The Effectiveness of Clinical Pathway Management Software

Mariëlle Floor Aarnoutse

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A collaboration between
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Graduate student:
Name: Mariëlle Floor Aarnoutse
Student number: 3469662
Address: Cambridgelaan 375, 3584 DB, Utrecht
Email: M.F.Aarnoutse@gmail.com
Phone: +31655976993

Supervisor:
Name: Dr. Ronald Batenburg
Department: Information and Computing Sciences
Company: Utrecht University
Email: R.S.Batenburg@uu.nl

Second supervisor:
Name: Prof. Dr. Sjaak Brinkkemper
Department: Information and Computing Sciences
Company: Utrecht University
Email: S.Brinkkemper@uu.nl

External supervisor:
Name: Dr. Marieke Vissers
Department: Dienst Informatie Technologie
Company: UMC Utrecht
Email: M.C.Vissers@umcutrecht.nl

Abstract

Background

Clinical pathways are known to lead to extensive benefits for all involved parties in hospital environments. Since several years IT supported clinical pathways (in this study: clinical pathway management software) are known to be developed. Few studies research the additional benefits of these software programs. Especially the effectiveness of clinical pathway management software for healthcare professionals remains underexposed.

Aims

The aim of this study is to provide a research-based conclusion about the effectiveness of clinical pathway management software for healthcare professionals. This is done by answering the main research question: Can clinical pathway management software be effective for healthcare professionals in hospital environments?

Methods

The research method consists of two parts: a desk-research in the form of a literature study and field research in the form of a single-case study. The main part of the literature study is guided by the process of a systematic literature review. Additional information about the case study is found in an unstructured way. The case study is held in four of the seven departments of the Utrecht Medical Center who work with the newly developed clinical pathway management software program, named Check-It. The participants in this study are asked about the perceived effectiveness in surveys as well as semi-structured interviews.

Findings

The systematic literature review showed that IT is known to be important for hospitals and also thought to be of importance for clinical pathways. Clinical pathway management software can lead to the opportunity to deliver faster and better information, economic benefits, and a higher patient satisfaction. The case study showed that Check-It is perceived effective in two of the four researched departments. These outcomes are dependent on the environment they work in. Healthcare professionals in departments with a positive attitude towards a (new) system and who collectively use the system, are more inclined to profit from Check-It. There are also strong indications that Check-It is more effective for 'physicians and medical specialists' than for other healthcare professionals in the hospital environment. This particular clinical pathway management program leads among others to less forgotten tasks, makes it easier to work due to pre filled orders and letters, leads to a better overview, but is also perceived as not flexible enough.

Conclusion

Clinical pathway management software can be effective for healthcare professionals in hospital environments. However, this depends on the environment the software is used in.

Acknowledgements

"Scientific research is one of the most exciting and rewarding of occupations" Frederick Sanger once said. Now this thesis is done, I can finally feel myself agreeing with him. While the road had several bumps and bends, the result presented before you is something that is exciting as well as rewarding for me. Months of hard work have resulted in this stack of paper, which will hopefully also bring some excitement and even a reward in the form of an extension of knowledge for you, as its reader.

Of course I cannot let the acknowledgements pass without a few words of heartfelt thanks to the people surrounding me and supporting me throughout the process. Especially my external supervisor Marieke Vissers for her constant enthusiasm and all her help within the UMCU. Ronald Batenburg, for his useful guidance during the bi-weekly feedback sessions and guiding me through the scientific part of this study. Last but not least, Sjaak Brinkkemper for being a critical and valued reader on the moments that matter the most. Mom, dad, friends, family: thanks for believing in me and being there when you needed to be.

All that's left for me to say now is enjoy reading!

Floor Aarnoutse

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GLOSSARY OF ABBREVIATIONS

AZU	Academisch Ziekenhuis Utrecht (the academic hospital in Utrecht). *ch. 6, p.65*
BI	Business Intelligence. *ap.H, p.194*
BPR	Business Process Redesign. *ch.5, p.43*
CAD	Computer-Aided Drafting. *ap.H, p.196*
CF	Cystic Fibrosis. *ch.8, p.86*
CP	Clinical Pathway. *ch.1, p.1*
CPs	Clinical Pathways. *ch.1, p.1*
CPM^1	Clinical Pathway Management. *ch.1, p.2*
CPM^2	Critical Path Method. *ch.5, p.43*
CPOE	Computerized Provider/Physician Order Entry. *ch.4, p.36*
DIT	Dienst Informatie Technologie (the IT department of the UMCU). *ch.1, p.3*
EBM	Evidence Based Medicine. *ch.1, p.5*
EHIS	Enterprise Health Information Systems. *ch.4, p.32*
EPA	European Pathway Association. *ch.5, p.44*
EPD	Electronic Patient Dossier. *ch.1, p.4*
ERP	Enterprise Resource Planning. *ch.4, p.37*
HIS	Hospital Information System. *ch.1, p.4*
KVO	Klinisch Vaardigheids Onderwijs (Clinical skill education). *ap.H, p.195*
LMS	Laboratory Management System. *ap.H, p.194*
METC	Medische Etische ToetsingsCommissie (Medical Ethics Review Committee). *ap.H, p.194*
MFU	Medical Faculty of Utrecht University. *ch.6, p.65*
MRQ	Main Research Question. *ch.1, p.6*
Nictiz	Nationaal ICT Instituut in de Zorg (National IT institute for healthcare in the Netherlands). *ch.6, p.67*
NVZ	Nederlandse Vereniging van Ziekenhuizen (Netherlands Association of Hospitals). *ch.6, p.67*
PACS	Picture Archiving and Communication System. *ch.4, p.37*
PDCA	Plan-Do-Check-Act. *ch.5, p.59*
PDMS	Patient Data Management System. *ch.4, p.36*
PERT	Program and Evaluation Technique and Review. *ch.5, p.43*

RDP	Research Data Platform. *ap.H, p.194*
RIS	Radiology Information System. *ch.4, p.37*
SLR	Systematic Literature Review. *ch.2, p.10*
SOP	Standard Operating Procedures. *ch.5, p.42*
SQ	SubQuestion. *ch.1, p.6*
TAM	Technology Acceptance Model. *ch.2, p.15*
ToC	Theory of Constraints. *ch.5, p.43*
TPB	Theory of Planned Behavior. *ch.2, p.15*
TRA	Theory of Reasoned Action. *ch.2, p.15*
UMCU	Universitair Medisch Centrum Utrecht (University Medical Centre Utrecht). *ch.1, p.3*
UU	Utrecht University. *ch.2, p.17*
WHO	World Health Organization. *ch.5, p.42*
WKZ	Willemina KinderZiekenhuis, (a Children's hospital in Utrecht). *ch.6, p.65*

1. INTRODUCTION

This thesis presents research about IT systems for healthcare professionals who work with clinical pathways. This first chapter elaborates on the problem definition, problem statement, objective, research questions, and relevance of the study.

1.1 PROBLEM DEFINITION

In the past thirty years many initiatives have been introduced to improve clinical effectiveness and patient care (Campbell, Hotchkiss, Bradshaw, & Porteous, 1998; Curran, Bauer, Mittman, Pyne, & Stetler, 2012). One of these initiatives is the development of clinical pathways (CPs). Clinical pathways — also known as integrated care pathways, care maps and a variety of other different terms — are task orientated care plans. They detail essential steps in the care of patients with a specific clinical problem and describe the patient's expected clinical course (Coffey et al., 1992). A clinical pathway represent a path that a patient can undertake if her conditions are associated with a routinely series of interventions. At each step of the path/moment in the care process, healthcare professionals can decide whether the patient must keep following the initial pathway, exit it, or begin a new one (Cabitza & Sarini, 2007). Clinical pathways build on the theories of critical path method, six sigma, lean productions, business process redesign, and the theory of constraints, which is elaborated on in Chapter 5. Over the last ten years, the usage of clinical pathways got extra stimulus after multidisciplinary guidelines were constructed on which hospitals could base their own clinical pathways (Schrijvers, van Hoorn, & Huiskes, 2012).

An example of such multidisciplinary guideline is the guideline for integrated oncological care, constructed in 2009. It is based on guidelines for doctors, nurses, and other healthcare specialists which already existed in the preceding years (Hummel, Meer, Vries, & Otter, 2009). These general multidisciplinary guidelines, are input for different operationalized multidisciplinary guidelines. Which means that the general multidisciplinary guideline is tuned to a specific situation and/or hospital. The operationalized multidisciplinary guidelines are also known as clinical pathways. This process is shown in Figure 1. An example of a clinical pathway (CP) for people with chest pain used in the medical center in Alkmaar can be found in Appendix A (Huiskes & Schrijvers, 2010). In the appendix the different activities of that particular clinical pathway are shown. In addition, also the duration of an activity is often specified in clinical pathways. The introduction of the chest pain CP in Alkmaar had several positive outcomes for the hospital and its patients. For example, the diagnosis time dropped to less than 24 hours for every patient coming in with chest pain, which is a remarkable contrast with the weeks it could take before the use of the CP. In addition to this, after introduction, patients got more coherent information from every healthcare specialist they had to deal with during their visits or stay, and they no longer had to answer the same question multiple times for different healthcare specialists.

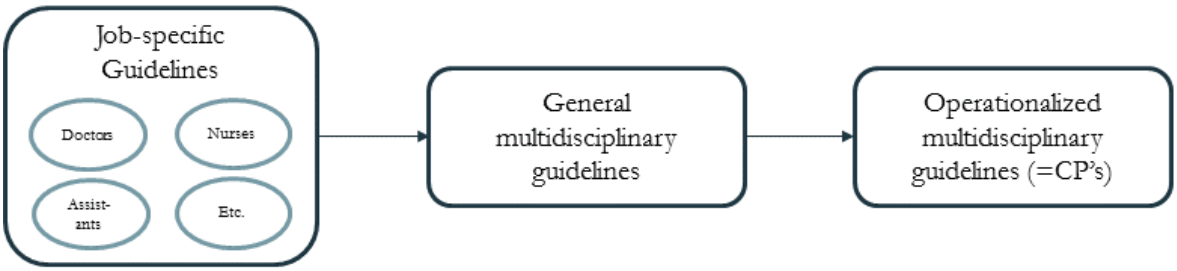

FIGURE 1: PROCESS FROM JOB-SPECIFIC GUIDELINES TO CP'S

This example shows that clinical pathways can improve clinical effectiveness and patient care, but research has indicated that clinical pathways can also be the answer to the increased financial pressures from managed care organizations, the government, and other stakeholders (Herck, Vanhaecht, & Sermeus, 2004; Weiland, 1997). In addition, Kohn, Corrigan and Donaldson (2000) state that clinical pathways improve patient care in the broadest sense; not only by reducing diagnosis time or giving coherent information, but also by the minimization of the probability of medical errors.

There are three major processes that have an influence on clinical pathways:

1. The first one is the definition of these clinical pathways. This can be done by the healthcare professionals who are going to work with the clinical pathway in combination with their patients, management, and experts in the field. The clinical pathway can be based on already existing guidelines, clinical pathways of other hospitals, scientific literature, and/or personal experience. The definition phase of a clinical pathway should be an iterative process; when there is a concept for a clinical pathway, this pathway should be tested and evaluated, and when necessary adapted, tested, and evaluated again.
2. The second process is the implementation of the defined clinical pathway. When the involved parties approve upon the definition of the clinical pathway, the process should be implemented. This may be accompanied with demos and training sessions. The implementation can be done for all patients and healthcare professionals in a certain clinical pathway at once, but also a phased-implementation is possible.
3. The third and last process that influences clinical pathways is the execution of them. In the execution phase the healthcare professionals actually going to work with the clinical pathways. In addition, also feedback loops after which the software is updated and the evaluation of variances (i.e. deviations from the clinical pathway) take place once the healthcare professionals are in the execution phase.

We define these three processes together as Clinical Pathway Management (CPM). In other words:

Clinical pathway management is the definition, implementation, and execution of clinical pathways.

A graphical representation of this definition can be found in Figure 2.

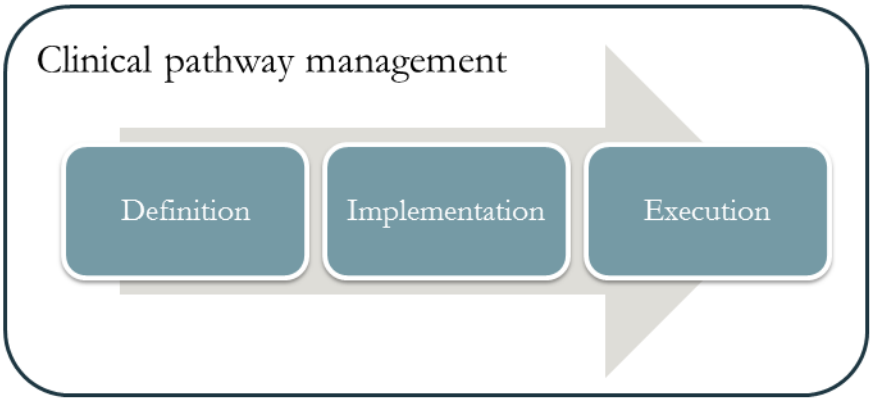

FIGURE 2: CLINICAL PATHWAY MANAGEMENT

Not only clinical pathways can lead to benefits for the health continuum, there are also studies that prove that software that support these clinical pathways add to these positive effects. We define these software programs as CPM software

Clinical pathway management software is software designed to support at least one of the processes of clinical pathway management.

Studies have shown that CPM software can lead to economic benefits (Ronellenfitsch et al., 2008), without negatively impacting the rate of complications or re-hospitalization (Müller et al., 2009). As an addition to this it is demonstrated that patient satisfaction can rise when using CPM software (Graeber et al., 2007) and it helps to achieve a patient-centric process, improving care coordination and efficient, as well as reducing medical errors (Li, Liu, Yang, & Yu, 2013). However, the effectiveness for healthcare professionals remains underexposed in these studies. A study of Schuld et al. (2011) does shed some light on this, by proving that in a hospital in Germany nurses (but not doctors) believed that CPM software was an additional workload for them. Something which suggests that CPM software maybe is not very effective for nurses. However, there is no concrete evidence for this. Hence, this study will add to this white spot in literature by researching the perceived effectiveness of CPM software according to healthcare professionals.

The case for this research: the UMCU

The 'Universitair Medisch Centrum Utrecht' (UMCU), one of the largest Dutch hospitals (UMC Utrecht, n.d.-b) has several clinical pathways defined. At the UMC departments are responsible for their own CPM. Previously there was no CPM software in the UMCU. The Dienst Informatie Technologie (DIT), the IT department of the UMCU, therefore developed a software program named Check-It to offer healthcare professionals support when using clinical pathways. The software is developed based on a concept of the Antoni van Leeuwenhoek hospital in Amsterdam. Emphasis has to be made to the fact that Check-It only focuses on one of the processes in CPM, which is the execution (i.e. use) of clinical pathways. The definition and implementation processes of clinical pathways remain unsupported by this software program. Check-It aims to support

process- and protocol-based working, and enable to, among others, ensure time savings and quality improvements. The software is integrated with the UMCU's Hospital Information System (HIS), which also serves as their Electronic Patient Dossier (EPD), called EZIS.

Currently Check-It is used in five different departments as a pilot. Two more pilot departments will be added, before the DIT will begin to "sell" Check-It to other departments of the UMCU. They have an internal buyer-seller relationship, which makes it currently not possible for other hospitals to acquire Check-It. For the running pilots no formal monitoring or evaluation system is in place. The DIT gets feedback on an unstructured basis during the trials and adjusts the software whenever necessary. Lack of evidence or the absence of structured feedback mechanisms results in no hard evidence whether or not Check-It is effective for healthcare professionals working with clinical pathways. The use of evidence based practice should give a definite answer to this question. Evidence-based practice is about making decisions through the conscientious, explicit and judicious use of the best available evidence from multiple sources (Center for Evidence-based Management, 2013; Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996). In addition to the DIT not having evidence-based conclusions about the effectiveness of Check-It, there is also little scientific literature about the effectiveness of CPM software according to healthcare professionals in general.

Research about the effectiveness of Check-It in particular, CPM software used by healthcare professionals in general, is of importance. For the DIT for the reasons explained above, but also other hospitals and the scientific community will benefit from this. When it is shown if and how CPM software can improve the workflow of healthcare professionals or have other positive effects like the reduction of turnaround time or even the reduction of medical errors, other hospitals can consider developing software to support their clinical pathways themselves. Since there is little scientific research about this subject, studying it will consequently add to the current knowledge base and can be an inspiration for further research about this subject. Subsection 1.4 will elaborate on the relevance of this study.

1.2 PROBLEM STATEMENT AND OBJECTIVE

Based on the problem definition explained in the previous section the following problem statement is formulated:

> ***There is insufficient understanding of clinical pathway management software and their added value for healthcare professionals***

Based on this problem statement, the following objective is formulated for this research:

> ***Provide a research-based conclusion about the effectiveness of clinical pathway management software for healthcare professionals***

There are two important constructs in this objective which should be defined in order to fully comprehend it. First of all, 'effectiveness' is defined as the degree to which objectives are achieved and the extent to which targeted problems are solved (Business dictionary, n.d.), other definitions of 'effective' are excluded (e.g. effectiveness in medical research is often used to relates to how well a treatment works in practice). In addition, 'research-based' is defined in this study based on two definitions of evidence-based medicine (EBM). The first one comes from Straus, Richardson, Glasziou, and Haynes (2005) which is one of the most used definitions of EBM and states that EBM is the integration of best research evidence with clinical expertise and patient values. As a derivative from this, the American speech-language-hearing association[1] formulated a goal of EBM: "The goal of EBM is the integration of clinical expertise/expert opinion, external scientific evidence, and client/patient/caregiver perspectives to provide high-quality services reflecting the interests, values, needs, and choices of the individuals we serve" (American Speech-Language-Hearing Association, n.d.). As an abstraction of these two definition we defined 'research-based' as the integration of external scientific evidence with experts' opinions.

By taking this as the objective, the outcome of this thesis will lead to a research-based conclusion about the effectiveness of CPM software for healthcare professionals who work with clinical pathways in general and one of these software programs, based on an empirical study at the UMCU, in particular. It will be known what the relevant conditions are that determine the effectiveness, what added value for healthcare professionals is, and whether it can be advised to other hospitals to also start with a software program for the execution phase of CPM. Consequently, this research will be on the on the intersection of clinical pathways, hospital software, and healthcare professionals, as can be seen in Figure 3.

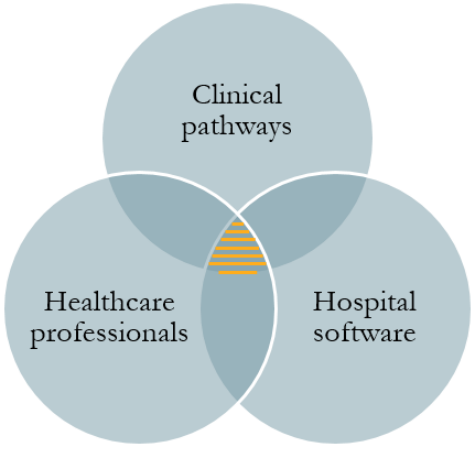

FIGURE 3: VENN DIAGRAM RESEARCH ELEMENTS

[1] The national professional, scientific and credentialing association for audiologists, speech-language pathologists, speech-, language- and hearing scientists, audiology and speech-language pathology support personnel.

1.3 RESEARCH QUESTIONS

In order to structure this research a main research question (MRQ) and several subquestions (SQ) are formulated. This is based on the objective formulated in the previous section: "[To] provide an evidence-based conclusion about the effectiveness of clinical pathway management software for healthcare professionals". As stated, clinical pathway management is about the definition, implementation, and execution of clinical pathways. Software for all three phases of CPM will therefore be object of study. However, an emphasis on the execution phase is made, since the case study only gives inside to that part of CPM. The before mentioned leads to the following questions, starting with the main research question:

MRQ: Can CPM software be effective for healthcare professionals in hospital environments?

In order to answer this main research question there are several subquestions formulated. The first four of these subquestions are posed in order to define the field and associated key concepts. Each of these subquestions can directly be linked back to the main research question.

SQ1: Which IT systems are generally used in hospital environments and what is known about their added value?

SQ2: What are clinical pathways and how do they contribute to the performance of hospital environments?

SQ3: What is known about clinical pathway management and related success factors?

SQ4: What is known about clinical pathway management software?

In addition to these four subquestions, the next subquestions are based on the single-case study that is conducted to answer the main research question. As mentioned in the introduction, Check-It is within the UMCU the software program for healthcare professionals who work with clinical pathways. This program will be evaluated in practice and therefore the following subquestions are formulated:

SQ5: What is the hospital environment of the UMCU and which IT systems do they use?

SQ6: What are the intended goals of Check-It, a CPM software program, and how does it work?

SQ7: Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?

SQ8: Evaluating the effectiveness of CPM software in general and the perceived effectiveness of Check-It according to healthcare professionals at the UMCU in particular, what recommendations for further research and hospital policy can be formulated?

Based on these eight questions this research can be split in two parts, a systematic literature study part and a case study part. These two parts can each be roughly divided in two sections. Which is illustrated in Figure 4.

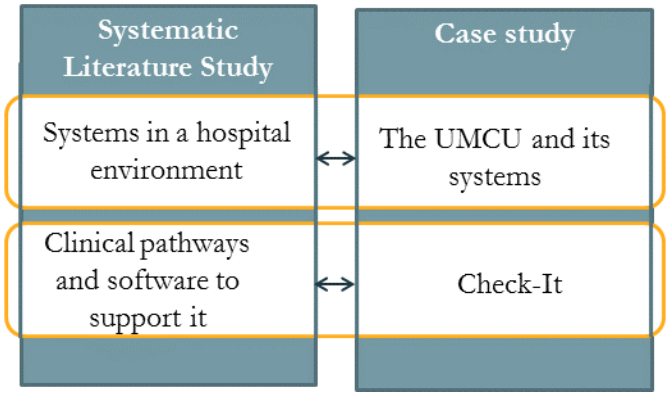

FIGURE 4: RESEARCH DIVISION

The first section is about software in hospital environments. This includes SQ 1, which IT systems are generally used in hospital environments and what is known about their added value, and SQ 5, which answers what the hospital environment of the UMCU is and which IT systems they use. The second section is about clinical pathways and software to support it. SQs 2, 3, and 4 answer what clinical pathways are, how they contribute to the performance of hospital environments, and what is known about the management and software programs of them. SQs 6 and 7 answer questions about Check-it, how it works, and what the perceived effectiveness is. SQ 8 encapsulates the two sections of the literature study as well as the case study and reflects on the answers of the other subquestions, by asking about recommendations for further research and hospital policy.

1.4 RELEVANCE

This research is relevant for several reasons that will be discussed in the following paragraphs. The reasons are divided in 'scientific relevance', 'economic relevance', and 'social relevance'.

1.4.1 SCIENTIFIC RELEVANCE

Generally speaking researchers agree with each other that clinical pathways among others do improve workflow and patient outcome, and reduce faults and costs (Panella, Marchisio, & Di Stanislao, 2003; Rotter et al., 2010; Vanhaecht et al., 2006; Zehr, Dawson, Yang, & Heitmiller, 1998). It is also known that CPM software can improve these positive outcomes even more (Graeber et al., 2007; Li et al., 2013; Müller et al., 2009; Ronellenfitsch et al., 2008). The effectiveness for healthcare professionals remains underexposed in these studies. As stated in the introduction, a study of Schuld et al. (2011) does shed some light on this, by proving that nurses (not doctors), believe that IT-supported clinical pathways is an additional workload for them. This can suggest that CPM software is less effective for nurses. However, there is no evidence for this. Hence, it is possible for this study,

which researches the unknown combination of CPM software in combination to the (perceived) effectiveness according to healthcare professionals, to fill this white spot in scientific literature.

