zorgverleners (hoofdstuk 5 en 6). Er bestaat een grote hoeveelheid kennis als het gaat om succes en falen van innovaties en informatiesystemen, bijvoorbeeld het standaard werk van Everett M. Rogers over de diffusie van innovaties (Rogers, 1995), het werk van Visnawath Venkatesh en Fred D. Davis over de acceptatie van technologie (Davis, 1989, Venkatesh and Davis, 2000, Venkatesh et al. 2003, Venkatesh en Bala, 2008) en het werk van William H. DeLone en Ephraim R. McLean over de categorieën van succesfactoren voor het succes van informatiesystemen (DeLone en McLean, 2002). Op basis van deze kennis, hebben Ton A.M. Spil, Roel W. Schuring en ik, het USE IT-model ontwikkeld met als doel de adoptie van informatie systemen in de zorg te voorspellen, verklaren en te onderzoeken (Spil et al., 2006). Echter, de toepassing van deze kennis in de praktijk is een uitdaging, vooral als deze praktijk de gezondheidszorg is. Dit heeft geleid tot de volgende onderzoeksvragen in dit proefschrift:

1. Welke aspecten bepalen de adoptie door zorgverleners van een elektronisch patiëntendossier?
2. Hoe moet het USE IT-model aangepast worden om de adoptie van elektronische patiëntendossiers door zorgverleners te voorspellen of te verklaren?

De vier case studies (hoofdstuk 3 t/m 6) behandelen de eerste onderzoeksvraag. Hoofdstuk 7 en 8 richten zich op de tweede onderzoeksvraag. In ieder onderzoek zijn meer gedetailleerde onderzoeksvragen geformuleerd.

M ETHODOLOGIE

In dit proefschrift presenteer ik vier case studies (hoofdstuk 3, 4, 5 en 6), omdat “case studies de voorkeursmethode zijn, wanneer (a) “hoe” en “waarom” vragen zijn gesteld, (b) de onderzoeker Weinig controle had over gebeurtenissen en (c) de focus ligt op een onderwerp in de tegenwoordige tijd binnen een werkelijke context” (Yin, 2009). Het USE IT-model is de theoretische kern van de gebruikte methoden in al het gepresenteerde onderzoek, met uitzondering van hoofdstuk 2. Het onderzoeksontwerp kan variëren in iedere case studie, afhankelijk van het doel, de voorwaarden en de mogelijkheden. In de MS-case in hoofdstuk 3 is gekozen voor een
kwalitatief verkennend ontwerp, waarbij USE IT-interviews zijn toegepast (MS staat voor multiple sclerose, een progressieve neurologische ziekte). In de CVA-case in hoofdstuk 4 is een longitudinale kwalitatieve aanpak toegepast om te verklaren waarom het geplande keteninformatiesysteem niet is gerealiseerd (CVA is een beroerte). Een longitudinale opzet is ook gekozen in de verpleeghuiscase in hoofdstuk 5. In dit onderzoek zijn de kwalitatieve USE IT-interviews gecombineerd met een kwantitatieve methode: de USE IT-vragenlijst. Bij de evaluatie van het elektronisch verpleegkundig dossier (NIS = nursing information system) in een ziekenhuis in hoofdstuk 6, is de combinatie van kwalitatief en kwantitatief onderzoek herhaald. De resultaten van de case studies zijn in hoofdstuk 8 gebruikt om het USE IT-model te evalueren. Op deze manier is een cyclus van evaluatie onderzoek en evaluatie van onderzoeksmethoden gecreëerd. In iedere case studie is de methodologie beschreven. In hoofdstuk 7 wordt de USE IT-vragenlijst geïntroduceerd en een uitgebreide beschrijving van het USE IT-model wordt gevonden in hoofdstuk 8. Het interviewmodel is te vinden in appendix I. De opzet van de meeste hoofdstukken volgt de STARE-HI-structuur, die aanbevolen wordt door de redacteuren van een aantal tijdschriften op het gebied van medische informatica (Talmon et al., 2009).

RESULTATEN

Voordat ik de resultaten van de case studies presenteer, geef ik in hoofdstuk 2 een overzicht van de situatie in Nederland met betrekking tot het elektronisch patiëntendossier. In 2002 hebben we ons EPD-oriëntatie-model voor het succes van elektronische patiëntendossiers (EPD’s) gepresenteerd. Het EPD wordt gezien als een manier om het informatieproces te verbeteren en de zorg efficiënter en effectiever te maken. Maar dit is al twintig jaar zo. In Nederland hebben in de laatste tien jaar veel initiatieven geleid tot de implementatie van EPD’s in zorg organisaties, maar ook zijn regionale infrastructuren voor informatie- en netwerkdienssten gerealiseerd. De wet om het nationale EPD te realiseren is echter door de Eerste Kamer verworpen.