1.4.2 Economic relevance

As already stated in the scientific relevance section, the use of clinical pathways can ensure a reduction of costs in a hospital (Macario et al., 1998; Markey, McGowan, & Hanks, 2000; Zehr et al., 1998) but also the available bed capacity seems to increase when hospitals choose to work with clinical pathways (Calland et al., 2001; Topal, Peeters, Verbert, & Penninckx, 2007). If software that support healthcare professionals who work with clinical pathways improve these advantages even more, hospitals can not only save time per patient but consequently also money.

In addition to the general economic relevance, also a very specific economic relevance is at play. With this research it can be proven whether or not Check-It has the before named advantages. If so, this thesis will provide the proof that Check-It is of value for at least other departments within the UMCU. This will make it easier for the DIT to convince other departments to work with Check-It.

1.4.3 Social relevance

Not only cost reduction, bed capacity, and the workflow of healthcare professionals encounter advantages when using clinical pathways, also patient outcome improves significantly (Kul et al., 2012). This is also illustrated by Rotter et al. (2010) who state that clinical pathways are associated with reduced in-hospital complications and improved documentation. This improved documentation is also one of the reasons there are less medical errors when healthcare professionals use clinical pathways. In addition, reduced variation is an effective means to minimize the probability of medical errors (Committee on Quality of Health Care in America, 2000). If CPM software proves to be supporting this effect even more and when more hospital departments chose to work with it, it can lead to an overall reduction of medical errors at the UMCU, nationwide, and eventually worldwide.

Not only patients can encounter the possible positive effects of CPM software, also healthcare professionals can benefit from such software programs. Brayfield and Crockett (1955) state that a happy worker is a productive worker. When a program improves the workflow and communication between healthcare professionals, and decreases the number of errors or things alike, it can be hypothesized that these professionals encounter less frustration in their jobs. This can improve their happiness and consequently, according to Brayfield and Crockett, their productiveness.

1.5 Thesis overview

In order to be able to give an answer to the presented research questions, the rest of this document is structured as follows: Chapter 2 gives an overview of the research method, which can be divided in a systematic literature review, and a case study. Chapter 3 reports the process of the systematic literature review, while chapter 4 and 5 elaborate on the results of it. Chapters 6 to 12 revolve around the case study. Chapter 6 sketches the case study background which enables the reader to put this research in perspective. This is followed by chapter 7 in which the metrics of the case study are

operationalized. Chapter 8, 9, 10, 11, and 12 elaborate on the case study results. When this is clear, chapter 13 will give an overview of all answers to the research questions in the conclusion. The last chapter in this thesis is the discussion, which elaborates on the limitations to this research. An overview of the different chapters the research questions they answer, can be seen in Figure 5.

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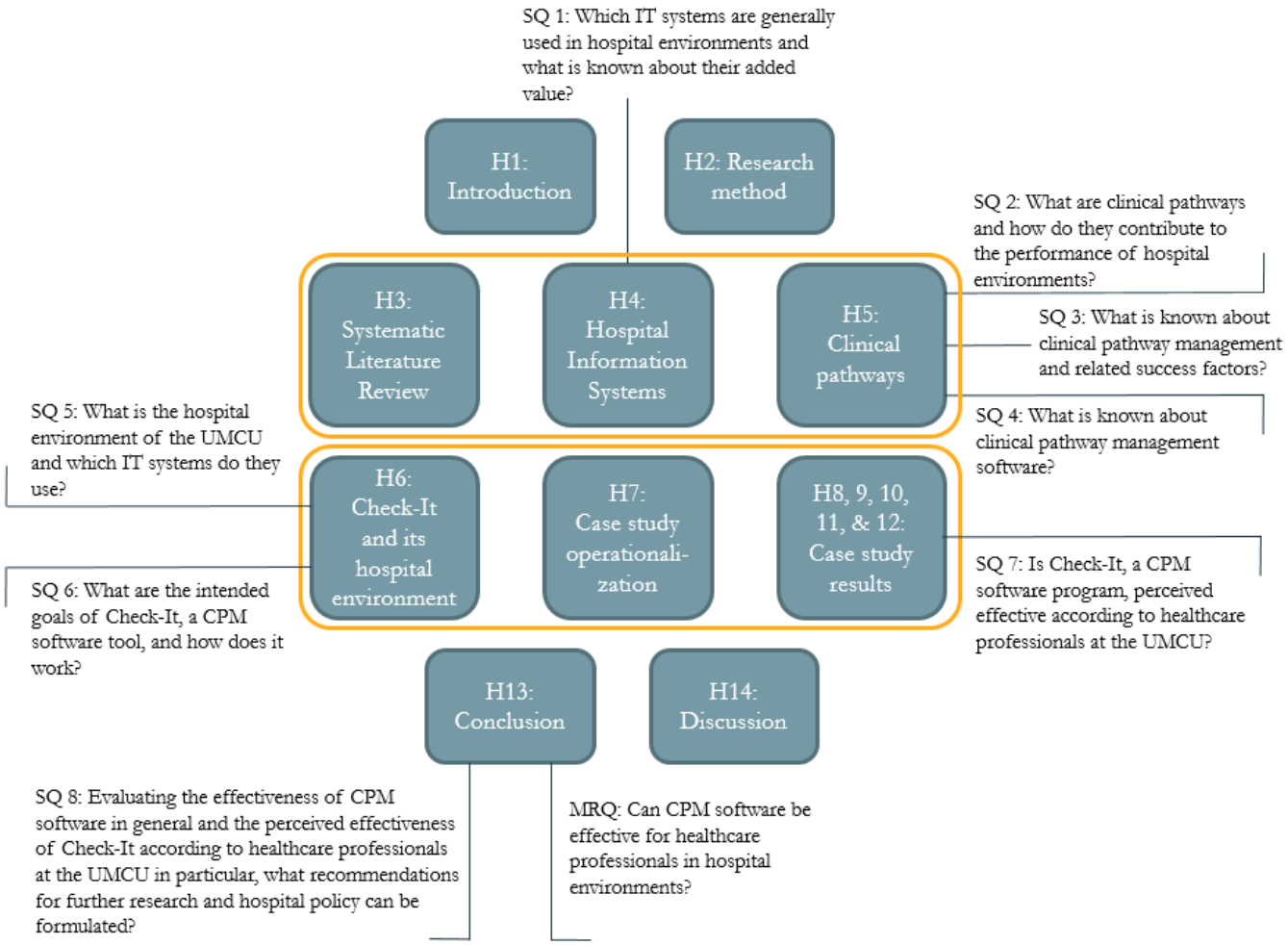

FIGURE 5: THESIS OVERVIEW

2. RESEARCH METHOD

In order to answer the main research questions stated in the previous chapter a research method is developed. This research method is elaborated on in this chapter. The study consists of two parts, a desk-research in the form of a literature study and field research in the form of a single-case study. In the next two sections these two parts will be discussed, after that the overall research process which is followed is elaborated on.

2.1 LITERATURE STUDY

The desk-research consists of two parts: a systematic literature review (SLR) and a case-study specific part. These two forms of desk research are discussed next.

2.1.1 SYSTEMATIC LITERATURE REVIEW

There are several ways to conduct a literature search. One of them, the systematic literature review, has become increasingly important in healthcare and is sometimes even used by healthcare professionals to base their clinical pathways on (Moher, Liberati, Tetzlaff, & Altman, 2009). Even though SLRs started out as a method only used in healthcare (Evidence Informed Policy and Practice, n.d.), nowadays also other fields of study, including information system research, recognize the advantages of them (Paré, Trudel, Jaana, & Kitsiou, 2014). A systematic review involve identifying, synthesizing, and assessing all available evidence, quantitative and/or qualitative, in order to generate a robust, empirically derived answer to a focused research question (Mallett, Hagen-Zanker, Slater, & Duvendack, 2012). The advantages of a SLR over an unstructured method of literature research is that the conclusions of a correctly performed SLR are replicable, scientific, and transparent (Tranfield, Denyer, & Smart, 2003), whereas the results of a more unstructured method can differ from person to person.

There are different methods to conduct a SLR. The first major guideline for systematic literature reviews was the Quality of Reporting of Meta-Analyses (QUOROM) (Moher et al., 1999), which evolved in Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) in 2009 (Moher et al., 2009). The PRISMA method is a versatile tool as opposed to other SLR methods which are designed for specific disciplines of study. For example MOOSE, which is a proposal for reporting meta-analysis of observational studies in epidemiology (Stroup, et al., 2002) and QUADAS which is a quality assessment tool for use in systematic reviews of diagnostic accuracy studies (Whiting, Rutjes, Reitsma, Bossuyt, & Kleijnen, 2003). Since its publication PRISMA has been endorsed and adapted by more than 100 journals as well as the Council of Science Editors, the Centre for Reviews and Dissemination, and the World Association of Medical Editors (Prisma Statement, n.d.), and is believed to lead to a better quality and completeness of systematic reviews (Tunis, McInnes, Hanna, & Esmail, 2013).

The PRISMA statement consists of a 27-item checklist of items to include when reporting on a SLR. This includes items such as ‘give the numbers of studies screened’ and ‘describe all information

sources in the search'. In addition to this checklist, PRISMA consists of a four-phased flow diagram which is used to structure the search in this study. The four successive phases in this flow diagram are: 'identification', 'screening', 'eligibility', and 'included'. The original PRISMA flow diagram can be found in Appendix B.

In the identification phase the researcher searches for relevant literature based on pre-specified search keys in multiple databases or other sources. Duplicate records are removed. In the screening phase the articles are screened based on their title and abstract to assess potential relevance. All irrelevant articles are excluded from further analysis. In the eligibility phase the full texts of the remaining articles are read. The articles which are deemed irrelevant are also excluded from further analysis. However, this exclusion must be accompanied by a reason for exclusion. The fourth and last phase of the PRISMA flow diagram is the inclusion phase. All articles which are in that phase are included in the literature review. Furthermore, for this study two additional inclusions are made. Also relevant articles which are referenced by the already included articles, which is known as snowballing, are included. In addition to these 'snowball articles', there are articles which provide necessary additional information to clarify and/or complete information found in other articles. By also including these last two types of articles to the SLR a more elaborate set of articles can be found.

The conduction of an SLR guided with the four phases of the PRISMA statement leads to an answer to the subquestions 1, 2, 3, and 4, which are listed below for convenience.

SQ1: Which IT systems are generally used in hospital environments and what is known about their added value?

SQ2: What are clinical pathways and how do they contribute to the performance of hospital environments?

SQ3: What is known about clinical pathway management and related success factors?

SQ4: What is known about clinical pathway management software?

2.1.2 Case study specific literature

Next to the literature search, a case study is carried out. Object of study is the clinical pathway management software program Check-It of the UMCU. In order to put the conclusions of this case study in the right perspective, additional research is done to obtain knowledge about the UMCU as an organization, EZIS as their Hospital Information System, and Check-It as their CPM software program. This research is done by reading available literature and attending courses, meetings, and demos about EZIS and Check-It. This literature search is not done using an SLR method, since most of the documents about the hospital environment of the UMCU, software they use, and Check-It cannot be found through (scientific) database search. The documents are obtained through contacts within the UMCU. The case study specific literature search, in addition to the attendance of courses, meetings and demos lead to answers to subquestions 5 and 6, which are listed next.

SQ5: What is the hospital environment of the UMCU and which IT systems do they use?

SQ6: What are the intended goals of Check-It, a CPM software program, and how does it work?

2.2 CASE STUDY

As already stated in the previous section, a case study is carried out in addition to the literature search. Object of study is Check-It, a software program developed by the DIT which is a part of the order management system clause in EZIS. Check-It is in succession piloted to seven departments. Four of these department are object of study. These departments, together with their 'going live' date can be found in Table 1.

TABLE 1: CHECK-IT DEPARTMENTS

Division	Department	Check-It in use	Object of study?
Surgical specialties	Ophthalmology	October 8th 2014	✓
Internal medicine and dermatology	Dermatology and allergology	November 10th 2014	✓
Internal medicine and dermatology	Internal medicine and infectious diseases	November 17th 2014	✗
Woman and baby	Gynecology	November 17th 2014	✗
Oncology	Otolaryngology and maxillofacial surgery	January 28th 2015	✗
Pediatrics	Pediatric pulmonology	March 9th 2015	✓
Surgical specialties	Vascular surgery	March 16th 2015	✓

Department of pediatric pulmonology and department vascular surgery are object of study since these are the only two pilot departments which did not began using Check-It at the time this research started, therefore a baseline could be obtained. To improve probative value of the conclusions, two additional pilot departments are included in this study: the department of ophthalmology and the department of dermatology and allergology. These departments are chosen over the other three pilot department since they are most accessible for a study in terms of opportunity to observe the healthcare specialists at the work floor, the voluntariness to contribute to this study of the healthcare professionals in these departments, the amount of months they work with Check-It, and the number of patients in the clinical pathway. The departments of internal medicine and infectious diseases, and gynecology have less experience with Check-It, since a fewer patients are in the defined clinical pathways. In addition, the department of otolaryngology and maxillofacial surgery does not only has fewer patients in the clinical pathways, but also has fewer months of experience than the departments that are included in this study.

The objective for this part of the study is to determine the perceived effectiveness of Check-It. As stated in the first chapter, 'effectiveness' is defined as the degree to which objectives are achieved and the extent to which targeted problems are solved. In other words: does Check-It what it promises to do? Check-It has four objectives:

1. To improve protocol-based working
2. To improve the monitoring of this protocol-based working
3. To ease administrative workload
4. To reach a more efficient workflow, among others by reducing consultation preparation time

A mixed method approach is chosen for this study, because it provides a means to answer different aspects of the complex research problem. Mixed methods research is formally defined as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study (Johnson & Onwuegbuzie, 2004) and is stated to be particular helpful in field research (Edmondson & McManus, 2007). The qualitative side of the method is for the exploratory part of the research. It is used to gain an understanding of underlying reasons, opinions, and motivations of the healthcare professionals who work with Check-It. It is also used to uncover similarities and differences in thought and opinions. The quantitative side of the method is used to quantify the research by generating numerical data which can be transformed to usable statistics. Which quantitative and qualitative measures are used is elaborated on the in Subsection 2.2.1.

After conducting the case study, subquestion 7 which is listed below, can be answered.

SQ7: Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?

When the desk-research and field research together have yielded answers to the first seven subquestions, subquestion 8 and the main research question can be answered, both are listed next.

SQ8: Evaluating the effectiveness of CPM software in general and the perceived effectiveness of Check-It according to healthcare professionals at the UMCU in particular, what recommendations for further research and hospital policy can be formulated?

MRQ: Can CPM software be effective for healthcare professionals in hospital environments?

2.2.1 PERCEIVED EFFECTIVENESS DETERMINATION

As already stated in Section 2.2, Check-It is in succession piloted to seven departments. For the last two of these pilot departments: the children division, department of pediatric pulmonology and the surgical specialties division, department vascular surgery, three points of measurement will be realized. A measurement before the departments started using Check-It, a so called baseline, and two points of measurements after the departments started using Check-It. The reason why there is chosen for two measurements after the departments started using Check-It, is because it can take time for causes to have effect, something that is called time lag (Gollob & Reichardt, 1987). By doing two instead of one of those tests, additional insight is provided about the process of healthcare professionals getting accustomed to CPM software. The three points of measurement will be respectively referred to as the pretest, posttest 1, and posttest 2. The two posttests take place after an incubation time of two and four months. These incubation times are chosen in collaboration with professionals from the UMCU, who in previous experience have noticed that this is what it takes to get accustomed to Check-It.

In order to improve the probative value of the conclusions, two more pilot departments are researched in this study, the department of ophthalmology and the department of dermatology and allergology. Consequently there is no opportunity to set a baseline, therefore these two pilot departments only undergo a posttest which will be comparable with the posttests conducted at the

department of pediatric pulmonology and vascular surgery. These two additional departments use Check-It 9 and 10 months at the moment of measurement. A graphical representation of the test timeline can be found in Figure 6.

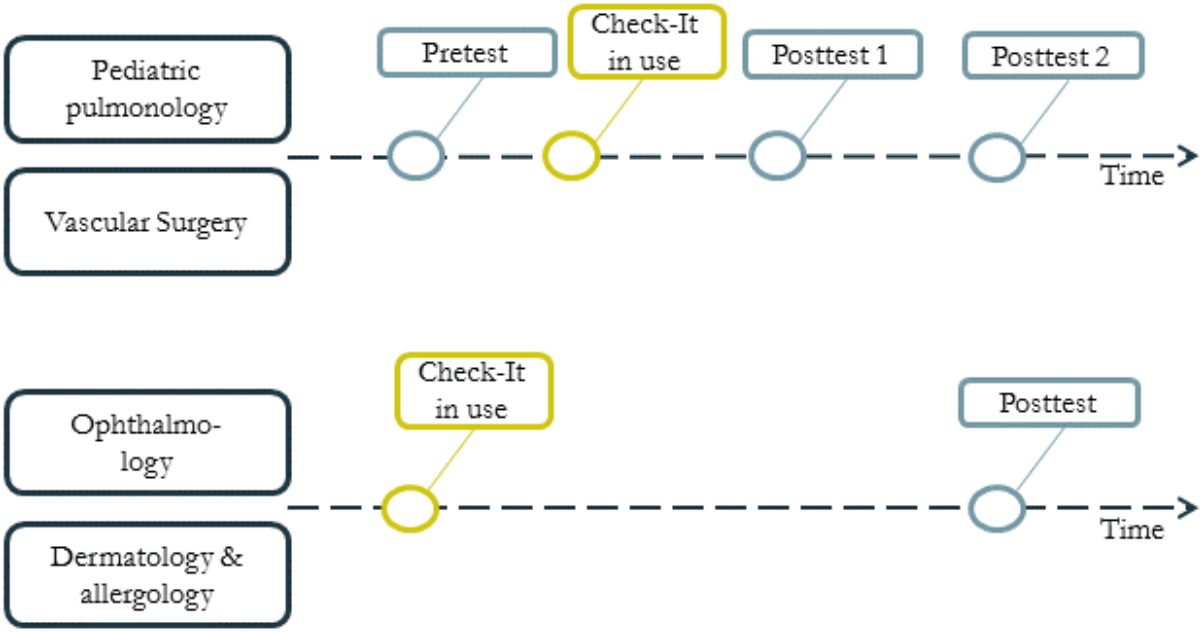

FIGURE 6: TEST TIMELINES

The pretests as well as posttests consist of a survey and an interview. There is chosen to do both to combine the strengths of these methods. While both methods contribute to uncover similarities and differences in thought and opinion, they have different ways in doing so. The strength of a survey is that it presents the questions in a highly structured way. Every participant gets the exact same questions, in the exact same order, with the exact same instructions. In addition, surveys can be filled out at the participant's preferred time, without having a researcher present. This minimizes the impact on a healthcare professional's schedule. Semi-structured interviews on the other hand, enable exploration of opinions in more agile directions. The participants have the freedom to express their views in their own terms, which can lead to unexpected topics, issues, and/or insights. By including all closed questions in the survey, the time it takes to conduct the interviews with the participants is minimized, which improves the willingness of participants to contribute.

The pretests for this study started after each participant underwent some sort of introduction/training about Check-It, which is regulated by the DIT. This ensured that each participant had basic knowledge about Check-It before answering any question. Both research methods will be discussed more in-depth in the next two sections.

SURVEYS

The surveys for this study consist of two parts. The questions in the first part are about the goals of Check-It, this is done in order to determine how well Check-It does what it promises, i.e. the

effectiveness of Check-It. It should be emphasized that the measurements do not actually measure the effectiveness of Check-It, but the perceived effectiveness of it, since it is based on the opinions of healthcare professionals.

The second part of the survey is based on the Technology Acceptance Model (TAM). TAM models regard the acceptance of technology by the people who are ought to use it. For this research it is reasoned that without the healthcare professionals accepting Check-It, it will not reach its full potential and thus losing (a part of) its effectiveness. As Berg (2001) already said: *"Whether or not a system is successful or not is decided on the work floor".*

TAM is introduced in 1989 and is nowadays still the most widely applied theoretical model in the information science field (Lee, Kozar, & Larsen, 2003; Ma & Liu, 2004; Yousafzai, Foxall, & Pallister, 2007) and is increasingly portrayed as a fitting theory for the healthcare context (Holden & Karsh, 2010). TAM is based on the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) which suggests that people form intentions to adopt a behavior or technology based on their beliefs about the consequences of adoption. Building on this, TAM (Davis, 1989) assumes that an individual's information systems acceptance is determined by two major variables: Perceived Usefulness and Perceived Ease of Use. Together these two constructs have an influence on people's Attitude and Intention to Use a piece of technology. Chau and Hu (2002) have proven that TAM is a better predictor of acceptance of technology of healthcare professionals than TRA.

Another dominant theoretical paradigm in the understanding of user acceptance of technology based on TRA is the theory of planned behavior (TPB) (Ajzen, 1991). TPB states that Behavioral Intention to perform an activity is determined by Attitude, Perceived Behavioral Control, and Subjective Norm. Perceived Behavioral Control is defined as the perception of how easy or difficult it is to perform a behavior and Subjective Norm as one's beliefs about whether significant others think that one should engage in the activity (Yi, Jackson, Park, & Probst, 2006). Just like TAM, TPB is widely applied to a diverse set of technologies in the information system context (Ajzen, Joyce, Sheikh, & Cote, 2011; Leonard, Cronan, & Kreie, 2004).

Over the years multiple additions to TAM are made to improve the predictive value of the model. TAM2 (Venkatesh & Davis, 2000) was the first and another widely used version of these additions. TAM and TAM2 both state that an individual's intention to use a system is determined by Perceived Usefulness and Perceived Ease of Use. However, TAM2 incorporates several additional constructs: Job Relevance, Output Quality, Subjective Norm, Image, Experience, Voluntariness, and Result Demonstrability, in addition to the Perceived Ease of Use have an influence of the Perceived Usefulness and ultimately the Intention to Use. Even though these constructs seem highly relevant for this study, Chismar and Wiley-Patton (2003) have proven that TAM2 is not necessary a good predictor of acceptance of technology in the healthcare context.

Multiple attempts are made to improve the predictive value of TAM/TAM2 for healthcare professionals (Chau & Hu, 2001; Holden & Karsh, 2010; Pai & Huang, 2011; J.-H. Wu, Shen, Lin, Greenes, & Bates, 2008). However, not all models have constructs which are applicable for a software used in a HIS. The TAM model as proposed in Wu, Li, and Fu (I. L. Wu, Li, & Fu, 2011) for the adoption of mobile healthcare by hospital's professionals has one of the highest predictive powers and is generally applicable for this research. This model combines the original TAM with TPB and adds the constructs Personal Innovativeness in IT, which is comparable with the construct

Experience in TAM2, and Perceived Service Availability, which is of importance in mobile health. How these constructs cohere can be seen in Figure 7. The survey questions associated with this model can be found in Appendix C. The operationalization of Wu, Li and Fu's model for this study is discussed in Section 7.1.2.