Het EPD-oriëntatie-model deelt EPD’s in in drie oriëntaties: administratie, medische technologie en zorgproces. De ontwikkelingen in de laatste tien jaar in Nederland zijn beschreven in relatie tot deze drie oriëntaties. Dit leidt tot de uitbreiding van het model met externe relaties en vergroting van het snijvlak tussen de administratieve en zorgproces oriëntatie. De vier criteria voor een succesvol EPD vanuit het eindgebruikers perspectief zijn geactualiseerd tot vijf criteria. Om succesvol te zijn, moet een EPD:

1. Micro-relevant zijn voor de eindgebruikers
2. Volledige en geïntegreerde patiëntgegevens leveren
3. Overal en altijd beschikbaar en toegankelijk zijn
4. Actieve elementen bevatten, zoals alerts, beslissingsondersteuning en workflow management
5. Financiële en kwaliteitsgegevens registreren zonder dat dit extra moeite kost voor de zorgverlener.

In hoofdstuk 3 en 4 presenteer ik twee case studies die een nulmeting betreffen in een ketenzorg setting. Van de MS-case in hoofdstuk 3 kan geleerd worden dat je eerst de samenwerking moet organiseren voor je een informatiesysteem kan ontwikkelen en implementeren. De belangrijke punten die uit deze case study naar boven kwamen, waren:

1. MS-zorg is slechts voor weinig zorgverleners micro-relevant
2. Informele communicatie overheerste
3. Alleen informele samenwerking plaatsvond.

Wij adviseerden de samenwerking te formaliseren door een MS-protocol in te voeren, een coördinator in te stellen om de samenwerking te regelen en de ontwikkeling van een patiënt relatie management systeem (PRM). Deze laatste bevat elementen van workflow management, een van de actieve elementen van de vierde eis om een succesvol EPD te creëren. ICT kan het proces van samenwerking ondersteunen, maar de ontwikkelingsstadia van het informatiesysteem en van het zorgproces moeten in evenwicht zijn. Wanneer het informatiesysteem ver voor loopt op het zorgproces, zullen de geavanceerde functies niet gebruikt worden. De EVD-case liet ook zien dat alleen die functies die noodzakelijk of duidelijk ondersteunend waren, gebruikt werden (hoofdstuk 6). De informatiebehoeften verschillen ook afhankelijk van het ontwikkelingsstadium van de samenwerking. In de MS-case wilden de zorgverleners weten waar de patiënt ‘was’ in de zorgketen en welke zorgverleners ook betrokken waren bij de patiënt, om te weten welke behandelingen de patiënt had ondergaan en om te weten met wie de zorgverlener contact kon opnemen voor informatie.

In de CVA-zorgketen (hoofdstuk 4) was de samenwerking beter georganiseerd: iedere zorgverlener wist waar de patiënt was in de zorgketen en zij wisten met wie contact te leggen, maar de zorgverleners wilden de informatie ‘automatisch’ ontvangen. Hoewel de prevalentie van een beroerte veel hoger is dan die van MS, is de microrelevantie toch laag voor de eerste lijn. Een specifiek CVA-keteninformatiesysteem is daarom niet relevant voor de meeste zorgverleners. De CVA-zorgketen voldoet niet aan het eerste criterium voor een succesvol EPD, zoals gepresenteerd in hoofdstuk 2. Een algemeen elektronisch overdracht informatiesysteem voor de uitwisseling van patiëntgegevens is waarschijnlijk wel relevant de zorgverleners in de CVA-keten.

Na deze twee case studies, is de USE IT-vragenlijst toegepast bij de evaluatie van een EPD in een verpleeghuis (hoofdstuk 5) en met enkele wijzigingen ook bij de
evaluatie van een EVD in een ziekenhuis (hoofdstuk 6), omdat je bij een evaluatie niet alleen meningen wilt verzamelen, maar je wilt ook in staat zijn om resultaten te kwantificeren om de adoptie te meten. Het onderzoek in het verpleeghuis in hoofdstuk 5 laat zien microrelevantie niet hetzelfde is voor verpleging, verzorging, paramedische en medische staf. Het onderzoek bevestigde ook dat gebruik niet hetzelfde is als adoptie en verplicht gebruik geen garantie is voor adoptie. In de eerste fase gebruikten de artsen het EPD wel, maar zijn waren niet tevreden met het systeem, met uitzondering van de beschikbaarheid van gegevens. Vier jaar later waardeerden de artsen het EPD voor de mogelijkheden, hoewel het systeem hen nog steeds niet ondersteunde in hun medische taken. In deze case studie werd de waarde van een gecombineerd kwalitatief en kwantitatief ontwerp getoond, aangezien de vragenlijst de ontevredenheid van de artsen kwantificeerde en de interviews de oorzaken blootlegden. Het verpleeghuisonderzoek liet ook zien dat als de microrelevantie hoog was en dat aan de informatiebehoeften voldaan werd – wat het geval was bij de verpleging en de paramedische staf – het EPD succesvol werd geaccepteerd. Het EPD in het verpleeghuis voldeed aan de eerste drie criteria die uit hoofdstuk 2.