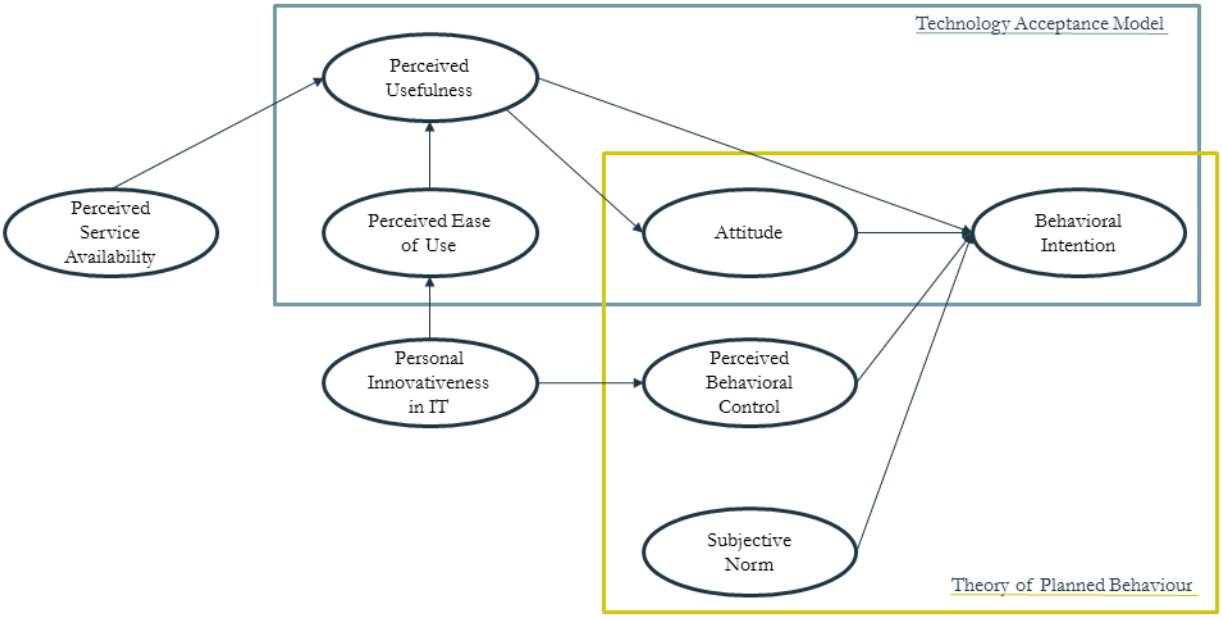

FIGURE 7: TECHNOLOGY ACCEPTANCE MODEL. ADOPTED FROM WU, LI, AND FU (2011)

INTERVIEWS

In addition to the surveys, interviews are held with all healthcare professionals who work/are going to work with Check-It. These interviews are kept as short as possible and ask the healthcare professionals about their expectations and experiences of Check-It. By keeping these interviews short it ensures that it is for all involved healthcare professionals possible to participate in this study.

There is chosen for a semi-structured interview format; each interviewee is presented with exactly the same question in the same order, however, when deemed necessary follow-up questions can be asked. This ensures that the questions are answered within the same context. This is important for minimizing the impact of context effects, where the answer given to a question can depend on the nature of preceding question (Schwarz, 1999). In addition, semi-structured interviews also give the opportunity to compare responses more accurately. The interview questions and schedules are further elaborated on in Section 7.2.

2.3 RESEARCH PROCESS

Ideally the method used in this research would follow the order of steps for validated for field research as shown in Figure 8. However, since there are several time constraints, this could not be the case. First of all already pre-arranged dates concerning Check-It must be complied with. In addition, also the funding for this research stops after a fixed period of time, within this timeframe the research should be completed.

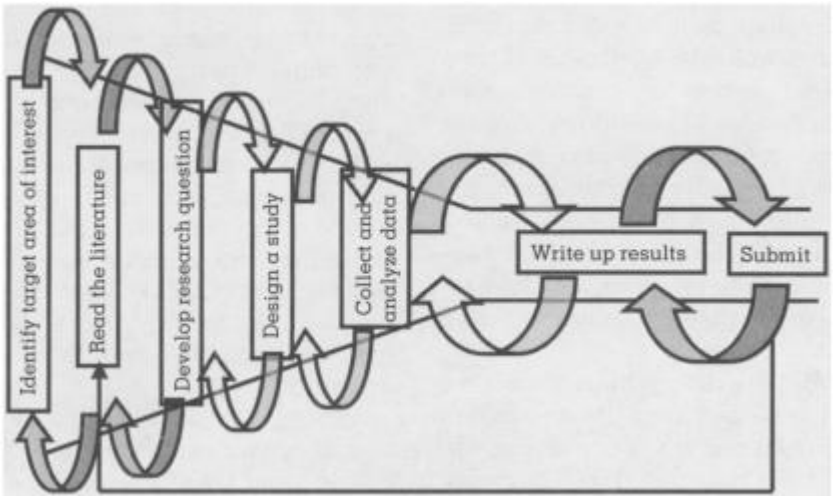

FIGURE 8: ITERATIVE STEPS FOR FIELD RESEARCH. REPRINTED FROM EDMONDSON AND MCMANUS (2007)

How this research will be conducted can be found in Figure 9 on the next page. This figure is modeled with the process deliverable diagram method as described by van de Weerd and Brinkkemper (2008). On the left side of the figure the process can be seen which will be carried out for this research on the right side the accompanied artifacts are shown. Each step is explained next.

Research proposal development

This research begins with the definition of the research scope. When the research scope is defined, a scoping review and exploratory meetings with all involved parties are conducted. These involved parties are the supervisors from Utrecht University (UU), a supervisor from the UMCU, the healthcare professionals who are involved with this research, and the department which developed Check-It, the DIT. These meetings are conducted in order to manage expectations, develop metrics for the Check-It evaluation, and get a feeling for current situation with its accompanied behavioral expectations. Based on the research scope, scoping review, and the exploratory meetings, the long proposal is written. After the proposal is approved upon by the supervisors, the second part of this research starts.

Method creation for the case study

After the proposal is agreed upon, three separate processes start: obtaining information about various subjects, the conduction of a systematic literature review and the creation of a method. The creation of the method is based on existing literature on the subject of method creation and tailored to the specific needs of this study. When the method is created, the result is sent for validation to the involved parties of the UMCU and UU. Based on their feedback the creation of the method is an iterative process of polishing the research method and sending it for validation until the method is approved. The result of this method creation is read in this chapter.

The remaining steps are explained after the figure.

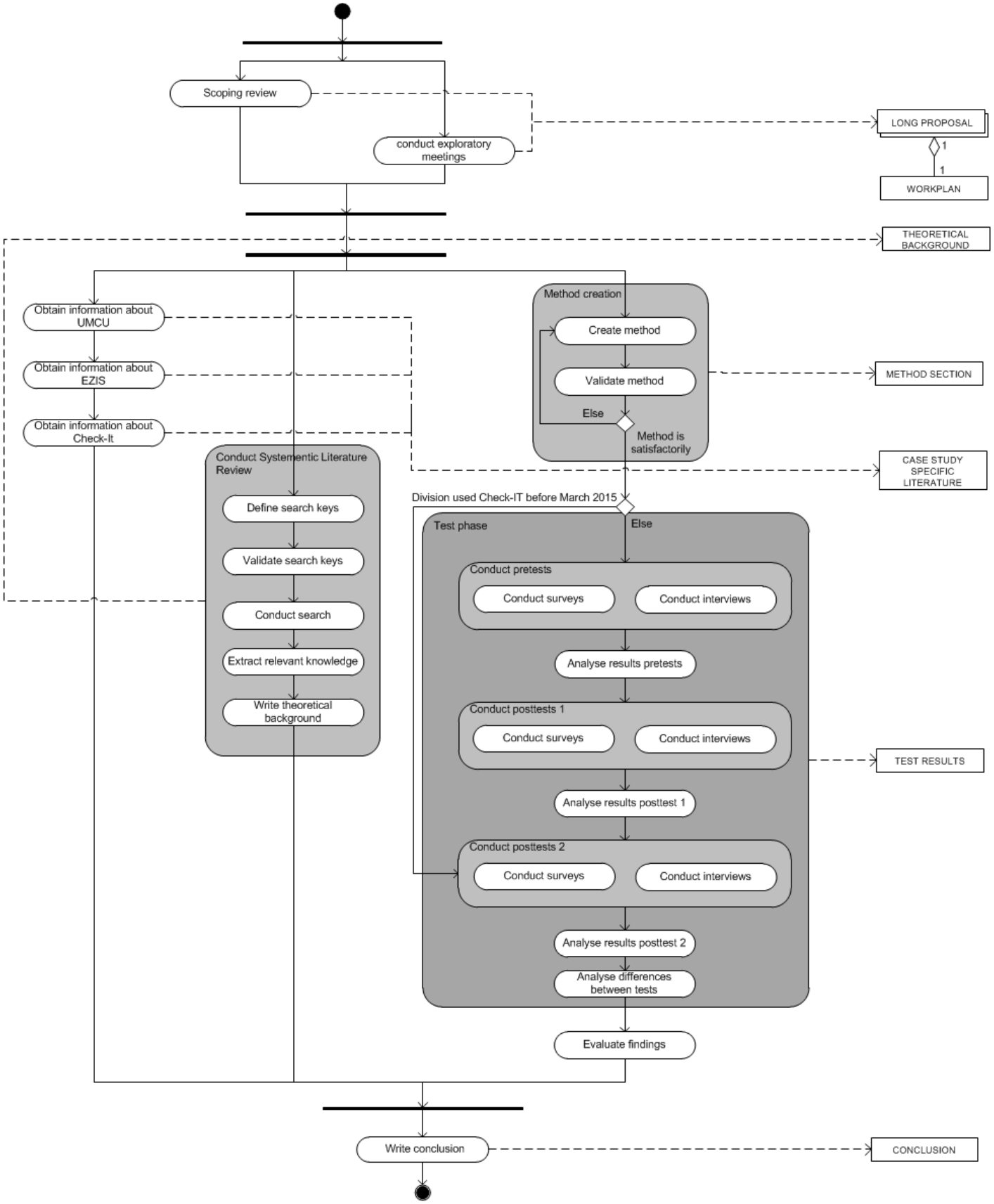

FIGURE 9: RESEARCH METHOD PDD

Case-study conduction

After the metrics based on the method are created and validated the test phase begins. The tests take place in four different departments and are dependent on the availability of the healthcare professionals and pre-arranged dates concerning Check-It. For example the exact date at which the two departments start using Check-It is already pre-arranged. This required the pretests to be completed before that date. After each test, the test results are analyzed and when possible compared with previous test results. The results of this phase can be read in Chapter 8, 9, 10, 11, and 12.

Desk-research conduction

Since there is a time constraint for the completion of the pretests, the development of the method and consequently the metrics to use, started early in the process. This means that there is not enough time to finish the desk-research before the start of the method creation. The desk-research and the creation of the method consequently start together. However, after the method creation is finished and evolves in the test phase, the desk-research will continue until it is done. The results of this phase van be read in Chapters 3, 4, 5, and 6.

Thesis finalization

When the desk-research and field-study are finished the thesis can be finalized. This is done by completing the texts accompanying the different process described in this section. In addition an abstract, conclusion and discussion are written. After the completion of all text all text, the thesis is sent for approval to the supervisors of the UU and UMCU. After the number of needed revision the final document is handed in.

3. SYSTEMATIC LITERATURE REVIEW

In this chapter the results of the systematic literature review will be presented. As stated in the research method chapter, the PRISMA statement of Moher et al. (2009) is used to structure this search. Each of the four successive phases with the yielded results per phase are discussed next.

Identification

For the identification of relevant literature two databases are searched: Google Scholar and PubMed. PubMed comprises a large number of citations for biomedical literature from MEDLINE, life science journals, and online books and is purely focused on medical literature (Pubmed, n.d.). Google Scholar on the other hand, indexes articles across an array of publishing formats and disciplines and includes most peer-reviewed online journals of Europe and America (Google Scholar, 2011). In addition, Google Scholar also includes many scholarly publishers, books and other non-peer reviewed journals. By not limiting the search only to PubMed, a larger number of articles can be searched through for the SLR, which will increase the completeness of the results.

In collaboration with the UMCU and UU a number of search keys are defined. An overview of the search keys can be found in Table 2. The exact search keys as inserted in Google Scholar and PubMed can be found in Appendix D. These search keys are selected based on their relevance with the different subquestions. Telemedicine, Clinical/Hospital information systems, E-health, Hospital, and Hospital environment plus their additions (i.e. ICT, IT, IS, Tool, System) are included since they can provide information to answer the first subquestion: 'Which IT systems are generally used in hospital environments and what is known about their added value?' For these search keys a restriction is imposed. Only articles are shown in the search results which date after the year 2000. It is chosen to only include these more recent papers, since IT is a fast moving field, which results in rapidly outdated papers. Also in the hospital environment IT changes are fast paced. Where in the 1960s the only systems in a hospital supported staff with administrative tasks. It took just twenty years to introduce HISs which support almost all functions in a hospital. After 2000 the systems where evolved enough that also organizational problems, change management, and social problems became apparent in these systems. These HISs serve as the basis for the systems we know now (Bhaskar & Somu, 2011).

To answer the next three subquestions 'What are clinical pathways and how do they contribute to the performance of hospital environments?', 'What is known about clinical pathway management and related success factors?' and, 'What is known about clinical pathway management software?' the remaining concepts are included. These are: Clinical pathway, Integrated care pathway, Critical pathway, Care pathway, and Care maps, which are all synonyms of each other, plus their additions (i.e. ICT, IT, IS, Tool, System, Performance, Success factors, Management). It is chosen too only include these synonyms and not others encompassing the concept of clinical pathways (e.g. care protocol, coordinated care pathway, pathways of care, collaborative care pathways) since de Luc and Kitchiner (2001) found these were the most common ones used in scientific literature. For each of the mentioned search keys the two databases are scanned. These search keys yield a total of 8,608,097 results divided over PubMed (134,148) and Google Scholar (8,473,949).

TABLE 2: SLR SEARCH KEYS

	X	&ICT	&IT*	&IS*	&Tool	&System	&Performance	&Succes factors	&Management
Telemedicine	✓	-	-	-	-	-	-	-	-
Clinical Information System(s)	✓	-	-	-	-	-	-	-	-
Hospital Information System(s)	✓	-	-	-	-	-	-	-	-
E-health	✓	-	-	-	-	-	-	-	-
Hospital (environment)	-	✓	✓	✓	✓	✓	-	-	-
Hospital (environment) & Effectiveness	-	✓	✓	✓	✓	✓	-	-	-
Hospital (environment) & Added value	-	✓	✓	✓	✓	✓	-	-	-
Clinical pathway(s)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Integrated care pathway(s)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Critical pathway(s)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Care pathway(s)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Care map(s)	✓	✓	✓	✓	✓	✓	✓	✓	✓

*IT = Information Technology & IS = Information System

Screening

Of the roughly 8.6 million results, 11,543 records are screened. This is done by reading the titles and when deemed relevant for this research, also the abstract. Per keyword the first hundred results were searched through for PubMed as well as Google Scholar. However, some search keys did not yield hundred results and other keywords yielded only articles on unrelated topics, which are not applicable for this research. The latter was the case when after fifty results none of the screened titles were slightly interesting for this research, after which the search stopped (e.g. when searching for 'hospital environment + tool(s)', all hits were about non IT tools in hospitals, like marketing tools or assessment tools). In addition, for the search keys 'telemedicine' and 'clinical pathway', 200 results are scanned on title and abstract. This is the case since the results were not saturated yet when reaching hundred results.

Divided over the 79 search keys and two databases, 11,543 records are screened. Based on this title and abstract screening, 630 articles are deemed interesting for this research. 113 of which originated from PubMed and 517 of Google Scholar. Consequently, 10,913 screened articles were deemed not interesting enough and are dismissed. Of the 630 remaining articles 403 were duplicates, which leaves 227 articles to be assessed on eligibility. An overview of the number of hits, number of screened articles, and number of articles marked as potentially relevant per search key can be found in Appendix E.

Eligibility

In order to access the eligibility of the remaining 227 articles, the full texts of these articles are sought. Of 41 articles no full text could be found and were thus excluded from further analysis. Another five articles could only be found in Japanese or German and are therefore also excluded. The full texts of the remaining 181 articles are further analyzed on their added value to the literature review. The articles are divided into four different categories: (1) outdated (2) not applicable (3) not relevant, and (4) include in review. Outdated articles are articles which study already superseded topics or systems. A total of 21 articles are marked as outdated. Of those 21 articles 18 articles came from the second part of the literature review (i.e. to answer subquestions 2, 3, and 4), which did not have a date restriction during the database search. However, it became apparent that articles written before the year 2000, were often obsolete. To keep the amount of literature within bounds there is chosen to mark the 16 already listed as 'potentially relevant' articles before 2000, as 'outdated' instead. In total 13 articles are deemed not applicable. These articles are often solely about a very specific country, region, or organization, which made in not applicable for this research. The last category in which articles are excluded are the articles which are deemed not relevant. An article is deemed not relevant when it has another scope than what is interesting for this study. In total 61 articles belong to this group. Of those 61 articles 13 articles are found through the 'telemedicine' search key, which is the total amount of articles found for that particular search key. Telemedicine seemed to be of importance to systems in the hospital environment, however, when reading the articles it became apparent that after 2000 it's an outdated concept which only elaborates on the possibility of communication between healthcare professionals, or healthcare professionals and patients.

Included

A total of 86 articles are included in the literature review based on this SLR process. As already stated in research method chapter (Section 2.1.1) there are two other inclusion criteria for articles. First of all, in those 86 articles other relevant works are cited. By means of snowballing to these earlier publications more relevant articles are included in this study. The 86 SLR-articles yielded a total of 68 additional papers to include. In addition to the SLR-articles and snowball-articles there is another category of articles that are included. These are articles which provide extra information about underexposed subjects mentioned in other studies. Examples are articles which provide extra information about the amount of medical errors, outpatients, Lean, Theory of Constraints, etc.. In total ten studies are included to provide extra information. This makes the grand total of included articles 164. In Figure 10 an overview of the included articles mapped on publication year can be found. It should be notes that two articles are not shown in this figure: one dating from 1961, and one from 1963. This is done to improve the scope of the figure.

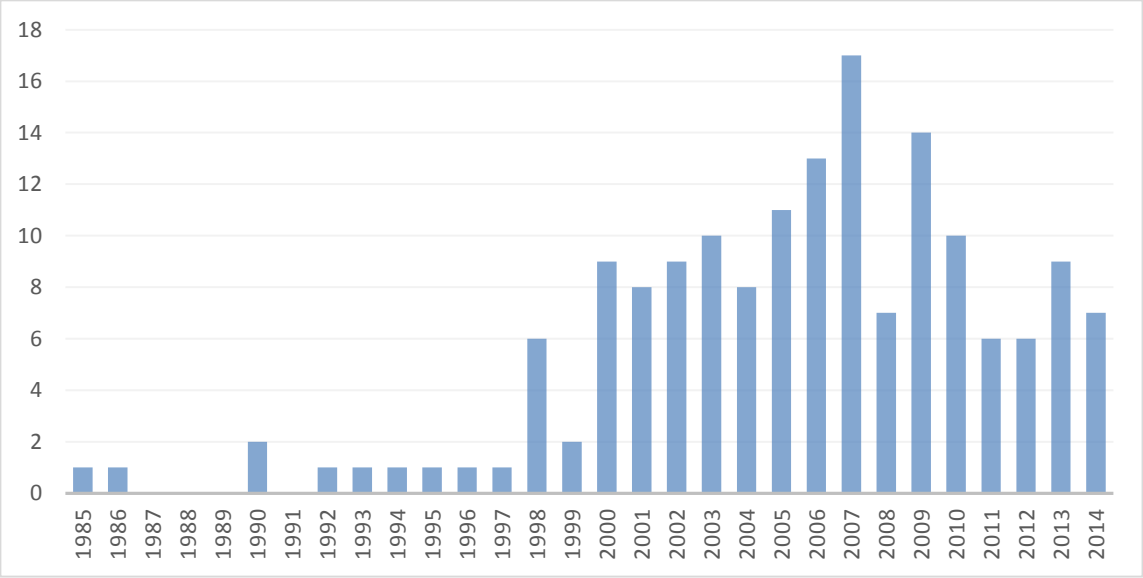

FIGURE 10: NUMBER OF SLR-PAPERS PER YEAR

The 164 included articles are read trough and the relevant sections are saved. The separate sections of all articles are grouped based on their subject (e.g. systems in a hospital environment, hospital information systems, components of hospital information systems, clinical pathway concept explanation, clinical pathway effects). Based on this, the following two chapters are written: Chapter 4: Hospital Information Systems, and Chapter 5: Clinical Pathway Management. The section subjects serve as guidance for the headings in these chapters.

An overview of the different phases of this SLR and their accompanied results can be seen in Figure 11. In Appendix F the results are dived between the results for subquestion 1 in Figure 71, and the results for subquestions 2, 3, and 4 in Figure 72.

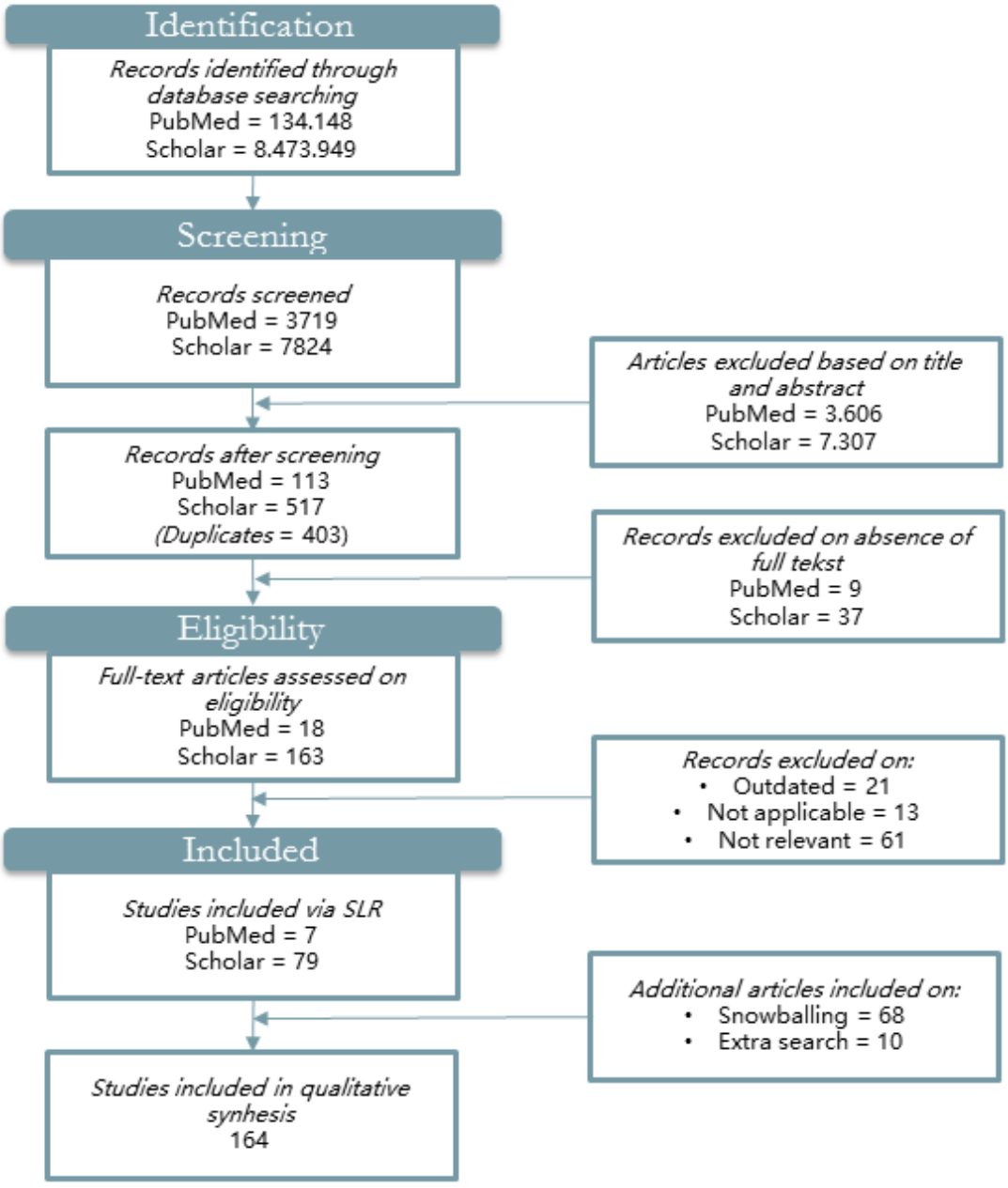

FIGURE 11: SLR RESULTS

4. HOSPITAL INFORMATION SYSTEMS

This chapter is the first result of the SLR described in the previous chapter. It will provide an answer to the first subquestion: 'Which IT systems are generally used in hospital environments and what is known about their added value?'. Therefore hospital software is object of study, as is shown in the Venn diagram of the elements of this study in Figure 12.

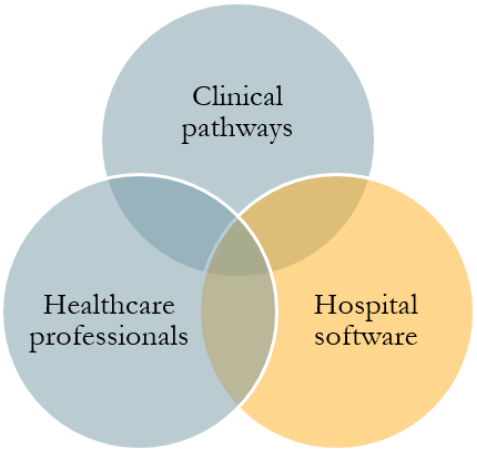

FIGURE 12: VENN DIAGRAM FOCUSED ON HOSPITAL SOFTWARE

This chapter is structured as follows: first the link between hospitals and IT will be explained. After that literature is presented on what a hospital environment entails. Section 4.3 will elaborate which systems can be found in such a hospital environment. Which is followed by a section about hospital information systems, components of hospital information systems, and how to implement them. The last section will conclude this chapter by giving an answer to which IT systems are generally used in hospital environments and what is known about their added value.

4.1 HOSPITALS AND IT

This section is split in two subsections. First it is elaborated on why IT in hospital is needed, where after the market share (which is a reflection of this need) of hospital IT is discussed.

4.1.1 WHY IT IN HOSPITALS IS NEEDED

Over the last few years a lot is written about hospital information systems and their added value. Researchers agree that hospitals and IT are currently so intertwined that hospitals cannot exist anymore without IT, something that is illustrated with the following quote of Sutherland, van den Heuvel, Ganous, Burton, and Kumar (2005):

> ***"The complexity of modern healthcare has outrun the capabilities of manual and paper based operations."***

Especially over the last few years, health information technology and management systems in hospitals have been seen as a potential game-changers that could transform the future of healthcare through its innovative capabilities, and improve safety, lower costs and make the life for staff working in the health sector easier (Lacanna, 2013). This is necessary since hospitals are subject to constant impulses from the national government and insurance companies to improve efficiency and effectiveness (Spanjers, Hasselbring, Peterson, & Smits, 2001) and better use of IT is essential to providing better care at lower cost. The government and insurance companies (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003) pressure hospitals among others because they recognize that our society changes rapidly. There has been a tremendous progress in medicine as well as in information technology during the last decades (Haux, 2006). According to the United Nations (2013) globally the number of older persons (aged 60 years or over) is expected to more than double by 2050. The proportion of the world's population aged 60 years or over increased from 8% in 1950, to 12% in 2013 and is expected to reach 21% by 2050. While the demographic dependency ratio –which is defined as the ratio of the number of children under age 15 plus older persons aged 65 years or over, to the number of persons aged 15 to 64 years– was 1 person to 12 persons in 1950, 1:9 in 2000 and is estimated to be 1:4 in 2050. This process is of influence to the organization of healthcare and to the future development of IT in hospitals (Haux, 2006).

IT is typically seen as a key enabler to improving healthcare processes due to its potential of providing rapid and comprehensive access to information at the point of care (Lenz & Kuhn, 2004). This is important since after heart disease and cancer, medical errors kill the most people every year (Starfield, 2000). Medical errors ranging from medication errors, adverse events and diagnostic errors have been sources of worry among healthcare consumers and providers for decades (Adetiba, Eleanya, Fatumo, Matthews, & Iruemi, 2010; Blendon et al., 2002). These medical errors range from incorrect medication doses or incorrect diagnosis, to failure to conduct the necessary tests or mistakes due poor communication (Committee on Quality of Health Care in America, 2000; Croskerry, 2003). According to the IOM report To Err is Human written by the Committee on Quality of Health Care in America (2000), medical errors are responsible for between 44,000 and 98,000 deaths solely in US hospitals per year. Which results in the US healthcare system wasting two billion dollar annually on hospital based adverse medication reactions alone. In the European Union medical errors and healthcare related adverse event occur in 8% to 12% of all hospitalizations (Conklin, Vilamovska, de Vries, & Hatziandreu, 2000). Most of these medical errors are preventable, and in a survey conducted by Robinson et al. (2002), it is reported that most physicians believe that reduction of medical errors should be a nation's priority. This is in accordance to the role of IT identified by the Institute of Medicine in six care improvement aims for the twenty-first century, which include safety, which is a direct consequence from reducing medical errors, but also effectiveness, patient-centered care, timely delivery, efficiency, and equity in healthcare (Corrigan, 2005). Furthermore, according to experts groups, national think-tanks, health authorities and physicians across different nations a lot of opportunities lie with an adoption and good integration of IT in hospitals (Adetiba et al., 2010).

It has been shown that information technology can reduce the rate of errors by preventing errors and adverse events -which is an undesired harmful effect-, by facilitating a more rapid response after

an adverse event has occurred, and by tracking and providing feedback about adverse events (Bates & Gawande, 2003). In addition, IT in hospitals is believed to improve the efficiency, cost-effectiveness, quality and safety of medical care delivery (Anderson, 2007; Shekelle, Morton, & Keeler, 2006) and therefore improve practitioner performance and patient outcome (Harrison & Palacio, 2006). A systematic literature review of Buntin, Burke, Hoaglin, and Blumenthal (2011) shows that of 154 researched articles about IT systems in hospitals, 92% had positive conclusions about these systems. The other 8% mostly represent potential problems associated with the implementation and use of IT in hospitals. The promise of positive effects of IT in hospitals is one of the reasons why Castells (2007, as cited in Kaye, Kokia, Shalev, Idar, & Chinitz, 2010) conclude that health IT systems are considered among the highest priorities of modern healthcare.

4.1.2 Market share of hospital IT

This priority is also reflected in the growth of the market. The worldwide information and communication technology (ICT) market volume is estimated at nearly 2.5 trillion euro's in 2009 with a growth rate of about 5% per year and since ICT has become a major factor for quality and efficiency of healthcare worldwide this market has emerged to a leading industry branch (Winter et al., 2011). Even though the exact percentage of healthcare ICT on the world wide ICT market is not known, the US estimated that the total expenditures of ICT equipment and software were about 330.9 billion Dollar in 2013, of which 8,5% (28,2 billion dollars) is spend in the healthcare market, which was 8,1% in 2007 (US Census Bureau, 2014). Unfortunately, these numbers are not known for the European Union. However, it may be clear that IT has an increasingly important role in the healthcare sector. This can also be seen in the paper of Hannah, Ball, and Edwards (2006) who state that most health informatics professionals agree that a reasonable expenditure on information systems in healthcare is at least 3% to 5% of the operational budget for a health organization. However, a the study of Anderson (2007) indicates that hospitals in 15 European nations spend on general only 1,8% of their total revenue on information technology, while another study shows this number lies between 2.5% and 3.3% (Healthcare Information and Management Systems Society, 2008). Even though both these numbers are is still too low according to most health informatics professionals, healthcare and healthcare information technology spending continues to rise at the fastest rate in history (Roberts, 2007). In 2005, total national health expenditure in the US rose with 6.9%, which is two times the rate of inflation and is expected to rise at this rate in the future (Borger et al., 2006).

This rise is for a part to devote to the fact that IT capabilities in healthcare have improved considerably in the past few years (Burke, Wang, Wan, & Diana, 2002). It has expanded steadily from primarily administration- and business oriented applications to more and more clinical oriented systems that are routinely used on a daily basis (Giuse & Kuhn, 2003). According to Haux (2006) there are seven lines of development in health information systems which influenced this process.

1. The first one being the change from paper-based processing and storage toward computer-based information processing tools. Parallel to this development, there was an increase of data to be processed and stored, mainly due to the increase of diagnostic and therapeutic procedures, which also made this computer-based processing and storage necessary.
2. The second line Haux identifies is the change from local to global information system architectures. Where in the 1960s, 1970s and 1980s research was mostly focused on

functionally limited applications in special departments of a hospital, this changed in the late 1980s to 1990s where information processing in a hospital as a whole became more important. Starting in the late 1990s research has shifted focus again to information processing in healthcare regions, mostly in rather global sense, which is still often object of study today.

3. The third line represents the shift from healthcare professionals to patients and consumers. Where at the beginning, computer-supported health information systems were primarily intended to support healthcare professionals (which in itself also shifted from mainly focused on physicians and administrative staff to also including nurses) nowadays the direct support of patients and their relatives is just as important.
4. The fourth line that has had an influence on the health information systems we know today, is the shift from using data only for patient care to also use this for research. Since the data is now also used for research which has a continuous influence to medical statistics and our knowledge about the domain, systems should be able to give structured output.
5. The fifth identified line is about the change from technical to strategic information management priorities. While from the 1960s to the 1990s the technical problems where the main focus of the computer-supported information systems, this changed after 2000. Organizational problems, social issues and change management aspects became as relevant and were even becoming dominant for the field of health information systems.
6. The sixth line identified by Haux is about the inclusion of new types of data. Especially since the higher degree of use of computer-supported information processing tools, it became important that the systems could support more types of data. DNA and protein data are examples of data which several years ago could not be processed by information systems in hospitals.
7. The seventh and last line which has had an influence on healthcare systems is the inclusion of new technologies. Especially the increase of functionality in computer supported health information systems, has had an influence on this.

Ball and Lillis (2001) add another important change to this. They state that especially the internet had a large influence on systems in hospital environments. According to them it has at least an influence on consumer education, disease management, clinical decision support, consumer communication and administrative efficiencies. Nowadays Winter et al. (2011) see that new technologies such as mobile devices and multifunctional bedside terminals proliferate and when looking to the future Ashraf, Härkönen, Hämäläinen and Riekki (2007) see yet another opportunity for wireless technology. They foresee that hospitals outfit every patient with tiny, wearable wireless viral sign sensors, which would allow doctors, nurses and other care givers to continuously monitor the status of their patients. However, how the technology or the hospital environment changes in the future, one thing stays the same; providing high-quality and efficient healthcare will continue to be strongly correlated with high-quality information and communication technology and a sound methodology for systematically processing information (Winter et al., 2011).

4.2 E-HEALTH AND THE HOSPITAL ENVIRONMENT

This section is split is two subsections. First the concept E-health is explained. In order to create a deeper understanding about E-health systems, it is important to know in which context, also known as the hospital environment, they operate. What a hospital environment entails is elaborated on in the second subsection.

4.2.1 E-HEALTH

An important concept combining IT and the hospital environment is E-health. Eysenbach (2001) sees it as a general buzzword, used to characterize not only 'internet medicine', but also virtually everything related to computers and medicine. That it is hard to give a concise definition of this concept is illustrated in the quote from the Editorial Board of Journal of medical Internet research (2001) they state:

> ***"Stamping a definition on something like E-health is somewhat like stamping a definition on 'the internet': it is defined how it is used – the definition cannot be pinned down, as it is a dynamic environment, constantly moving."***

However, several researchers and companies try anyway. One of the earlier definitions comes from Intel (as reffered in Eysenbach, 2001), who refer to E-health as "a concerted effort undertaken by leaders in healthcare and hi-tech industries to fully harness the benefits available through convergence of the internet and healthcare". In addition, a very recent definition comes from Fernando and Dawson (Fernando & Dawson, 2014) who state that E-health refers to "the application of facsimiles, computers, fixed telephones, mobile phones and other information and communication devices to support patient care". While the definition of Intel focuses on a general activity undertaken by people combining internet and healthcare, the definition of Fernando focuses more on the technology side of E-health, and only states which ICT elements it contains. A definition which includes both and is often used, states that "E-health is a field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhances through the internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology."(Eysenbach, 2001).

4.2.2 HOSPITAL ENVIRONMENT

Before we go into detail which E-health systems exist in the hospital environment, first it is important to elaborate on the context these systems operate in. This is referred to as 'healthcare context of use' (Gil-Rodríguez, Ruiz, Iglesias, Moros, & Rubió, 2007; Kuziemsky, Downing, Black, & Lau, 2007; Viitanen, 2010). Context of use is defined by the ISO standard 9241-11 as the circumstances in which a specific system, product or service is used and which includes the following four elements: users, tasks, equipment, and environment (ISO Standard, 1998). Viitanen (2010) describes the four elements of context of use for hospital environments;

1. He states that the users of healthcare systems include healthcare professionals, patients, and other actors like insurance companies and research facilities. Of these three groups healthcare professionals and in particular nurses and clinicians are the primary users of the systems in a hospital environment. The secondary users Viitanen identifies are other care workers, healthcare administrators and researchers.
2. The tasks of healthcare systems range considerably (Winter et al., 2011) even though the main goal of all physicians and nurses in a hospital is to take care of and cure patients. Nevertheless, different groups of healthcare professionals require different working practices. In addition, the goals of patients are completely different form the goals of healthcare professionals. They might be more related to increasing the understating of one's own health, information retrieval, communication with healthcare professional or interacting with other patients (Viitanen, 2010). Therefore the tasks of a system that is designed to be used for patients as well as healthcare professionals, should support a variety of tasks.
3. The third element of the ISO standard lists equipment. Viitanen states that the technology environment in healthcare organizations consists of thousands of healthcare information systems, medical devices, and other technology applications. Additionally, handheld technologies, wireless applications, and mobile support for care delivery are currently entering the field.
4. The last element, (hospital) environment, is the hardest to pin point. Since environment incudes physical environment, as well as social and cultural environment and can even been seen as the wider technical environment. With regards to all these aspects of environment, it can be stated that the environment in which healthcare systems are used vary significantly (Viitanen, 2010). Healthcare professionals use the systems in their working places, whereas patients use it in their own time or even place. Even though the healthcare work itself is characterized with intensive processes, cooperative activities, and continuous communication between workers, which doesn't differ much from hospital to hospital, the physical environment can differ considerably. Physical environments which can affect healthcare systems usage are for example, wards, operation rooms, control rooms, emergency department, healthcare professionals' workrooms, corridors, cafeterias, and so forth. To make it more complicated, patients and all citizens may use healthcare technologies in some of these surroundings or outside the hospital environment. Thus when looking at the context of use in a hospital, it can be concluded that there are common denominators, but in general the hospital environment can vary a lot.

How the hospital environment differs and corresponds with other sectors has been examined by Avison and Young (2007). They state that there are several general differences and similarities between the healthcare sector and other sectors, as can be seen in Table 3.

TABLE 3: HEALTHCARE COMPARED TO OTHER SECTORS. ADOPTED FROM AVISON AND YOUNG (2007)

Healthcare compared to other sectors	
Differences	**Similarities**
Management	Process orientation
Customer	Center of attention
Variants	System integration

Starting with the similarities, it can be said that process orientation, which is defined as the improvement in quality, costs and delay through integrated processes, is important for every sector. Also the center of attention is shifted to patient-centered, following product-centered and customer-centered success in other sectors. The last similarity that Avison and Young list, is about system integration. Although healthcare systems are typically larger, more complex, and employ more people than other systems, they still benefit from a whole-system analysis. In addition to these similarities, there are also several difference between the healthcare sector and other sectors. For example when looking at the management. While this is unified in most sectors, in healthcare is has both clinical and operational reporting. Also when looking at the customers you can see an important difference. While most sectors have clear customers, it varies considerably in health care. Patients can be seen as healthcare customers, but in addition, also clinicians, the government and service providers can be seen as such. Together the elements listed in this section make up for the hospital environment. This is the environment many different systems should operate in. Which systems exists will be elaborated on in the next section.

4.3 SYSTEMS IN A HOSPITAL ENVIRONMENT

A wide variety of information systems are used in hospitals (Viitanen, 2010). They play a key role in healthcare delivery and patient care, as well as the administrative tasks of a hospital. There are several attempts to classify these hospital systems. One of these classifications comes from Norris (Norris, 2002). He divides the hospital systems in three typical health information processes and types, which are shown in Figure 13.

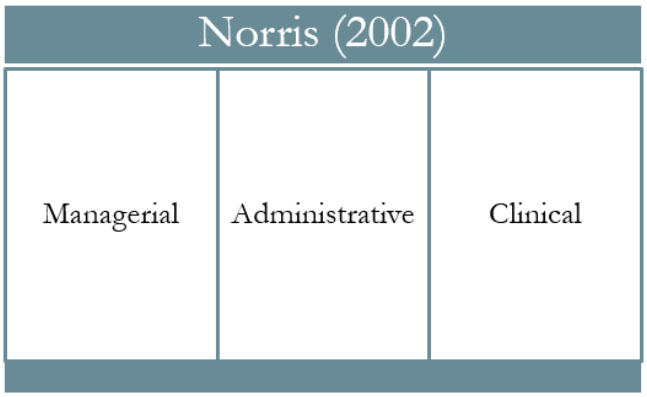

FIGURE 13: SYSTEMS CLASSIFICATION ACCORDING TO NORRIS (2002)

Performance data, service planning data, demographic information, and epidemiological statistics are examples of information that is used in managerial hospital systems. Procurement, contracting data, resource utilization and information about education and training is typically seen in administrative hospital systems, and test data, diagnostic information, evidence-based medicine, and clinical pathways and procedures are grouped under the term clinical hospital systems. Another classification comes from Hannah, Ball, and Edwards (2006), as is shown in Figure 14. Instead of focusing of the information which is used in the systems, they categorize systems used in hospital environments based on their objective and scope. Just like Norris, they recognize three different types.

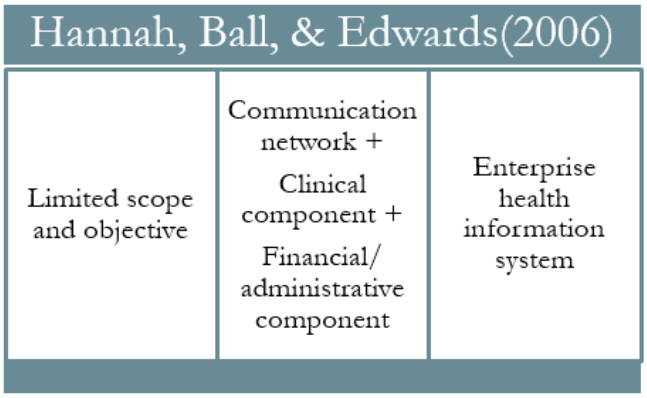

FIGURE 14: SYSTEMS CLASSIFICATON ACCORDING TO HANNAH BALL, AND EDWARDS (2006)

The first type is composed of systems that are limited in objective and scope. They mostly exist as a stand-alone module and address a single application area. Hospital systems that are commonly included in this category are clinical laboratory systems, financial systems, dedicated radiology, electrocardiography, pulmonary function, pharmacy, and dietary systems. The second type of information system is composed of hospital information systems, which usually consist of a communications network, a clinical component, and a financial/administrative component. The overall communication component integrated the three major parts in a cohesive information system. The third type of information system identified by Hannah, Ball, and Edwards are the so-called enterprise health information systems (EHISs). EHISs capture and store comprehensive patient information across the entire continuum of care in health organizations using integrated healthcare delivery models. These systems are characterized by the fact that they are focused on patients (rather than departments or disciplines) receiving care in multiple integrated setting (e.g. ambulatory care, acute care, long-term care) having one common organizational structure (i.e. a single enterprise). This last type is currently rapidly expanding. Not everybody however, makes the distinction between these last two categories, HISs and EHISs are often both grouped under the term HIS. What HIS exactly entails and how it is used is elaborated on in the next section.

4.4 HOSPITAL INFORMATION SYSTEMS

In this section two important questions which will deepen the understanding about HISs are answered: What is a HIS? And why use HISs?

These two questions correspond to the subsections they are answered in. Starting with a concept explanation in 4.4.1: What is a HIS?, followed by a summary of different studies which why hospitals need HISs in 4.4.2: Why use HISs?.

4.4.1 WHAT IS A HIS?

Currently when doing a Google Scholar search on "Hospital Information System" around 30,400 papers pop up (including some meta-analyses on the subject). The writers of the articles present a variety of different studies with different perspectives on the subject. In those studies HISs are defined in many different ways and presented from various points of view. Some articles focus on the organization aspects of information processing, while others focus on the technology used. A HIS can for example be defined as "a computer system designed to ease the management of all he hospital's medical and administrative information and to improve the quality of health care" (Degoulet & Fieschi, 1997) or "as a communication network linking terminals and output devices in key patient care or service areas to a central processing unit that coordinates all essential patient care activities" (Hannah et al., 2006). But also "as the information processing and information storing subsystem of a healthcare organization, which may be a single institution (…) or a group of healthcare institutions (…)" (Winter et al., 2011) or as "a comprehensive, integrated information system designed to manage the administrative, financial, and clinical aspects of a hospital" (Petroudi & Giannakakis, 2009). The one constant is that HISs are dealing with processing data, information and knowledge in hospital environments. For this research, an adjusted version of the definition of Petroudi and Giannakakis (2009) is used as the leading definition of HIS. A HIS is therefore defined as a comprehensive, integrated information system designed to manage different aspects of a hospital. It is chosen to omit naming the aspects of a hospital which can be supported by a HIS since it may well be this changes from time to time.

The first HISs were developed in the mid-1960s in the US and a few European countries, such as the Netherlands, Sweden and Switzerland (van de Velde & Degoulet, 2003). The original purpose of HISs was to provide a computer-based framework to facilitate the communication of information within a hospital setting (Hannah et al., 2006). Nowadays the aim of an HIS is somewhat broader formulated, HIS are said to be aimed to achieve the best possible support of patient care and administration by electronic data processing (Petroudi & Giannakakis, 2009) and to sufficiently enable the adequate execution of hospital functions for patient care, including patient administration, taking into account economic hospital management as well as legal and other requirements (Winter et al., 2011). In order to achieve these aims Winter et al. (2011) formulated different tasks for HISs. First of all they are to make information available. This information should be provided on time, at the right location, to authorized staff, in an appropriate and usable form. To be able to do this, data must be collected, stored, processed, and systematically documented to ensure that correct and up-to-date patient information can be supplied. In addition, HISs should make knowledge, for example about drug-drug interactions, available to support diagnostics and therapy. Information about the quality of patient care and the performance and cost situation within the hospital should also be made transparent for healthcare professionals.

4.4.2 WHY USE HISS?

According to Haas and Kuhn (2011) the need to use HISs is the result of three relevant fundamental aspects. The first is that hospitals are placed under a high level of pressure with regard to their effectiveness and efficiency. In addition, the translation of medical knowledge into everyday clinical work can barely be achieved without appropriate support in terms of information technology and the last listed aspect, which is highly relevant for this thesis, is that the implementation of guidelines and the organizational coordination and streamlining by means of clinical pathways cannot be achieved effectively without corresponding supporting IT functions. Today's HISs are an answer to these fundamental aspects. Several benefits of HISs have been well documented in a number of clinical studies (Jamal, McKenzie, & Clark, 2009). HISs are for example known to decrease paperwork and workload of healthcare professionals, increasing administrative efficiencies and expanding access to affordable care (Hillestad et al., 2005; Schoen et al., 2006) and have also shown to be effective in preventing medical errors (Bates et al., 1998). In addition there are also several benefits expected by healthcare professionals. Haas and Kuhn (2011) and, Petroudi and Giannakakis (2009) both list some of these benefits. Their lists include: the reduction or repression of registrations, the reduction of office duties for medical and nursing staff, easier access to medical data, reduction of duration of hospital stay, minimization of the insufficient medical recipes, minimization of errors in the recording of results, redeployment reorientation or reduction of staff, improvement of quality of registrations, improvement of quality of care, better communication, reduction of hospital costs, increase of satisfaction of nurses, growth of common hospital database, improvement of perception of patients on their care, improvement of general appearance of the hospital, better operational transparency, improved integration between different professional groups, and a more comprehensive view of patient treatment. These examples illustrate that the relevance of 'good' HISs is of importance, because it can potentially lead to important benefits (Haux, 2006). Whether or not these benefits are reached depend on a lot of different factors. It can for example depend on the attitude of the people who are working with the system(s), the integration between the components, the conditions within the hospital, but also on the set of components in the HIS.