Het onderzoek in het ziekenhuis in hoofdstuk was een voorbeeld van een succesvolle implementatie van een Elektronisch Verpleegkundig Dossier (EVD). In dit geval werd het duidelijk dat alleen die functies die microrelevant waren, werden gebruikt. Informatiekwaliteit was meer microrelevant dan verlichting van de tijdsdruk. De attributen van informatiekwaliteit werden duidelijk: de verpleegkundigen verwachten volledige, juiste, actuele en bereikbare patiëntinformatie. Een heel belangrijke bevinding was dat informatiekwaliteit afhankt van de gebruikers en niet een systeemeigenschap is, aangezien het systeem niet de informatie produceert, maar alleen de informatie die ingevoerd is door de gebruikers, toont. Dit aspect is niet aangetroffen in de literatuur over informatiekwaliteit. Ook dit onderzoek bevestigde de eerste drie criteria voor een succesvol EPD.

In hoofdstuk 7 zijn de resultaten van de twee onderzoeken in hoofdstuk 5 en 6 gecombineerd en is een factoranalyse uitgevoerd op die delen van de USE IT-vragenlijst die in beide onderzoeken gelijk waren. De factoranalyse resulteerde in vier factoren die microrelevantie meten: (a) taakondersteuning tevredenheid, (b) compatibiliteit, (c) samenwerking en (d) beschikbaarheid en in twee factoren die micro-eisen meten: interface tevredenheid en (b) leerbaarheid.

DISCUSSIE

Welke aspecten bepalen de adoptie van een elektronisch patiëntendossier door zorgverleners?
Van de gepresenteerde case studies kan geleerd worden dat een systeem microrelevant moet zijn voor de eindgebruiker. Microrelevantie omvat taakondersteuning, effectieve zorg, efficiënte zorg en patiënt tevredenheid. Om dit te bereiken moet een informatiesysteem voldoen aan de eisen, die ingedeeld kunnen worden als: kwaliteit, beschikbaarheid (altijd en overal), compatibiliteit, interface tevredenheid en interoperabiliteit. Om aan de micro-eisen te kunnen voldoen, moeten voldoende middelen beschikbaar zijn. Als dat het geval is en de eindgebruiker ervaart geen negatieve gevolgen, zal de weerstand heel laag of afwezig zijn (hoofdstuk 8).

Hoe moet het USE IT-model aangepast worden om de adoptie van elektronische patiëntendossiers door zorgverleners te voorspellen of te verklaren?

Het USE IT-model gaf een goede theoretische basis voor de case studies. Vergeleken met het Technology Acceptance Model (Venkatesh en Bala, 2008) en het Information Systems Success Model (DeLone en McLean, 2002), geeft het USE IT-adoption-model meer specifieke resultaten die gebruikt kunnen worden om de adoptie in een specifieke situatie te verbeteren. Alle case studies samen droegen bij aan de evaluatie van het USE IT-model, hetgeen leidde tot een consistenter en specifieker USE IT-adoption-model. Uit het onderzoek kan geleerd worden, dat relevantie de meest invloedrijke is van de vier determinanten. Dit was te verwachten, aangezien ‘ervaren nut’, dat een element is van relevantie, ook de meest betekenende factor is in adoptie van ICT in de zorg (Chau en Hu, 2002a). ‘Eisen’ is de op een na belangrijkste determinant. Relevantie en eisen gaan over de inhoud van de innovatie. Voldoende middelen zijn een voorwaarde voor een succesvolle implementatie, resulterend in de adoptie door de eindgebruiker. Hypothesen zijn ontwikkeld over de relaties tussen de determinanten. Aangezien het onderzoek voornamelijk op een kwalitatieve manier is uitgevoerd, kunnen de relaties niet bevestigd worden door statistische toetsen.