4.5 COMPONENTS OF HOSPITAL INFORMATION SYSTEMS

Each hospital can use a different set of components (i.e. subsystem) for their HIS. These components can be grouped based on their function. Haas and Kuhn (2011) have made such a high-level grouping of the components of which HISs exist. They state that in most successful HISs there are components for data processing support (e.g. generating statistics and evidence), documentation support (e.g. clinical diagnosis documentation), organizational support (e.g. bed management on wards), communication support (e.g. transmission of case data to health insurers) and decision support (e.g. clinical reminders and warnings during order entry). Another grouping comes from Degoulet (2014), he groups the three major categories of processes in a HIS and considers these three groups as HIS subsystems. These HIS subsystems are the decision systems, clinical information systems, and logistic information systems. Together these three subsystems are linked by (digital) communication, as can be seen in Figure 15.

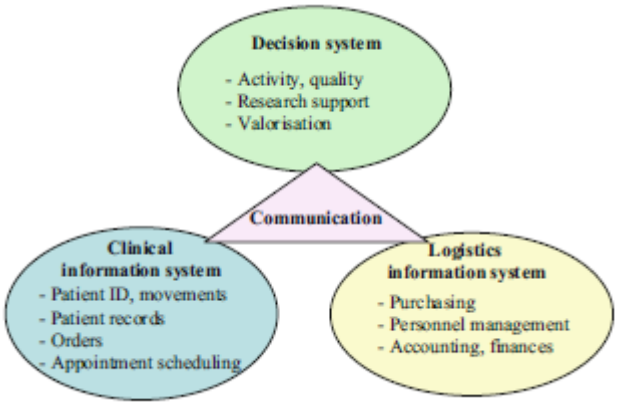

FIGURE 15: THREE HIS SUBSYSTEMS. REPRINTED FROM DEGOULET (2014)

Winter et al., (2011) do not attempt to group the underlying components, but list the basic (and most used) components of HISs. Before each of these components will be elaborated on, it should be noted that not every HIS contains these discussed components as a separate, identifiable application but it can be integrated as a part of another system.

Patient administration system

This system supports the administration of patients and their contacts at the hospital. It typically serves several hospital functions like scheduling and resource allocation (e.g. proving means for ordering transport services), patient identification (e.g. generating a unique patient identification number), administrative admission (e.g. merging patient information from two records), visitor and information service (e.g. proving relatives with information on the location of a patient), coding of diagnoses and procedures (e.g. provide catalogs and other means for coding patients' diagnoses, which is a basis for the hospital's billing), and administrative discharge and billing (e.g. proving means for initiation of final billing).

Medical documentation system

This system supports specific documentation tasks and often contains specialized modules for different medical fields. It typically serves the following hospital functions: medical admission (e.g. providing forms for documenting diagnosis), decision making and planning of patient treatment (e.g. provide context-related medical knowledge), execution of diagnostic, therapeutic, and nursing procedures (e.g. provide forms for preparing clinical reports), patient discharge and transfer to other institutions (e.g. provide means for finalizing documentation), and human resources management (e.g. assign doctors to patients or rooms).

Nursing Management and documentation system

This system offers similar features as the medical documentation system except that it is focused on nurses. It typically serves several hospital functions including nursing admission (e.g. providing forms for documenting the nursing history), medical and nursing care planning (e.g. provide forms

for documenting nursing tasks), execution of nursing procedures (e.g. providing forms for documenting the outcome of nursing tasks), coding of diagnoses and procedures (e.g. provide catalogs and other means for coding of nursing diagnosis), nursing discharge and nursing report writing (e.g. providing forms for writing the nursing discharge report), and human resources management (e.g. providing means for managing ward staff).

Outpatient management system

Outpatient services are medical procedures or tests that can be done in a medical center without an overnight stay (WebMD, 2013). An outpatient management system is, just like the nursing management and documentation system, comparable with a general medical documentation system. However, in an outpatient management system there is a stronger support of appointment scheduling. Other functions which are supported by these kind of systems are: human resources management (e.g. assigning staff to patients or outpatients units), medical admission (e.g. providing means for patients' check-in), decision making and planning of patient treatment (e.g. providing forms for documenting planned tasks), execution of diagnostic, therapeutic and nursing procedures (e.g. proving forms for clinical reports), patient discharge and transfer to other institutions (e.g. providing forms for writing the discharge report) and, administrative discharge and billing (e.g. providing means for initiating final billing for outpatient treatment). Outpatient management systems should be closely connected to other application components used on the ward.

Computerized Provider or Physician Order Entry System (CPOE)

A CPOE system only supports order entry. This can be order entry for diagnostic or therapeutic procedures, as well as ordering medication. Typical features in order entry are for example providing orders for patient-related drugs, providing drug catalogs, but also providing orders for patient-related examinations and the selection of orders from order sets. Some POE systems support receiving and presenting findings, however, this is usually done by other components such as RISs and LISs, which are elaborated on in the next paragraphs.

Patient Data Management System (PDMS)

A PDMS is specialized to automatically monitor, store, and clearly present a vast amount of patient-related clinical data in an intensive care unit. Because these intensive care units deal with seriously ill patients who are treated in intensive care units, PDMSs typically serve the following features: medical admission (e.g. providing means for patients' check-in), medical and nursing care planning (e.g. offering decision support for care planning), execution of diagnostic, therapeutic and nursing procedures (e.g. displaying vital parameters from monitoring devices), coding of diagnoses and procedures (e.g. providing catalogs and other means for coding of procedures), patient discharge and transfer to other institutions (e.g. communicating discharge information), supply and disposal management (e.g. assigning staff to patients or rooms), scheduling and resource allocation (e.g. providing means for managing medical devices) and, human resource management (e.g. work scheduling).

Operation Management System

This system supports healthcare professionals in ORs. The typical supported displaying vital parameters from monitoring devices), coding of diagnoses and procedures (e.g. providing catalogs and other means for coding diagnoses), patient discharge and transfer to other institutions (e.g. providing forms for preparing operation reports), supply and disposal management (e.g. providing means for managing rooms), scheduling and resource allocation (e.g. providing means for creating operation plans, either daily, weekly or monthly) and, work scheduling and time management (e.g. providing means for preparing work schedules).

Radiology Information System (RIS)

A RIS offers features comparable to those of out-patient management systems, even though in radiology department in- and outpatients are examined. Typical supported hospital functions are: medical admission (e.g. providing means for patients' check-in), execution of radiological examinations (e.g. receiving orders and assigning them to modalities), appointment scheduling (e.g. assigning patients to modalities), coding of diagnoses and procedures (e.g. providing catalogs and other means for coding radiological diagnoses), management of medical devices (e.g. managing modalities), and work scheduling and time management (e.g. providing means for preparing work schedules).

Picture Archiving and communication system (PACS)

Digital pictures are stored in PACSs. They allow the storage, management, manipulation, and presentation of large numbers of image data. In a hospital a RIS should be closely connected to the PACS, but the PACS should also be able to connect with the patient administration system, medical documentation system, CPOE and PDMS, since they all need quick access to reports and images.

Laboratory Information System (LIS)

A LIS supports the management of the whole procedure of laboratory analysis. This includes the receiving the order and sample, the distribution of the sample to the different analytical devices, the collection of the results, the technical and clinical validation of the results and the communication of the findings. A LIS should be closely connected to the medical documentation system, outpatient management system, POE, and PDMS.

Enterprise Resource Planning System (ERP)

ERP systems enable hospitals to manage its financial, human, and material resources. It supports hospital functions such as controlling (e.g. providing means for overhead cost management), financial accounting (e.g. providing means for asset accounting), facility management (e.g. providing means for incident tracking), human resources management (e.g. providing means for organizing requirement), quality management (e.g. providing a collection of internal processes and regulations) and, supply and disposal management (e.g. providing means for managing logistics). Most of the software products used for ERP systems in hospitals are not specific to hospitals, but are also used in other industries outside healthcare where similar administrative functions have to be supported.

Data Warehouse System

This systems contains data which has been extracted from other application components. This data is typically used for hospital management and/or research by integrating data from different application components, structuring and analyzing this data, and providing means for data mining.

Document Archiving System

Depending on national laws, patient related data has to be stored for many years. Document archiving systems make sure this is possible. It uses sustainable standardized data formats, document formats and interfaces. It is typically closely linked to all other application components which generate data and/or documents and should be able to import and scan documents, manage storage formats and media, index document content, provide access, and attach digital signatures.

Others

In addition to these commonly used application components, there are several other components which are less common. Examples are blood bank management systems, cardiovascular information systems, decision support systems, dialysis information systems, digital dictation systems, oncology information systems, orthopedics information system, pathology information systems, pharmacy information systems, and teleradiology systems. The use of these systems among others depend on the size of the hospital and willingness of healthcare professionals to work with these systems.

4.6 HOSPITAL INFORMATION SYSTEM ARCHITECTURE

How these application components of the previous section relate to each other in a HIS is shown by Reichertz (2006) and can be found in Figure 16. He distinguishes patient management from hospital management. These management areas are combined by the 'core'. This core preferably consists of a central database and central communication system (even though cases are known which have a more distributed construction of databases or communication systems, sometimes due to legacy systems). This database and communication system are serving the central operational purposes of the hospital in the context of its dual goals. The horizontal service layers provide the means for daily operations for patient care as well as hospital management. They are directly connected to the core, since the data exarches between these systems is frequently and in high volume. The vertical department layers support the functions of a department or a subsystem within the hospital. In hospital management, these systems process patient data and communicate with the world, for example for supplies or finances. In patient care it serves the medical departments and services with for example their administration, planning and control, documentation, and scientific evaluation. The last two layers, respectively patient proximity level and office system level, do not necessarily have to communicate to the core. Examples are word processing or special purpose systems like nuclear medical systems.

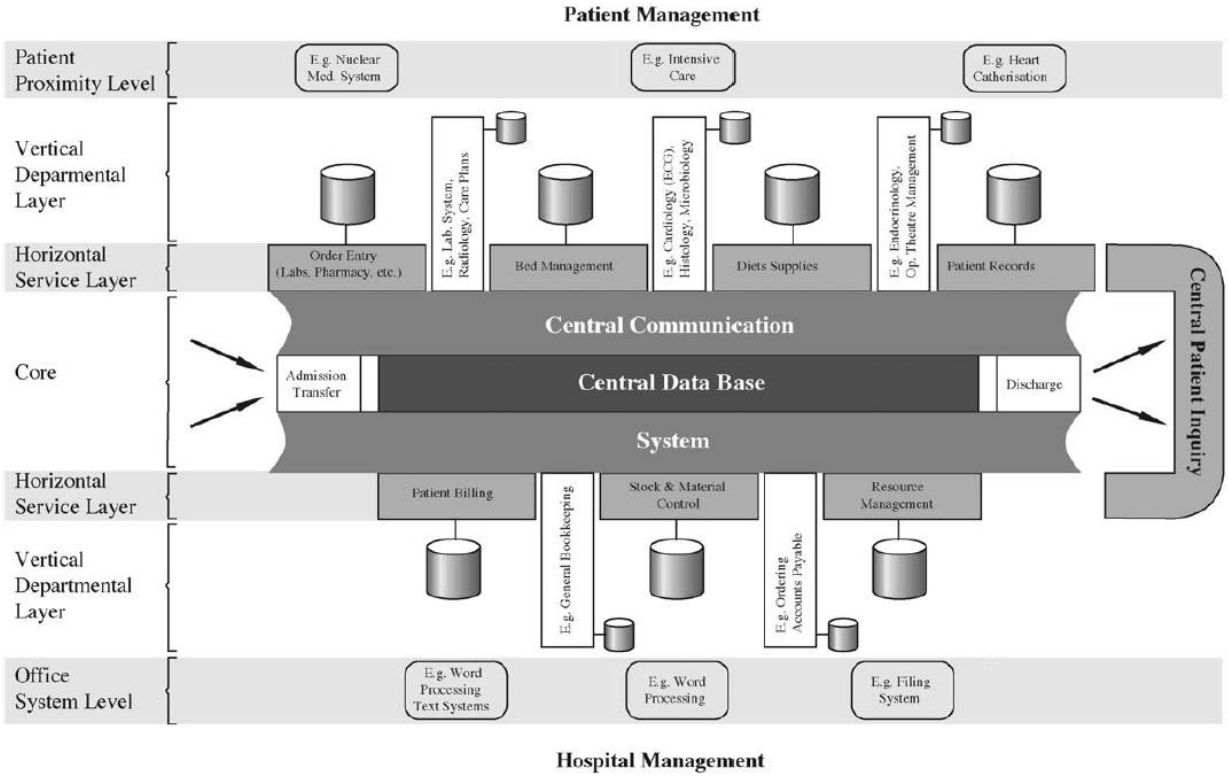

FIGURE 16: CONCEPTUAL MODEL OF HISS. REPRINTED FROM REICHERTZ (2006)

4.7 CONCLUSION

The goal of this chapter was to give an answer to the first subquestion: 'Which IT systems are generally used in hospital environments and what is known about their added value?'

It can be stated that the delivery of safe and effective healthcare remains an ongoing challenge for healthcare professionals (Jamal et al., 2009). IT is seen as a key enabler to improve these healthcare processes and can lead to several benefits including the reduction of medical errors and costs, and improving efficiency, quality, practitioner performance, and patient outcome. Whether or not a system is effective in a particular hospital depends on the hospital environment. A hospital environment is the circumstance in which a specific system is used in terms of users, tasks, equipment, and environment. Needless to say, a hospital environment can differ a lot from hospital to hospital.

There is a wide variety of systems that are generally used in hospital environments, these can be for example grouped based on their based on the processes they support or how many systems they entail. The most common systems found in hospitals are: patient administration systems, medical documentation systems, nursing management and documentation systems, outpatient management systems, computerized provider/physician order entry systems, patient data management systems, operation management systems, radiology management systems, picture archiving and communication systems, laboratory information systems, enterprise resource planning systems, data warehouse systems, and document archiving systems.

When linking several of these systems together it can be called a Hospital Information System. A HIS is a comprehensive, integrated information system designed to manage different aspects of a hospital. They are aimed to achieve the best possible support of patient care and administration by

electronic data processing. Next to investments in these HISs, another investment that hospitals make to improve their safety and effectiveness in patient care, is in the development of clinical pathways (Nagykaldi & Mold, 2007). These clinical pathways will be object of study in the next sections.

5. CLINICAL PATHWAYS

This chapter is the second and last result of the SLR described in Chapter 3. It will provide an answer to the second, third, and fourth subquestions: 'What are clinical pathways and how do they contribute to the performance of hospital environments?', 'What is known about clinical pathway management and related success factors?' and, 'What is known about clinical pathway management software?'. As can be derived from these subquestions, clinical pathways are object of study in this chapter, this is shown in the Venn diagram of the elements of this study in Figure 17.

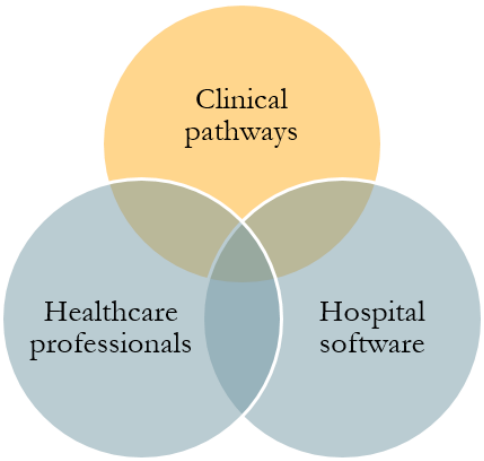

FIGURE 17: VENN DIAGRAM FOCUSED ON CLINICAL PATHWAYS

This chapter is structured as follows: it starts with a brief introduction to clinical pathways, followed by clinical pathway history and a concept explanation. When it is clear what a clinical pathway precisely entails, the effects of them will be elaborated on. Section 5.5 will thereafter, list studies about clinical pathway management, which is followed by a section about clinical pathways in combination with IT. Just as Chapter 4, this chapter concludes by giving an answer to the covered subquestions.

5.1 INTRODUCTION TO CLINICAL PATHWAYS

As stated in Section 4.1 one of the main challenges of modern healthcare organizations is the increment of treatment quality combined with the decrement of healthcare provision costs (Alexandrou, Skitsas, & Mentzas, 2011). This struggle between the cost and quality of healthcare has led providers to look for new and innovative ways to deliver cost-effective care in an efficient manner (Cheah, 2000). To address this, many different management concept have been introduced which have in common that they try to reduce complexity in order to increase performance of healthcare operations (Broekhuis & van der Vaart, 2005). Examples of this are the design of niche-type healthcare facilities, such as 'focused factories' (Leung, 2000), the development of more integrated jobs oriented toward a particular patient domain, such as the nurse practitioner (van Offenbeek &

Knip, 2004), and new ways for the allocation of resources, such as clinical pathways (Atwal & Caldwell, 2002; Vanhaecht & Sermeus, 2003). According to Carnett (1999) healthcare organizations could cut costs by as much as 30% if they adopt best practices that eliminate waste and overuse. Panella, van Zelm, Sermeus and Vanhaecht (2012) identified next to the growing healthcare costs, another challenge in healthcare which ensures that clinical pathways are tools that even doctors propose themselves (Cabitza & Sarini, 2007). They state that a part of the growing healthcare costs are due to the aging population. These patients are more often chronically ill than patients with other ages. Current healthcare delivery systems are often unable to meet the complex needs of chronically ill patients for several reasons; the healthcare is traditionally focused on acute care management and short term goals, there is a fragmented delivery of health and social services and, often chronic care approaches feature an uniformed, passive patient interacting with a poorly coordinated team of health professionals.

Clinical pathways have not only become popular for their opportunity to allocate resources, and as a consequence degrease healthcare expenditure, but they are also seen as a fundamental step to ensure that the latest evidence is used in the care of patients. This is especially important due to the increasing amounts or research information and the belief that evidence should be used as a basis for clinical decision making (MacDermid, 2008) as opposed to several years back, when the decision making process in hospitals was mostly opinion based (Rotter et al., 2010). In addition, clinical pathways are seen as a solution for the high amount of variation that exist in clinical pathways (Currie & Harvey, 2000), and it is used as a means of enhancing interprofessional and interorganizational relationships (Atwal & Caldwell, 2002; Deneckere et al., 2012). Especially in western countries, interprofessional teamwork is perceived as being essential for delivery of high-quality healthcare (Committee on Quality of Health Care in America, 2007). Reports of the Joint Commission show that 70% of medical errors are caused by lack of communication between team members (Joint Commission on Accreditation of Health Care Organizations, 2006). In reaction to this, the World Health Organization (WHO) identified this lack of communication and coordination as the first priority for patient safety research (Bates, Larizgoitia, Prasopa-Plaizier, & Jha, 2009).

5.2 CLINICAL PATHWAY HISTORY

This section is divided in three subsections. In the first subsection the management theories which have the same body of the though as clinical pathways are discussed. When it is clear to which paradigm clinical pathways belong, the evolution of clinical pathways is elaborated on. This section concludes with a subsection about clinical pathways today.

5.2.1 MANAGEMENT THEORIES

The term clinical pathway was first coined by Zander, Etheredge and Bower (1985) in the mid-'80 at the New England Medical Center in Boston and is believed to be derived from several industrial quality improvement processes (Rooney, 2014; Schrijvers et al., 2012) and so-called Standard Operating Procedures (SOP) (van Dam et al., 2013) from the '50 to the '80. SOPs are defined as "detailed, written instructions to achieve uniformity of the performance of a specific function" (Meenakshy, 2013). In these SOPs and industrial quality improvement processes the variation and timing of processes is monitored to track changes and make improvements (Every, Hochman, Becker, Kopecky, & Cannon, 2000). There are several which share the same paradigm:

1. The first of these procedures which is of importance to clinical pathways is the Critical Path Method (CPM), which identifies critical and non-critical tasks with the goal of preventing time-frame problems and process bottlenecks (Kelley, 1963).
2. CPM led to the Program and Evaluation Technique and Review (PERT), which treats statistically probable durations together with confidence intervals (Kelley, 1961).
3. Motorola combined PERT and CPM and created Six Sigma (Schrijvers et al., 2012). Which is a quality management approach to improve operational performance of an organization by identifying weaknesses and improving processes within the organization (Tennant, 2001).
4. At the same time Motorola developed Six Sigma, Toyota began to use Lean. Lean is a systemic method for the elimination of waste within a manufacturing process (Naylor, Naim, & Berry, 1999).
5. In 1986 the Theory of Constraints (ToC) was developed. ToC adopts the common idiom "a chain is no stronger than its weakest link" and focusses on identifying constraints and restructuring the organization accordingly (Goldratt, 1990).
6. The last management theory that should be mentioned is Business Process Redesign (BPR). BPR focuses on the analysis and design of workflows and business processes within an organization (Earl, 1994).

Even though these management theories were originally not applied in healthcare, the concept of clinical pathways has its roots in these management theories and shares the same philosophy.

5.2.2 Clinical pathway evolution

Clinical pathways were developed as a managed care initiative to stabilize spiraling healthcare costs (Cheater, 1996, as cited in Kent & Chalmers, 2006). A study from 1998 (Currie & Harvey, 1998b) shows that after the initial use of clinical pathways in the USA, they were adopted in different countries in different ways. This resulted in multiple views about the aims, definition, and implementation of clinical pathways (Hummel et al., 2009), something which will be discussed in more detail in Section 5.3. After the USA, the UK was the first to adopt clinical pathways in the early 1990s (Vanhaecht, Panella, van Zelm, & Sermeus, 2010). While in the USA the global concept was originally used as a framework for balancing costs and quality, with a focus on decreasing these costs, in the UK clinical pathways were viewed as a way of achieving higher quality of care across care settings (Currie & Harvey, 2000; de Bleser et al., 2006). After the UK, the rest of the world followed with its adoption of clinical pathways in the late 1990s (Vanhaecht et al., 2010).

While the first pathways reflected only the activity within a single institution or service, developers came to the realization that it is much more important to link pathways along the continuum of care (e.g., hospital to home) (MacDermid, 2008). In addition, the first-generation pathways were usually diagnosed-based (e.g., diabetes, stroke), symptom-based (e.g., chest pain, high blood pressure), or procedure-based (e.g., total joint replacement, heart biopsy). In contrast to this, the second-generation pathways highlights activity or function (e.g., enteral feeding, memory loss) with a resulting focus on education, teaching, and client outcomes rather than specific medical interventions (MacDermid, 2008). And while the early clinical pathways were based on paper, nowadays IT becomes of more importance, something which will be elaborated on in Section 5.6.

5.2.3 CLINICAL PATHWAYS TODAY

That we still know clinical pathways today is according to Kent and Chalmers (2006) due to the fact that clinical pathways focus on the cost as well as quality outcomes, in contrast to other initiatives which pit one against the other. Clinical pathways are accepted as a process management tool in healthcare which helps in cost effective patient management while maintaining a high standard for quality of care (Meenakshy, 2013). Over the years the enthusiasm for clinical pathways has grown. Nowadays there is an international community of clinical pathway enthusiasts, a number of national associations and regional networks, a dedicated journal, an annual conference (Allen, 2009) and many hospital have numerous pathways in use (Darer, Pronovost, & Bass, 2002; Schrijvers et al., 2012). A study from the European Pathway Association (EPA) reported that in 2005, 23 countries worldwide were involved with clinical pathways, with a median experience of five years (European Pathway Association, 2005). Another research, also conducted in 2005, uncovered the level of pathway use for 17 European Union members (Hindle & Yazbeck, 2005). They concluded that there was a substantial increase in pathway use between 2004 and 2009 in all researched countries. In addition, a paper from 2003 reports that at least 80% of the hospitals in the United States use clinical pathway for at least some of their interventions (Saint, Hofer, Rose, Kaufman, & McMahon, 2003). In a study among 46 Dutch hospitals clinical pathways were the most used management theory (van Lent, Sanders, & van Harten, 2012), as can be seen in Table 4 and at least over half of the Dutch hospitals have a clinical pathway in use (Raad voor de Volksgezondheid & Zorg, 2005). Even with these numbers, there are researchers that are of opinion that the prevalence of pathways is still rather meagre, and hope to see these numbers grow in the future (Vanhaecht, de Witte, & Sermeus, 2007a).

TABLE 4: FREQUENCY OF MANAGEMENT THEORIES USED IN DUTCH HOSPITALS. REPRINTED FROM VAN LENT, SANDERS AND VAN HARTEN (2012).

Approaches	Total (%)	*CP**	*BM**	*BPR**	*LM**	*TOC**	*CI**	*TQM**	*OR**	*FF**	*LSS**	*SS**
*Clinical pathways (CP)***	91		32	20	20	18	15	10	12	10	8	6
*Benchmarking (BM)***	78	32		20	18	18	13	11	11	7	6	4
*Business Process reengineering (BPR)***	48	20	20		14	10	6	6	10	6	5	4
*Lean management (LM)***	48	20	18	14		13	7	4	8	7	2	5
*Theory of constraints (ToC)***	43	18	18	10	13		8	6	7	6	2	4
*Continuous improvement (CI)***	33	15	13	6	7	8		4	1	5	2	1
*Total Quality Management (TQM)***	28	10	11	6	4	6	4		5	2	2	1
*Operations research (OR) **	28	12	11	10	8	7	1	5		4	3	3
*Focused factories (FF)***	22	10	7	6	7	6	5	2	4		1	1
*Lean six sigma (LSS)***	17	8	6	5	2	2	2	2	3	1		3
*Six sigma (SS)***	13	6	4	4	5	4	1	1	3	1	3	

*= Other approaches used by hospitals that used the approach indicated in the left-hand column. Result in column CP till SS in numbers.
**= approach used.

5.3 CLINICAL PATHWAY CONCEPT EXPLANATION

Although clinical pathways have been in use for around 30 years, there is still a great deal of uncertainty surrounding the definition, actual use, methods to develop and implement, and the effect of pathways on outcome (Vanhaecht, de Witte, & Sermeus, 2007b). This section will elaborate on

the definition and aims of clinical pathways, of what components they exist and how they differ from medical guidelines.

The high level of uncertainty around the definition of clinical pathways, is partly due to the many variations to the term clinical pathway (Currie & Harvey, 2000). A study from de Luc and Kitchiner (2001) concluded that there are 17 different terms encompassing the concept of clinical pathways. The most common terms besides clinical pathway, are care pathway, critical pathway, integrated care pathway and care map, but also care protocol, anticipated pathway, care profile, collaborative care plan etc. are used to indicate this term. In a later study from the European Pathway Association (EPA) (Vanhaecht et al., 2006) which included 23 countries, 13 different (English) synonyms were mentioned. This confusion surrounding the terminology of clinical pathways is partly due to the fact that that there are a lot of different definitions for clinical pathways. These definitions can differ per county (e.g. the USA and UK had different views of CP's), per region, per medical field, per hospital and even per professional. In a study about these definitions, de Bleser et al. (2006) have found 84 different definitions for clinical pathways. This lack of a uniformly accepted definition about what a clinical pathway entails has an impact on the understanding of the phenomenon and on the ability to scientifically evaluate them (Kinsman, Rotter, James, Snow, & Willis, 2010).

The remainder of this section is dived in five subsections. The first three elaborate on the different definitions and aims of clinical pathways. After which subsection 5.3.4 list the components of clinical pathways. This section is concluded with a subsection about the difference between clinical pathways and medical guidelines.

5.3.1 Different clinical pathway definitions

Because of the lack of uniformity discussed before, two trends in literature emerged. The first trend is that authors began to use their own definition for clinical pathways (Ellis & Johnson, 2013; Every et al., 2000; Graeber et al., 2007). If there is no uniformly accepted definition, there is room to create one's own. In addition it can be speculated that researchers wanted to solve this problem and hoped that their own definition would become leading. The other trend in literature is of the researchers who try to make an abstraction of different versions of the definition of clinical pathways. An example of this is the research of Kinsman et al. (Kinsman et al., 2010) who have identified five key descriptors of clinical pathways. According to them clinical pathways:

1. Are a structured multidisciplinary plan of care
2. Are used to translate guidelines or evidence into local structures
3. List detailed the steps in a course of treatment or care in a plan, pathway, algorithm, guideline, protocol or other 'inventory of actions'
4. Have timeframes or criteria based progression and,
5. Are aimed to standardize care for a specific clinical problem, procedure or episode of health care in a specific population.

Another abstraction comes from Vanhaecht et al. (2006). They made a top 10 pathway characteristics based on answers from the same 23 countries which are mentioned in the previous paragraph. This top 10 is as follows:

1. Improvement of quality of care
2. Improving evidence-based care

3. Multidisciplinary use
4. Improving efficiency of care
5. Communication tool between professionals
6. Standardization of care
7. Plan to manage the respondent's care
8. Outcome oriented
9. Use of guidelines
10. Communication tool between patient and professional.

Summarizing these two studies it can be said that the characteristics of clinical pathways are focused on having a multidisciplinary character, improving efficiency and effectiveness of healthcare, the ambition to work on a structured and systematic way to achieve goals and, coordination issues within the whole health sector for homogenous patient groups (Hummel et al., 2009).

5.3.2 Different clinical pathway aims

Not only the definitions of clinical pathways vary considerably, also about the aims of CPs there are a lot of different opinions. Kinsman, James, and Ham (2004) for example, state that the aim of CPs is to link evidence-based guidelines or recommendations for specific conditions, with interdisciplinary clinical practice. While an aim formulated at the starting years of clinical pathways state that CPs aim at achieving coordination along the whole chain of care, often also including pre and post hospitalization interventions and are often developed for high-volume, high-risk, and high-cost diagnoses and procedures (Coffey et al., 1992). Often aims of clinical pathways are formulated based on what is of importance for that particular healthcare professional or researcher. An study about professional communication (Allen, 2010) for example states that clinical pathways aim to improve inter- and intra-professional communication, a study about optimizing clinical pathways (Graeber et al., 2007) states that they intend to minimize variance in treatment and thus reduce cost, increase efficiency, and ultimately improve patient care outcomes, and yet another study about the outcomes of clinical pathways (de Bleser et al., 2006) state that the aim of clinical pathways if to improve the quality of care, reduce risks, increase patient satisfaction and increase the efficiency in use of resources. One of the most comprehensive aims comes from the National Electronic Library for Health (2005, as cited in Allen, 2009) they state that the aim of clinical pathways is having the right person, in the right place, doing the right thing, at the right time, with the right outcome and with attention to the patient experience.

5.3.3 A uniform definition and aim?

Over the years different researchers and healthcare professionals began asking for a uniform definition and aim of clinical pathways. After several consensus meetings of the board of EPA, they came up with the following definition (European Pathway Association, 2006):

> ***"A clinical pathway is a methodology for the mutual decision making and organization of care for a well-defined group of patients, during a well-defined period"***

To try to clarify this even more, the EPA listed several defining characteristics of clinical pathways:

1. An explicit statement of the goals and key elements of care based on evidence, best practice and patient expectations.
2. The facilitation of the communication, coordination of roles and sequencing the activities of the multidisciplinary care team, patients and their relatives.
3. The documentation, monitoring and evaluation of variances and outcomes, and
4. The identification of the appropriate resources

In addition to these characteristics the EPA also included the aim of clinical pathways: "to enhance the quality of care by improving patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources". However, after several international discussion, EPA summer schools and the results of the PHD study of Vanhaecht (Vanhaecht et al., 2007b) the EPA decided that their first proposition was not complete enough and adjusted it accordingly. This slightly adjusted version is now the leading definition for clinical pathways and states (note that the adjusted parts are underlined):

1. An explicit statement of the goals and key elements of care based on evidence, best practice, and patients' expectations and their characteristics;
2. The facilitation of the communication among the team members and with patients and families;
3. The coordination of the care process by coordinating the roles and sequencing the activities of the multidisciplinary care team, patients and their relatives;
4. The documentation, monitoring, and evaluation of variances and outcomes; and
5. The identification of the appropriate resources

Also the official aim adjusted slightly to: "to enhance the quality of care across the continuum by improving risk-adjusted patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources". Most of the contemporary researchers now use this definition and aim of clinical pathways. However, it takes time to get all involved parties to accept and use it, that is why there are still researchers who believe this definition does not capture everything a clinical pathway is, and introduce a definition of their own (Allen, 2009; Cabitza & Sarini, 2007; Lux, 2012).

5.3.4 Components of clinical pathways

In order to create even more understanding Ye, Jiang, Diao, Yang, and Du (2009) did a study about the main components of clinical pathways. They concluded that these main components are:

- Intervention
- Outcome
- Temporal aspect
- Variance, and
- Resources

The intervention aspect consists of different categories of clinical activities and tasks (i.e. the tasks described in a CP). The outcomes are the results from these intervention, this means that within a CP there could be multiple outcomes. The next main component are the temporal aspects, which cover the timeline of the interventions and outcomes (i.e. how many days later the next intervention should take place). The resources represent the multi-disciplinary team which consists of healthcare professionals in different parts of the health continuum. The last main component are the variances. Any deviations from the pathway that occur during the clinical pathway are known as the variances. These variances can either be positive of negative for the patient outcome (Hyett, Podosky, Santamaria, & Ham, 2007) and can occur for four reasons: patient condition, healthcare worker condition, hospital condition, and society condition (Vanhaecht & Sermeus, 2003). In addition unnecessary variance is seen as diagnostic or therapeutic interventions which are not required by the patient's condition (Kurtin & Stucky, 2009). The idea behind it is that similar patients should be treated similarly based upon the best available evidence or expert consensus, while patient with important differences in their condition should be treated differently, something in which a clinical pathway can assist (De Luc & Todd, 2003; Panella et al., 2003). These unnecessary variances can lead to increased costs and decreased quality (Kurtin & Stucky, 2009).

5.3.5 CLINICAL PATHWAYS VS. MEDICAL GUIDELINES

It is important to know the difference between clinical pathways and medical guidelines for people to fully comprehend the concept. Clinical pathways offer a structured approach in developing and implementing local protocols of care based on evidence-based clinical guidelines (Li et al., 2013). Therefore it is important to stress the difference between clinical pathways and medical guidelines. It can be said that guidelines can serve as an input for clinical pathways, which consequently means that clinical pathways can be based on guidelines (Vlayen, Aertgeerts, Hannes, Sermeus, & Ramaekers, 2005). The Institute of Medicine created the most widely used (Rosenbrand, Croonenborg, & Wittenberg, 2008), definition of guidelines: "Guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances" (Institute of Medicine, 1990). Guidelines are developed to summarize and synthesize knowledge an innovations in medicine, to reduce variation in practice, to promote evidence-based clinical practice and to satisfy the need for transparency and accountability (Carnett, 1999). The development of guidelines is a labor intensive task, since it is based on literature reviews, critical appraisal, multidisciplinary consultation, and grading of recommendations by level of evidence (Campbell et al., 1998). These steps are all performed by a guideline team consisting of multiple experts, mostly from different countries, in the field for which the guideline is constructed. In contrast to guidelines, clinical pathways consider available resources like staff, level of education, available equipment, hospital typology, and typically include a time component (Lenz et al., 2007). The differences between clinical pathways and guidelines are described by MacDermid (2008) and Alexandrou, Skitsas and Mentzas (2011). Their combined results are shown in Table 5.

TABLE 5: DIFFERENCE BETWEEN CLINICAL PATHWAYS AND GUIDELINES

Clinical pathways	Guidelines
Focus on quality and orchestration of treatment plan execution	Focus on specific medical circumstances
Focus on operationalizing options	Focus on identifying the best clinical option
Are a structured multidisciplinary treatment scheme	Are a systematically developed flow for medical practice and decision making
Define optimum sequence and timing of interventions	Guide practice in an explicit manner; with a focus on linking evidence to recommendations
Offers a detailed guidance for each step of the treatment	Presents the best available research results on clinical research
Based on evidence from research studies and practice settings (including process and outcomes)	Based on evidence, may also include expert opinion or consensus
Are produced by a multidisciplinary team	Are developed and supported by a group of experts
Are setting/institution specific; tailored to fit local conditions	Are useful across clinical settings; can be applied generally
Are used by a multidisciplinary healthcare provision team	Are used by clinical doctors and carers

While guidelines are a consensus of medical experts, clinical pathways require a consensus among different stakeholders in the complete patient treatment process. As a consequence clinical pathways may deviate from a guidelines on which it is based. Which can be the case if a hospital does not have all the resources necessary to complete the recommended procedure (Lenz & Reichert, 2007). While this example can lead to believe that clinical pathways are defined for one specific site (e.g. a particular hospital), it is not always the case. Site-specific can also refer to a collaboration of different sites within one clinical pathway (e.g. a clinical pathway can start at a general practitioner, where after the patient is redirected to the hospital for medical treatment, and ends with home care). Based on the clinical pathways a specific individual treatment plan can be made. This treatment plan evolves in an actual treatment process, which are the interventions the patient actually received. An overview of this can be seen in Figure 18.

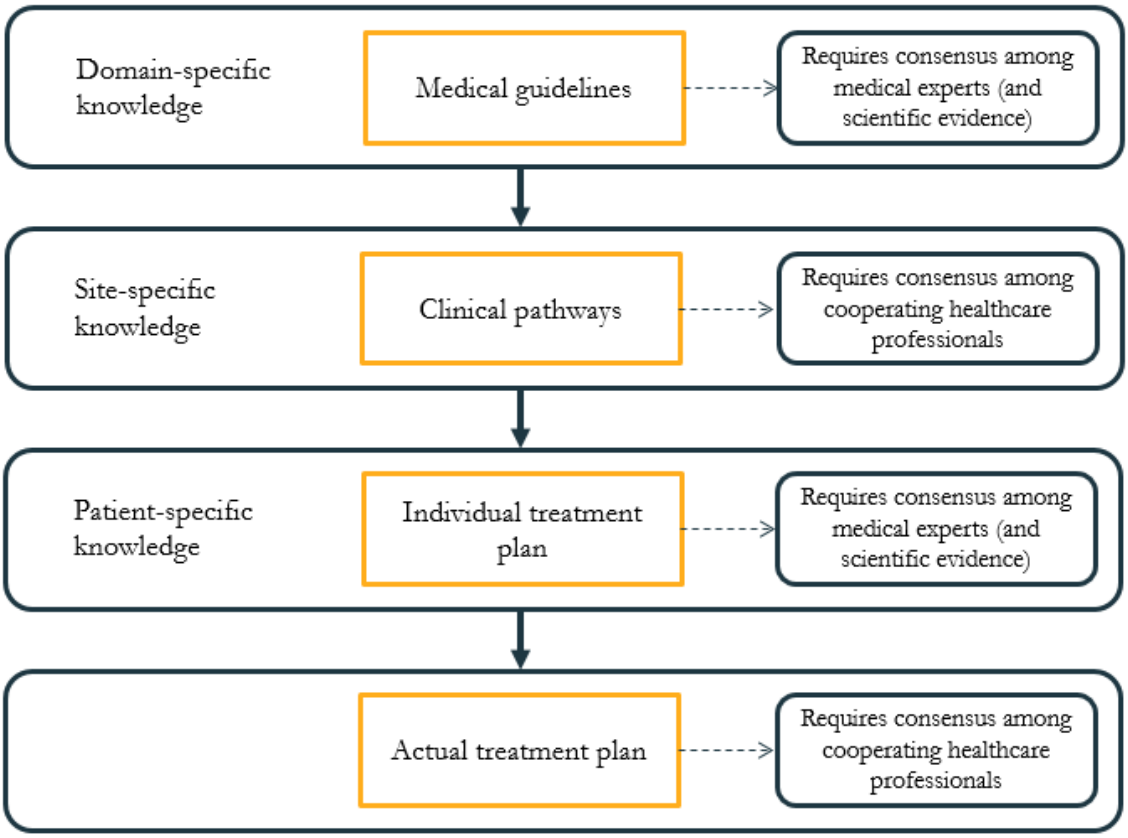

FIGURE 18: FROM MEDICAL GUIDELINES TO ACTUAL TREATMENT. ADOPTED FROM LENZ AND REICHERT (2007)

5.4 CLINICAL PATHWAY EFFECTS

Now we know what clinical pathways are and where they came from it is important that know what the effects of clinical pathways are, because these effects ensure clinical pathway usage is on the rise ever since its introduction. The positive clinical pathway effects are discussed in the first subsection, which is followed by the negative clinical pathway effects. This section concludes with an elaboration about the different critical success factors which are known for clinical pathways.

5.4.1 POSITIVE CLINICAL PATHWAY EFFECTS

There are a number of ways in which clinical pathways hypothetically could support the involved parties is the healthcare continuum. Curry and Harvey (2000) for example reckon that clinical pathways could function as a template that enables clinical staff to incorporate evidence into practice and that they could help to tackle complex multidimensional issues. According to Schrijvers, van Hoorn, and Huiskes (2012) clinical pathways can possibly shorten the diagnosis -and therefore recover- process, increase coherence –which can lead to reduces risk of opposing therapies-, reduce the risk of errors, reduce the costs by avoiding duplication, shorting hospitalization and the number of outpatient visits, and increase job satisfaction by having a clear coordination between occupational groups. Muscholl (2005) goes even further and states that clinical pathways can help with improving the overall quality of care and can relate conflicting aspects of treatment (i.e. medical requirements, economy of treatment, and patient satisfaction). This is listed in Table 6.

TABLE 6: POTENTIAL POSITIVE CP EFFECTS

Potential positive CP effects	
Serves as template function	Reduces cost
Tackles complex multidimensional issues	Shortens hospitalization
Shortens diagnosis time	Reduces number of outpatient visits
Shortens recover time	Increases job satisfaction
Shortens process time	Increases coordination
Increases coherence	Increases overall quality of care
Reduces risk of opposing therapies	Relates conflicting aspects of care
Reduces risk of errors	

However, these claims are all speculations, some researchers were of opinion that there in the past there wasn't much strong evidence that clinical pathways are clinically and economically effective even though many hospitals already adopted them (Darer et al., 2002). However, the amount of research about clinical pathways has grown steadily over the years, which ensured there is more evidence about the effectiveness of clinical pathways today. Even though it is still the case that there are positive as well as negative results in clinical, service, and financial outcomes (Panella et al., 2012) and since most studies only focus on a specific outcome (e.g. length of stay, cost reduction) for a specific clinical pathway (e.g. hip and knee arthroplasty, esophageal cancer) for a specific hospital/region, it is hard to draw conclusions if clinical pathways improve the overall quality of care (Dey et al., 2013). Even though a study from 2009 identified the presence of clinical pathways as a determining organizational factor of high performing hospitals (Vina, Rhew, Weingarten, Weingarten, & Chang, 2009).

What can be stated about clinical pathways however, is that they improve patient outcome (Campbell et al., 1998; Hassan, 2013; Renholm, Leino-Kilpi, & Suominen, 2002) by reducing clinical variance due to standardization (De Luc & Todd, 2003; Kurtin & Stucky, 2009; Middleton, Barnett, & Reeves, 2001; Panella et al., 2003), increasing participation of patient or cares in the patient's treatment procedures (Cabitza & Sarini, 2007; Middleton et al., 2001; Williams, Roberts, & Rigby, 1993), reducing the patient's length of stay in hospitals (Alexandrou et al., 2011; Hassan, 2013; Rotter et al., 2010), and above all ensuring better clinical outcomes and less adverse events (Cabitza & Sarini, 2007). Which together leads to an increase in patient satisfaction with the service (Hassan, 2013; Middleton et al., 2001; Street, Makoul, Arora, & Epstein, 2009).

Improved communication between doctors and nurses is another important positive effect of clinical pathways (Alexandrou et al., 2011; Mater & Ibrahim, 2014). An effect that is associated with this, is that due to multidisciplinary collaboration -something that is enforced by clinical pathways-, there is a consensus view of care and treatment among the healthcare professionals (Cabitza & Sarini, 2007; Hassan, 2013; Middleton et al., 2001), which leads to a better collaboration of these healthcare professionals and strengthens their relationships (Gittell, Seidner, & Wimbush, 2010; Van Gerven, Vanhaecht, Deneckere, Vleugels, & Sermeus, 2010). Sharing information helps healthcare professionals develop learning processes within an organization, to understand their roles and responsibilities better, and to improve integration among the whole healthcare continuum (Panella et al., 2003).

In addition to an improved patient outcome and multidisciplinary collaboration, clinical pathways maximize the efficient use of resources (Cabitza & Sarini, 2007), reduce the costs of patient care (Hassan, 2013; Rotter et al., 2010), enhance junior and new staff education and training (Hassan, 2013), and reduce the time healthcare professionals spent carrying out paperwork (Alexandrou et al., 2011; Cabitza & Sarini, 2007; Hassan, 2013; Middleton et al., 2001). Not only the time spend on carrying out paperwork reduces due to clinical pathways, Rotter et al. (2010) has analyzed 27 studies involving 11,398 participants, and concludes that also the quality of this documentation improves, something which is also stated by de Luc and Todd (2003), in addition to the amount of in-hospital complications.

Kurtin and Stucky (2009) state that there are five barriers to high quality care that are addressed by clinical pathways. They have defined high quality care as care that is safe, timely, effective, efficient, equitable, and patient and family centered. The first two of these five barriers, unnecessary variance and patient safety, are already discussed. The third barrier Kurtin and Stucky identified is the gap between knowledge and practice. This gap is the time it takes a proven new practice to go from the medical literature into routine clinical care. They state his gap can be as large as 17 years. That clinical pathways are an effective tool to (speed up the process to) implement evidence-based practice and make sure clinical guidelines are used in everyday practice, is also recognized by among other Middleton, Barnett and Reeves (2001) and de Luc and Todd (2003). The fourth barrier that Kurtin and Stucky identify is about the failure of many physicians to appreciate, understand, and work within the complex systems of care that exist within hospital today. According to them in-patient care is multi- and interdisciplinary and involves a large number and variety of patient-provider interactions and therapeutic interventions. The process to develop clinical pathways includes all provides who will take part in caring for the patient, including nurses, social workers, dieticians, pharmacists, etc. The advantages of this multidisciplinary consensus are already elaborated on in the previous paragraph. The fifth and last barrier that is addressed by clinical pathways is the slow adoption and routine use of practices by providers that can improve clinical outcomes and patient safety. The root cause that Kurtin and Stucky identified for this is the lack of a 'business case' for quality. What they mean with this, is that while providers spend considerable resources (e.g. people, technology, training) to improve care, the financial benefits of this often go to the payers. An example of this is the reduction of length of stay; hospitals often get paid per day a patient is in the hospital, which consequently means that if the hospital improves the quality of the treatment and it results in less days at the hospital for the patient, they decrease their own income. According to Kurtin and Stucky clinical pathways are potentially helpful in 'pay for performance programs' in which providers are rewarded for reliably and routinely delivering well specified, evidence-based processes of care. All proven positive effects of clinical pathways discussed in this section are listed in Table 7.

TABLE 7: POSITIVE CP EFFECTS

Positive CP effects	
Improves patient outcome	Improves clinical outcomes
Reduces clinical variance	Ensures less adverse events
Increases participation in treatment process	Increases patient satisfaction
Reduces the of length of stay	Improves learning processes
Improves inter-professional communication	Improves understanding of professional roles
Enhances consensus view on care	Reduces gap between knowledge and practice
Improves inter-professional collaboration	Improves integration in healthcare continuum
Strengthens inter-professional relationship	Accelerates routine use of new practices
Improves staff understanding of complex systems of care	Improves understanding of professional responsibilities
Ensures a more efficient use of resources	Reduces time spend on paper work
Reduces costs	Improves the quality of documentation
Enhances staff education/training	Reduces number of in-hospital complications
Accelerates adoption of practices	

5.4.2 NEGATIVE CLINICAL PATHWAY EFFECTS

In spite of these advantages there are also several disadvantages of clinical pathway usage. Some medical providers for example, feel that standardization leads to "cookbook" medicine or medical care that is prescriptive and restricts creativity, intuition, and clinical judgement (Resnick, 2014), which means that there is a limited scope for professional development (Atwal & Caldwell, 2002). This is also related to a study of Currie and Harvey (2000) in which they state that clinical pathways can lead to a reduction in clinicians' status and discourage appropriate clinical judgement being applied to individual cases, and a study of Schrijvers, van Hoorn and Huiskes (2012) who state that the relationship between healthcare professionals and patients can become less personal. Something that is not the only disadvantage for patients in a clinical pathway, since clinical pathways can also reduce the patients' choices in their treatment. Another important disadvantage that can be found in literature is that some are of opinion that (a part of the) clinical pathways focus rather on costs than quality (Norris, 1998). The potential negative effects of CP's are listed in Table 8.