STERKTEN EN ZWAKTEN

Het USE IT-model combineert de sociale context van de gebruiker met de technische context van het informatiesysteem, hetgeen nodig is om adoptie van technologie te begrijpen. Het uitvoeren van pre-evaluaties leverde informatie op over wat helpt om implementaties succesvol te laten zijn en hoe mislukken voorkomen kan worden. Het longitudinale ontwerp van de case studies in hoofdstuk 4 en 6, maakte het mogelijk om op eerdere resultaten in dezelfde case te reflecteren. De combinatie van kwalitatief en kwantitatief onderzoek in de case studies in hoofdstuk 5 en 6 leverden een rijkere resultaat op dan wanneer alleen een methode was toegepast. Kwalitatieve resultaten helpen om kwantitatieve bevindingen te verklaren en te duiden en de kwantitatieve resultaten helpen om het belang van kwalitatieve resultaten te onderbouwen. De verscheidenheid in case maakt generalisatie voor de zorg
mogelijk, maar het aantal cases is nog beperkt en meer onderzoek is nodig. Tot nu toe is de toepassing van het USE IT-model beperkt gebleven tot de onderzoeken die uitgevoerd zijn door de ontwikkelaars en hun studenten.

ONBEANTWOORDE EN NIEUWE VRAGEN

Het onderzoek leverde antwoorden op vragen, maar lokt ook veel nieuwe vragen uit. Is het USE IT-adoptie-model geldig in andere sectoren dan de zorg? Is de lijst van dimensies bij iedere determinant volledig? Moeten het interviewmodel en de vragenlijst aangepast worden? We veronderstellen relaties tussen de vier determinanten, maar zullen we in staat zijn deze te onderbouwen? Zal het algemene e-overdracht dossier in de CVA-zorg geaccepteerd worden en zal dit ook de oplossing zijn voor het gebrek aan relevantie in de MS-case?

CONCLUSIE

Het onderzoek dat in dit proefschrift gepresenteerd wordt laat zien dat informatiesystemen, zoals EPD's succesvol geïmplementeerd kunnen worden, zolang het systeem microrelevant is voor de eindgebruiker. Het proefschrift geeft ook de methoden om te analyseren wat microrelevantie inhoudt voor specifieke gebruikers in een specifieke situatie. Echter, adoptie is niet een dichotoom fenomeen, maar een proces, zoals Rogers visualiseerde in het innovatiebeslissingsproces: adoptie kan voortgezet worden of niet, net zo als afwijzing (Rogers, 1995, p.162). Niet allen gebruikers kunnen van gedachte veranderen, ook het zorgproces ontwikkelt voortdurend en verandert, zoals in de longitudinale onderzoeken te zien was (hoofdstuk 4 en 5). We kunnen nooit voorspellen hoe de maatschappij en de overheid zich zullen ontwikkelen, zoals te zien was in de ontwikkeling van het Nederlandse landelijke EPD (hoofdstuk 20).
BIOGRAPHY

After becoming a medical doctor in 1985 I started teaching medicine to nurses and later to doctor's assistants. In the same time, I took several courses in Computer science at the Open University, and after 15 years of teaching I decided to become a project manager for educational ICT-projects. I liked being a project manager, so I decided to study more seriously at the University of Twente. Being a female and about twice the age of my fellow (male) students, I was noticed by one of the university teachers (Christiaan Katsma, thanks!). This lead to a position as a research assistant in 2001 at the Business Information Systems group (now IEBIS), of which Robert Stegwee was the chair at that time (now Jos van Hillegersberg). That is how I became interested and involved in the topic ICT in healthcare, and more specifically Electronic Patient Records. In those years I studied Business Information Technology (BIT) and investigated how ICT could support collaborative care for multiple sclerosis and stroke. After my graduation I left the university as an employee, but I came back one day a week as a PhD-student. I chose to bring my knowledge into practice and took a part-time job as coordinator of the palliative care network in Mid-Twente for two years. Simultaneously I started to work for TriviumMeulenbeltZorg, a care organisation (elderly care) as a policy advisor for ICT. That gave me not only the opportunity to implement an EPR, but also to evaluate the implemented system. After several years I also became the ICT-manager. In 2008 I switched jobs and became a project manager for ICT-projects in healthcare in the Twente region at IZIT. The e-transfer project was one of my projects. I combined this task with being a lecturer and researcher at Saxion, Knowledge Centre Health, Social Work & Technology, knowledge circle Technology in Healthcare & Social Work, where I coordinate the research program Electronic Patient Record. I am also involved in the development and lecturing of the study-route Health & Technology in the bachelor of Nursing. When Saxion gave me the opportunity in 2010 to finish my PhD, I resigned from IZIT. To date I also work as a research coach for students in the Master of Healthcare Social Work and the Master Advanced Nursing Practice, at Saxion.

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