TABLE 8: POTENTIAL NEGATIVE CP EFFECTS

Potiential negative CP effects	
Leads to "cookbook" medicine	Reduces clinicians's status
Restricts creativity	Discourages deviation for individual cases
Restricts intuition	Reltionships become less personal
Restricts clinical judgement	Reduces patients' choices in their treatment
Limits professional development	Focuses on costs

However, these disadvantages are all theoretical ones. There are just a few disadvantages concerning clinical pathways that are actually proven in scientific literature. The first of which is concerned with

the increased level of documentation which clinical pathways entail (Currie & Harvey, 2000) which can bring a higher workload especially for the nursing staff. However, this is directly contradicted by the earlier mentioned studies (Alexandrou et al., 2011; Cabitza & Sarini, 2007; Hassan, 2013; Middleton et al., 2001). It can therefore be concluded that whether or not clinical pathways have a positive effect on documentation in healthcare is not proven yet, but probably depends on the situation. Which situational factors are of importance to this, is not known yet. Another proven disadvantage of clinical pathways is that they are costly to develop, since it involves many staff members and takes considerable time. Authors who reported their experience with implementing a single pathway have described processes that take several months' time (Calland et al., 2001; Chen et al., 2000; Hoffart, Cobb, & The Clinical Pathways Study Group, 2002). Something that is diminished by failing to implement a successful clinical pathway (Hoffart et al., 2002).

Studies have shown that clinical pathways are not always helpful (Panella et al., 2003). A number of them are (too) difficult to follow (Claridge, Parker, & Cook, 2005) therefore not fully understood and supported by the medical staff (Schuld et al., 2011), and the documentation involved can be disappointing (Crawford & Shanahan, 2003). When the implementation of a clinical pathway is unsuccessful, it can lead to fragmentation of care with its accompanied negative effects (Atwal & Caldwell, 2002). Therefore it is of importance to ensure the success of clinical pathways. All proven negative effects of clinical pathways discussed in this section are listed in Table 9.

TABLE 9: NEGATIVE CP EFFECTS

Negative CP effects	
Increases levels of documentation	Is sometimes too difficult to follow
Ensures a higher workload	Is not always fully understood
Has high developing costs	Is not always supported by staff
Ensures fragmentation of care	Has sometimes disappointing documentation

When merging the two tables about the proven CP effects, an overview of all effects of clinical pathways is created. It is chosen to omit the potentially negative and positive effects, since even though some are highly likely, it still remains speculation. The overview can be found in Table 10 on the next page.

TABLE 10: PROVEN CP EFFECTS

Proven CP effects	
Positive	Negative
Improves patient outcome	Increases levels of documentation
Reduces clinical variance	Ensures a higher workload
Increases participation in treatment process	Has high developing costs
Reduces length of stay	Ensures fragmentation of care
Improves inter-professional communication	Is sometimes too difficult to follow
Enhances consensus view on care	Is not always fully understood
Improves inter-professional collaboration	Is not always supported by staff
Strengthens inter-professional relationship	Has sometimes disappointing documentation
Improves staff understanding of complex systems of care	
Ensures more efficient use of resources	
Reduces costs	
Enhances staff education/training	
Accelerates adoption of practices	
Improves clinical outcomes	
Ensures less adverse events	
Increases patient satisfaction	
Improves learning processes	
Improves understanding of professional roles	
Reduces gap between knowledge and practice	
Improves integration in healthcare continuum	
Accelerates routine use of new practices	
Improves understanding of professional responsibilities	
Reduces time spend on paper work	
Improves quality of documentation	
Reduces number of in-hospital complications	

5.4.3 CRITICAL SUCCESS FACTORS OF CLINICAL PATHWAYS

To overcome a part of the negative effects of clinical pathways, it is of importance to ensure the success of clinical pathways. These critical success factors of clinical pathways is a popular object of study in recent years. One of the most named factors is the support of the executive board (Atwal & Caldwell, 2002; Gray, 2008; Rees, Huby, McDade, & McKechnie, 2004; Wolff, Taylor, & McCabe, 2004) and healthcare professionals (Currie & Harvey, 1998a; Gibbon et al., 2002; Gray, 2008; Hoffart et al., 2002). Gray (2008) recognized that when clinical pathways are consistently used to provide information to meet multiple agendas, both at an organizational level (e.g. for resource, financial,

and risk management, controls assurance, clinical governance), at a team level (e.g. for outcomes and performance), and at a personal level (e.g. to inform personal appraisal/development plans and to support induction and supervision), there is greater awareness of their benefits and a greater buy-in to using and further development over time. Which result in leaders who express a strong belief in the value of clinical pathways. This inspires teams to change the systems around them and to embrace new ways of working.

In addition to executive board and healthcare professional involvement, MacDermid (2008) and Middleton, Barnett, and Reeves (2001) also listed several other critical success factors for clinical pathways. Starting with MacDermid who states that a clinical pathway should revolve around a single, well-defined clinical problem, that the resulting documents should be simple and clear in language, and that there should be a reduction of administrative barriers. Middleton, Barnett, and Reeves add that clinical pathways should be part of an organizational quality program, that different professional groups should collaborate under a strong medical lead, that clinical pathways should be based on best practices and include goals and outcomes, that project facilitators gave appropriate skills, that the expectations of staff are clearly managed, and that variations from clinical pathways are collected and analyzed. Another critical success factors that is mentioned in a different study is that clinical pathways should be up-to-date and relevant, which can only be done by systematic follow-up (Atwal & Caldwell, 2002; Goldszer et al., 2004; Lemmens, van Zelm, Vanhaecht, & Kerkkamp, 2008; Van Gerven et al., 2010; Vanhaecht et al., 2006). To which Dey et al. (2013) add that also a planned financial investment is necessary.

In addition to these critical success factors, Resnick (2014) listed some pitfalls and according solutions which should be taken into account when developing and implementing clinical pathways. Resnick constructed this list based on a study of Kotter about why transformation efforts fail (Kotter, 1995). An adjusted version of the research of Resnick in which only the relevant information is listed, can be seen in Table 11.

TABLE 11: CLINICAL PATHWAY PITFALLS. ADOPTED FROM RESNICK (2014)

Reason	Explanation	Solution during clinical pathway development
Not creating a large enough sense of urgency	Without motivation, individuals are not likely to help, causing the effort to fail	- Explain the importance of treatment standardization
Not creating a strong guiding coalition	Only having a few individuals within an organization see the potential in a new transformation effort	- Identify key leaders (clinical and administrative) who have the authority and influence to drive the effort - Include those who understand the need for change and are willing to put forth the effort - Leadership support at the highest levels is necessary
Lacking a clear vision	If individuals are unaware of what the outcome is supposed to look like, they likely will not participate in the new effort	- Clearly articulate how clinical pathways will address market or industry changes in a positive, forward-thinking way - Define the steps required to move from the current to future states
Not communicating the vision effectively	Before individuals can understand the new vision, they must hear it multiple times using various methods of delivery	- Develop a comprehensive communication plan that uses various formats (e.g. email, huddles, open forums, letters) - Provide opportunities for bi-directional communication and solicit staff feedback through surveys, forums and other channels
Not removing obstacles	Obstacles or roadblocks must be removed for the transformation to occur	- Leverage leadership support to remove identified obstacles and barriers as they arise - Use consistent progress reports to ensure issues are brought to leadership's attention in a timely manner
Not generating short-term wins	Most individuals are not willing to go for a long period of time unless they see concrete results	- Create short-term wins through various phases of the effort (e.g. development of guideline, implementation and results of specific pathways)
Declaring victory too soon	Most individuals will be more inclined to stop the program if their win turns into a loss	- Use caution in declaring victories during the creation and implementation phases. For example, simply creating the clinical pathway is a small win but does not complete the overall goal
Not embedding changes into an organizational culture	Ensuring all individuals within an organization understands the new vision and approaches needed to meet the new vision	- Embed clinical pathway development and use into the care delivery model of a hospital - Incorporate clinical pathways in training and continues education - Report clinical pathway outcomes regularly

5.5 CLINICAL PATHWAY MANAGEMENT

The success factors listed in the previous section are important to keep in mind when managing clinical pathways. As stated in the introduction clinical pathway management revolves around the definition, implementation, and execution of clinical pathways. This can be seen as a continuous process of quality improvement (Gustaman, 2014) where several complex factors, such as the evidence based key interventions, interdisciplinary teamwork, patient involvement and available resources, should be taken into account (Panella et al., 2012). Depending on the situation (e.g. number of healthcare professionals involved, whether or not it is a clinical pathway which only focusses on the hospital environment) a different management approach can be followed. In literature several of these management approaches for clinical pathways are proposed. Four of these approaches are included via this SLR, and will be described in the remainder of this section.

HARRKLEROAD, SCHRIF, VOLPE, AND HOLM

In 2000 a study was conducted that synthesized nine clinical pathway management approaches in order to create a state of the art overview for healthcare professionals (Harkleroad, Schirf, Volpe, & Holm, 2000). This overview consist of four phases, consisting of multiple steps. The first phase is the focus and recognition phase, in which there should be an evaluation of baseline data in order to identify the need for clinical pathways, preliminary goals and measurable outcomes should be established, and literature should be reviewed in order to obtain the latest information relevant to the pathway. The second phase is the assess and analyze phase, in which a data analysis should be conducted. Based on this analysis it should be determined whether there is a performance gap, what the most common practices are, where additional data can be found for problem areas, and potential clinical benefits and harms. The third phase is the development phase, in which a multidisciplinary team should be formed, documentation and a system for variance analysis should be constructed, and the clinical pathway should be developed. In order to do this there should be a decision for a clinical pathway format and length, critical elements should be clarified, the pathway should be reviewed, an implementation plan constructed, and the staff should be educated. The last phase is the implementation phase, in which the final draft should be distributed to all healthcare professionals, a start-up date should be established, a compliance check should be conducted, variances should be examined, and concrete results should be communicated to the involved healthcare professionals.

LUC AND TODD

Three years later de Luc and Todd (2003) introduced their ten-step clinical pathway management approach. These ten steps are divided, just like in the approach of Harkelroad et al., in four phases. In which the first phase is called the planning phase, in this phase the development should be planed and information should be obtained about, the best-evidence, patient/user views, activity, critical incidents, and examples. The second phase is the development phase, in which the clinical pathway should be scoped, the process should be mapped, and documentation should be designed. The third phase is the implementation phase. In this phase the changes in the processes are planned, the staff is trained, pilot tests are conducted, and when that is all done, the clinical pathway itself is

implemented. The last phase de Luc and Todd recognized is the maintenance phase, in which on-going maintenance on the clinical pathway is key. This maintenance can eventually lead back to the planning phase, which turns it into a cycle.

WAKAMIYA AND YAMAICHI

A very high-level clinical pathway management approach comes from Wakamiya and Yamaichi (2009) who state that clinical pathway management approaches should follow the Plan-Do-Check-Act (PDCA) model, also known as Deming cycle, of continuous quality improvement (Deming, 1986). According to Meenakshy (2013) the 'plan' and 'do' phases constitute respectively the development and modeling, and implementation of the clinical pathway. The 'check' phase compares the outcome against predefined clinical pathway goals and analyses the differences to identify potential improvements. Finally the 'act' phase applies the identified improvement to the next PDCA cycle.

VANHAECHT ET AL.

Vanhaecht et al. (2012) deliberated further on these PDCA cycles (in which the C of check, is replaced by the S of study) in clinical pathway management and created a seven-phased model that is aimed at offering a systematic approach to a multidisciplinary team that is developing a new pathway or aims to improve an existing one. According to Panella et al. (2012) is this seven-phased model a good synthesis of what was known about clinical pathway management. It consists of a screening phase, project management phase, diagnoses and objectification phase, development phase, implementation phase, evaluation phase, and continuous follow-up phase. Figure 19 shows these seven phases, in addition to the PDCA cycles which are the basis of this seven-phased model. Each phase in the method will pass a PDCA cycle. Each of the phases will be elaborated on next.

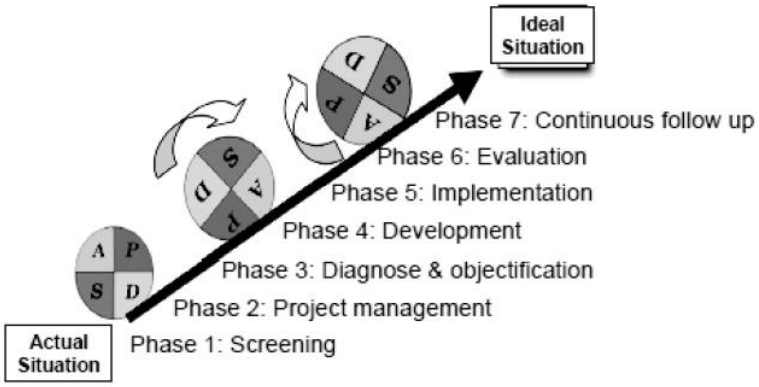

FIGURE 19: 7-PHASED MODEL FOR CPM. REPRINTED FROM VANHAECHT ET AL. (2012)

The objective of the screening phase is to determine whether a clinical pathway is the appropriate method to improve the care process. This phase can be initiated when there is a demand for a new clinical pathway or there is a need to adapt or improve an existing one. Information should be assembled and analyzed regarding the already existing clinical pathway or the actual healthcare

process. When this is done, the process management phase can start. In this phase the care process for which the clinical pathway is developed should be defined. In addition, a work group/core team should be assembled. They should define the project related entities, such as the patient group, start and endpoint of the clinical pathway, a project plan, available resources etc. After the project management phase the diagnosis and objectification phase can start. In this phase the as-is care process will be evaluated from four perspectives: the organization's and team perspective, the patient's perspective, the evidence and legislation perspective, and the external partners' perspective. This phase is considered very important as the outcome of this phase (i.e. the as-is situation) will be the basis for the evaluation phase. In the development phase, the actual clinical pathway is constructed, based on the information gathered in the previous phases. There are several activities that should be undertaken in this phase, including the redefinition of the inclusion and exclusions criteria for the patient group if it's necessary, the definition of evidence-based key interventions, and the practical organization of the care process like resources, staff, and training. After the clinical pathway is developed, the implementation phase start by creating an implementation plan, training team members, and conducting an implementation test in order to determine if the clinical pathway addresses all aspects of the care process. This can be done by pilot testing (elements of) the clinical pathway. The feedback from the test(s) can be used to adjust the clinical pathway before the actual implementation takes place, which is consequently the last step in this phase. In the evaluation phase the effects and usability of the clinical pathway is determined. The last phase is the continuous follow-up phase, in which the clinical pathway is 'kept alive and up-to-date' by monitoring the evaluation results and variances and making adjustments whenever deemed necessary. It is recommended that there is a substantive discussion among the work group/core team every six months and that at least once a year an objective measurement should take place.

FOUR APPROACHES COMBINED

The four clinical pathway management approaches discussed in this sections are summarized in Table 12. The phases are assessed on the steps of which they contain, which enabled corresponding phases to be placed on the same row. It can be stated that the clinical pathway management approach from Vanhaecht et al. is the most elaborate one, with the project management phase as a unique determinant of their approach.

TABLE 12: CPM APPROACHES

Harkleroad et al. (2002)	De Luc & Todd (2003)	Wakamiya and Yamaichi (2009)	Vanhaecht et al. (2012)
Focus and recognition	Planning	Plan	Screening
			Project management
Assess and analyze		Study	Diagnose and objectification
Development	Development	Act	Development
Implementation	Implementation		Implementation
		Check	Evaluation
	Maintenance		Maintenance

5.6 CLINICAL PATHWAYS AND IT

This section is divided in two subsections. The first elaborates about the differences between paper-based and IT-based clinical pathways, while the second subsection elaborates on CPM software.

5.6.1 PAPER-BASED VS. IT-BASED CLINICAL PATHWAYS

During the time hospitals started using clinical pathways, IT didn't play a large role in the healthcare sector. When a hospital or other player(s) in the healthcare sector did choose to work with clinical pathways, the pathway were implemented in their paper-based system. Paper-based clinical pathways are basically big manuals written in natural language (Fernandez-Llatas, Meneu, Benedi, & Traver, 2010). On the work floor clinical pathways were implemented mostly as an additional sheets to the patient's record, often resulting in more paperwork instead of facilitating daily routine (Schuld et al., 2011). However, as stated in Section 4.1, IT managed to play an increasing important role in healthcare. It ensured hospitals to work safer, more effective and more efficient. In the 21st century the first clinical pathway management software programs were developed. Since then there have been numerous proposals about structural design of clinical pathway management software (Wakamiya & Yamauchi, 2009). Nowadays clinical pathways can be managed either by electronic-based methods or by traditional paper-based methods that make use of printouts (Wakamiya & Yamauchi, 2006), in which it is possible to have a computerized method (e.g. for the analyses of variance, the different types of checklist) for the management of the paper-based clinical pathways.

A study of van Gerven et al. (2010) at 57 hospitals in the Netherlands and Belgium showed that only 17% of their clinical pathways where completely electronic. Which is an improvement as opposed to four years earlier, when Vanhaecht et al. (2006) found that 91% of the clinical pathways were completely paper-based. The reason why hospitals often still choose to work with (partly) paper-based clinical pathways, is the high investments costs they entail (Wakamiya & Yamauchi, 2006; Zhang, Yamauchi, Mizuno, Zhang, & Huang, 2004).

Several authors state that there are plenty of reasons why healthcare organizations should move away from paper-based clinical pathways. First of all Li et al. (2013) prove that paper-based clinical pathways are challenging for knowledge sharing, and bring burdensome paper work which causes inefficiency and a lack of accuracy in care processes. In addition to this Du, Jiang, Diao, Ye, and Yao (2009) state that paper-based clinical pathways have a limited capacity of data recording and collection, and lack support for monitoring and handling variations.

To overcome these problems with paper-based clinical pathways, IT should play an important role within clinical pathways. Several authors highlight the feasibility of IT supported, HIS integrated clinical pathways (Blaser et al., 2007; Lenz et al., 2007). They have the opportunity to deliver faster and better information, and make this information available at every location for patients and the different healthcare professionals (Sermeus et al., 2008). Clinical pathway management software can lead to economic benefits (Ronellenfitsch et al., 2008), without any negative impact on the rate of complications or re-hospitalization (Müller et al., 2009). Even patient satisfaction can rise when using clinical pathway software instead of a paper-based system (Graeber et al., 2007). As mentioned in the previous paragraph there is a lack of information accuracy in the treatment process when working with paper-based clinical pathways, according to Li et al. (2013) it is necessary to computerize clinical

pathways and integrated pathway knowledge with existing information systems such that the shared pathway knowledge can provide seamless support in the treatment of patients. This will help in achieving a patient-centric process, improving care coordination and efficiency, as well as reducing medical errors. Van Gerven et al. (2010) even go so far to state that technical support for clinical pathways must be developed, if we want a future for clinical pathways.

5.6.2 CPM SOFTWARE

However, most of the hospitals which try to move away from the paper-based clinical pathways have only digitalized parts of the clinical pathway, since existing HISs only support special functional tasks of the whole clinical pathway (Lux, 2012). For example in some of the HISs decision support intelligence has been implemented (Lenz & Kuhn, 2004; Mathe et al., 2009). In other cases some basic CPM functionalities are integrated with CPOE systems (Tschopp, Despond, Grauser, Staub, & Lovis, 2009). Therefore the IT systems only support certain parts of the medical practice of the clinical pathway instead of the whole treatment process, which leads to less optimal support for the processes in the complex clinical environment. To overcome this Wakamiya and Yamauchi (2009) determined the minimal desired functions in CPM software:

1. Displaying
2. Recording
3. Ordering
4. Editing
5. Variance
6. Statistics

Each of these functions is discussed next.

Displaying: First of all there should be a displaying function, which improves the visibility of checklists and lets users switch views between the CPM software and the electronic records of the patients.

Recording: In addition a recording function should computerize records and automatically order medications, examinations, or injections included in the clinical pathway.

Ordering: Next to displaying and recording, there should be an extensive ordering function. This function should enable to enter orders including medicine guidance, nourishment guidance, and rehabilitation directly from the checklists in the clinical pathway. In addition it should cancel remaining scheduled orders in a clinical pathway if a variance occurs. It should also be possible to add or cancel orders while the clinical pathway stays active for a particular patient, a patient should be able to be in multiple clinical pathways, and it should include a calculation of the rough costs for each clinical pathway.

Editing: The next function Wakamiya and Yamauchi label as desired is editing. Healthcare professionals should be able to prepare templates, record the history of both addition and revisions of the clinical pathway, and edit checklists for staff as well as patients.

Variance: Variance is also of importance for CPM software. A variance function should check for the occurrence of, and report on variances.

Statistics: The last identified function is a statistics function. This function should calculate statistics of circulation of clinical pathways, calculate and show reports of variance in a multitude of forms (e.g. each day the variance occurred, variance for each action plan, for each variance code). Alexandrou (2011) formulates the needs of a comprehensive CPM software program differently. He states that the system should be responsible for the observation of the execution and the current status of the applied clinical pathway, offer the characteristic of automatic recognition of variances, and provide decision support services in order to handle the exceptions in an efficient and effective way. Moreover, the system should be capable to dynamically adapt the treatment process.

When HIS integrated CPM software does support at least all the execution processes of CPM then there are, according to Lux (2012), two important competitive advantages to be gained. First of all there would be a more efficient and effective personnel assignment. A process oriented HIS allows a consistent data capture and reduces the documentation effort. The second competitive advantage to be gained is in the field of transparency. Often the clinical treatment process is characterized by lacking transparency, for the patients, as well as healthcare professionals, and the hospitals' managerial staff. CPM software would make the pathway a patient follows transparent for all involved stakeholders.

5.7 Conclusion

The goal of this chapter was to give an answer to the second, third, and fourth subquestion: 'What are clinical pathways and how do they contribute to the performance of hospital environments?', 'What is known about clinical pathway management and related success factors?' and, 'What is known about clinical pathway management software?'.

Over the past years a multitude of articles have been written about clinical pathways. Even though there is uncertainty surrounding the concept and definition of clinical pathways, a leading definition has come forward. This definition comes from the European Pathway Association and states that clinical pathways are a methodology for mutual decision making and organization of care for a well-defined group of patients, during a well-defined period. The aim of these clinical pathways is to enhance the quality of care across the continuum by improving risk-adjusted patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources.

Clinical pathways are seen as a critical organizational factor for high performing hospitals. Different studies provide evidence that they improve patient outcome, ensure less adverse events, increase participation of patients in treatment procedures, reduce length of stay, and increase patient satisfaction. Also, a reduction of the costs of patient care, a more efficient use of resources, an improvement of the quality of documentation, a reduced clinical variance, and better clinical outcomes, are proven to be true by multiple studies. For healthcare professionals clinical pathways are proven to enhance junior and staff education and training, and improve communication and collaboration between healthcare professionals. However, some articles report clinical pathways to lead to "cookbook" medicine, an increased level of documentation, increased cost, fragmentation of care, a less personal relationship between professionals and patients, and a restriction of creativity, intuition and clinical judgement of healthcare professionals. Therefore it can be concluded that

different studies provide evidence to a multitude of positive as well as negative effects of clinical pathways. It will depend on the circumstances whether positive or negative effects dominate.

Several authors propose models for Clinical Pathway Management. The seven-phased model based on PDCA cycles of Vanhaecht et al. (2012) is the most used and elaborate one. It consists of a screening phase, project management phase, diagnoses and objectification phase, development phase, implementation phase, evaluation phase, and continuous follow-up phase. These phased can be incorporated in the CPM definition that is in use in this study, which consists of a definition phase, implementation phase, and execution phase. Screening, project management, and diagnosis and objectification falls in the definition phase, the development and implementation in the implementation phase, and evaluation and continuous follow-up in the execution phase. For the execution phase to have success there are several factors to consider when managing clinical pathways. These factors include the (financial) support of the executive board and involved healthcare professionals, the requisite of the clinical pathway to meet multiple agenda's, the inclusion of goals and outcomes, the management of staff expectations and variances, having a single well-defined clinical problem, producing simple and clear documents, being a part of an organizational quality program, and the clinical pathway being up-to-date and relevant.

IT is argued in many publications to be important for hospitals and also thought to be of importance for clinical pathways. Even though the majority of clinical pathways in the Netherlands and Belgium are at least for a part paper-based, there are some clear advantages for using clinical pathway management software. These advantages include the opportunity to deliver faster and better information, economic benefits, and a higher patient satisfaction. This can be reached if the CPM software program supports the complete treatment process. In order for a CPM software program to do this is should at least support displaying, recording, ordering, editing, variance, and statistics. Despite the evidence that nurses think that clinical pathway management software is an additional workload, whether or not CPM software can also be considered effective for healthcare professionals is not known yet, this is tested in the case study which is elaborated on in the next chapter.

6. CHECK-IT AND THE HOSPITAL ENVIRONMENT OF THE CASE STUDY

This chapter elaborates on the desk research for the case study which is conducted to ascertain the perceived effectiveness of the clinical pathway management software program called Check-It. This chapter is split into two sections. The first section elaborates on the hospital environment of Check-It, while the second section goes into more detail about Check-It itself.

6.1 UMCU'S HOSPITAL ENVIRONMENT

This subsection will provide an answer to the fifth subquestion: 'What is the hospital environment of the UMCU and which IT systems do they use?' It is of importance to sketch the hospital environment of Check-It, since it will provide a deeper understanding of the complex environment it has to interact with.

The University Medical Centre Utrecht is affiliated with the Utrecht University, which makes it one of eight academic hospitals in the Netherlands. It is founded in its current form in 1999 after a fusion between the 'academic ziekenhuis Utrecht' (AZU), which is the academic hospital in Utrecht, the 'Willemina Kinderziekenhuis' (WKZ) which is a hospital focused on children, and the medical faculty of Utrecht University (MFU). In total approximately 11,000 people work at the UMCU, including medical staff, nursing staff, support personnel, and researchers (UMCU, n.d.). Freely translated is the mission of the UMCU to be a leading international academic medical center, where knowledge about health, decease, and care, for patients and society is made, tested, shared, and used. Their vision is that they excel at 21 selected syndromes/diseases or patient groups (e.g. arteriosclerosis, stem cell therapies, breast cancer, immunodeficiencies, ALS, fertility interventions) which have national as well as international allure, for which they combine top research and top care. In addition to these 21 selected syndromes/deceases or patient groups, the UMCU provides acute medical care for patients in their region and has a sound specialist expertise. The organizational chart of the UMCU can be found in Figure 20 (UMC Utrecht, n.d.-a), in which the department which developed Check-It is marked green, and the divisions of which a department is object of study in the case study are marked orange. The organizational chart is straightforward, except for the left upper corner; UNOVATE connects the UMCU with corporate businesses for innovations in healthcare, and the UMC Utrecht participations manages the entire patent portfolio of the UMCU and is responsible for the successful commercial exploitation of it.

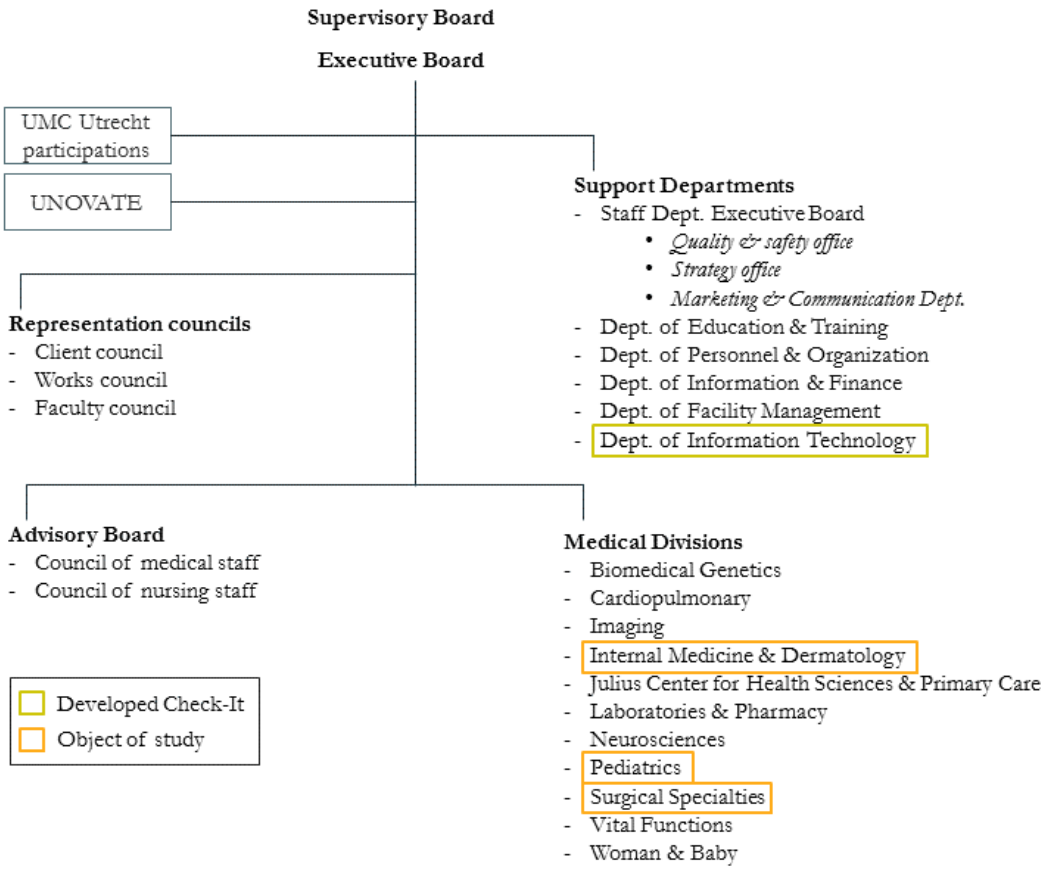

FIGURE 20: ORGANIZATIONAL CHART UMCU

In 2007 the UMCU began a project to renew the IT in their hospital, since their ambitions for high quality patient care were unsupported by the HIS they used at the time (UMC Utrecht, 2011). After a strategy study in collaboration with the Leiden University Medical Center, a process of different indentations to tender started. In 2010 EZIS.NET (after this 'EZIS') of ChipSoft was chosen as the UMCU's next HIS. In 2011 the UMCU officially started using EZIS. ChipSoft's EZIS is the most widely used HIS in Dutch hospitals (Furore, 2013). Most hospitals use this system, just like the UMCU, as their HIS as well as their EPD. EZIS consist of several modules which interact which each other to support healthcare professionals in their daily activities. Examples of these modules are patient enrollment, patient scheduling, filing, outpatient processes, order management, medication, billing, research, emergencies, radiology, decision support, and transmural communication. As stated in Chapter 4 (Section 4.5), Degoulet (2014) group three major categories of processes in a HIS:

1. Decision systems
2. Clinical systems
3. Logistic information systems

These systems/processes are all linked in the HIS. When looking at the global consistency of processes at the UMC (as can be seen in Figure 21), the same three categories can be recognized. However, another classification is used (i.e. administrative systems, clinical systems, and information

& control systems). Degoulet's decision systems are recognized as a part of the clinical systems category. Clinical systems are categorized as is, but the logistic information systems are divided over the administrative and information and control categories.

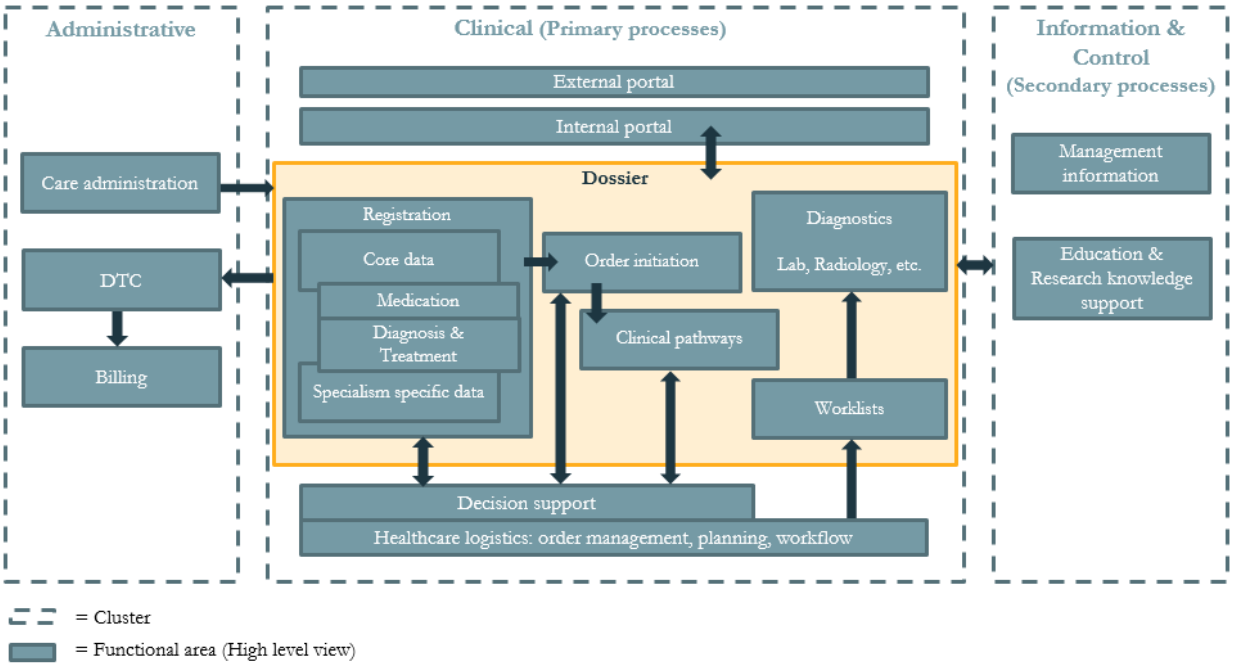

FIGURE 21: GLOBAL CONSISTENCY PROCESSES

Next to the systems that belong to EZIS, the UMCU has several separate systems. The UMCU maps these systems to the domain reference model of the i-Ziekenhuis. I-Ziekenhuis is an initiative of the NVZ (Netherlands Association of Hospitals) and Nictiz (National IT institute for healthcare in the Netherlands), which started in 2009. It offers hospitals a joint platform and knowledge center for information exchange and sharing best practices in relation to information management in Dutch hospitals (van der Stigchel et al., 2012). One of the goals of i-Ziekenhuis is to provide a reference architecture that supports the organization of IT in Dutch hospitals. This reference model is shown in Appendix G, and lists the domains, business activities, and information objects which generally can be found in a Dutch hospitals. The UMCU adjusted this reference model to match their own hospital environment. This UMCU specific model is shown in Figure 22 (UMC Utrecht, 2013). As can be seen they recognize seven main categories, each with own sub categories:

1. Cooperation, which list categories that support the collaboration within and between hospitals/hospital systems.
2. Governance and accountability, which consists of categories of systems which support this governance and accountability, like innovation, performance, and marketing systems.
3. Scientific research, which consists of all system categories that support the professional scientific community within the UMCU, this ranges from systems for the inception phase (i.e. idea development) to the publication phase.

4. Care, which lists all system categories that support healthcare professionals with the actual delivery of care. In this category an extra sub-layer is added, to divide the systems categories in systems that support consults, treatment, or additional examination.
5. Education, which list all categories of systems that support education in its broadest sense. System categories include among others accreditation, testing, and evaluation.
6. Careprocess support, which list all categories of systems that do not directly have to do with care itself, but with the processes of delivering care. Examples are resource planning, care logistics, and billing.
7. Business support, which lists all system categories that support the operational side of the hospital. Categories like the financial administration, legal support, human resources, ICT, and building and inventory management belong to this.

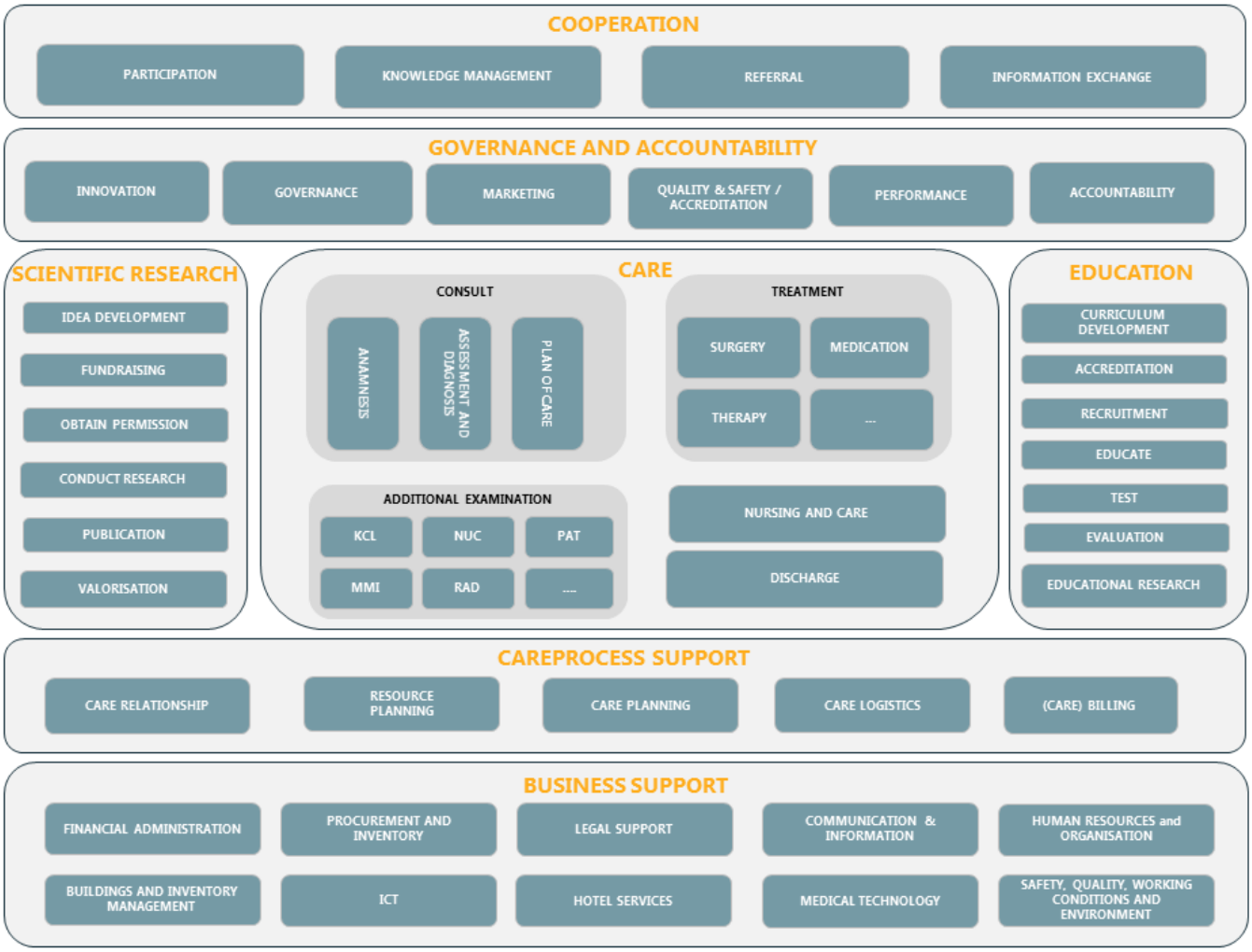

FIGURE 22: DOMAIN REFERENCE MODEL HOSPITALS OF I-ZIEKENHUIS, ADJUSTED FOR THE UMCU

Based on this figure, the UMCU made an overview of the most important systems they use in the hospital. Note that this list is far from exhaustive and there are much more systems beside the systems in the HIS that are used in the UMCU. This overview can be seen in Figure 23. As the figure shows there are four overarching systems: MyUMC, SAP, EZIS, and Ultimo. These systems are

responsible for a lot of system subcategories of the domain reference model. This is shown with the use of colored boxes. The parallelograms in the figure indicate the other systems which are often used in the UMCU. Most of these systems belong to one system category, however some of them, like Diamant and PDMS MV, support the healthcare professionals in multiple system categories. The four overarching systems will be discussed briefly after the figure, a description of the remaining systems can be found in Appendix H.

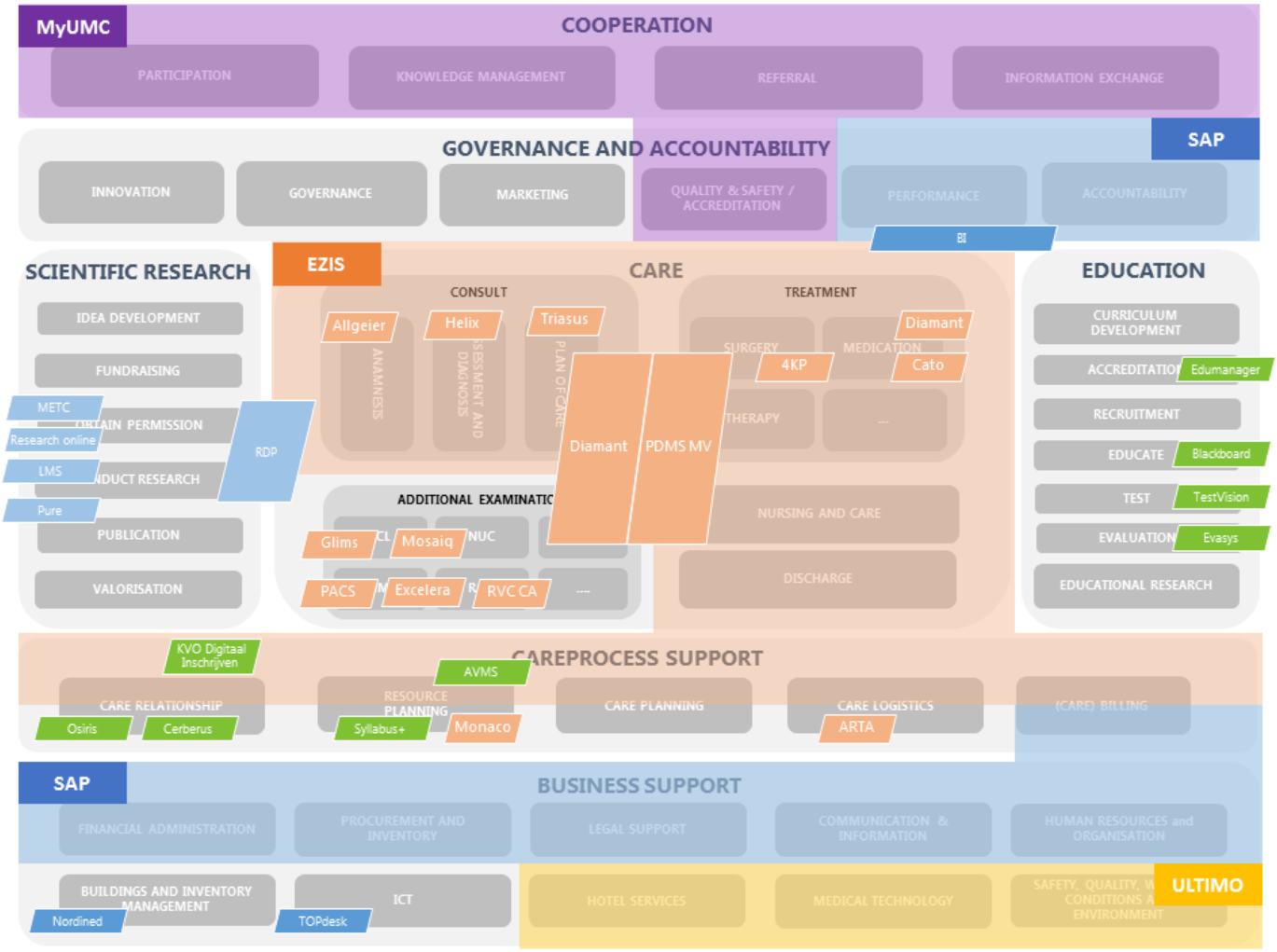

FIGURE 23: IT SYSTEMS AT THE UMCU

- **MyUMC**: This is the UMCU's patient and employee portal. At the patient portal, patients can view their medical information and share information with their healthcare professionals. The employee portal serves as a place where healthcare professional can find documents such as protocols and work schedules. It supports the UMC in the areas of participation, knowledge management, referral, information exchange, quality and safety, and accreditation.
- **SAP**: The ERP system in use at the UMC is SAP. As stated in section 4.5 ERP systems enable hospitals to manage its financial, human, and material resources. It supports among others the UMCU in performance, accountability, billing, financial administration,

procurement and inventory, legal support, communication and information, and human resources and organization.

- **EZIS**: As stated earlier in this section, EZIS is the HIS the UMCU uses. As can be seen in the figure it supports the UMCU in a wide array of domains, including: anamnesis, assessment and diagnosis, plans of care, surgery, medication, therapy, nursing and care, discharge, care relationships, resource planning, care planning, care logistics, billing and more.
- **Ultimo**: Ultimo is the UMCU's facility management system, which is used for the back as well as front office. It supports the UMCU in its hotel services (which is the provision of hospitality services to patients, visitors, and staff), medical technology, and safety, quality working conditions and environment.

To conclude this section an answer must be given to the question: 'What is the hospital environment of the UMCU and which IT systems do they use?'. This will be done based on what is written in this section, in addition to the description of the context of use for hospital environment of Viitanen (2010), as is described in Section 4.2.2. The ISO standard on which this context of use for hospital environments is based describes four elements: users, tasks, equipment, and environment (ISO Standard, 1998). Each of them is specified for the UMCU.

1. Users: the (system) users at the UMCU are the healthcare professionals (including medical staff and nursing staff), support personnel, researchers, patients, and other actors like insurance companies and pharmacies.
2. Tasks: the tasks of these users range considerably. However, they have one main goal in common; take care of and cure patients.
3. Equipment: the technology environment of the UMCU consists of a large quantity of HISs, handheld technologies, wireless applications, and mobile support. The most important/used ones are: MyUMC, SAP, EZIS, Ultimo, BI, METC, Research Online, LMS, Pure, RDP, Allgeier, Helix, Triasus, Diamant, PDMS MV, 4KP, Cato, Edumanager, Blackboard, TestVision, Evasys, Osiris, KVO Digitaal inschrijven, Cerberus, Syllabus+, AVMS, Monaco, ARTA, Nordined, and TOPdesk.
4. Environment: the environment of the UMCU consists of a physical environment and technical environment, as well as a social and cultural environment which are too hard to pin point. The physical environment at the UMCU consists among others of wards, operation rooms, control rooms, an emergency department, healthcare professionals' workrooms, corridors, and cafeterias. The technical environment differs per user. However, in general it can be stated that healthcare professionals, support personnel, and researchers often use systems during the workday and in their workplace, while patients use the systems in their own time and place.

This description of the UMCU's hospital environment seems to be almost generally applicable to most hospitals. With the goal of the subquestion in mind (i.e. to provide a deeper understanding of the complex environment Check-It has to interact with), the hospital environment of the UMCU will be sketched again in the next section, this time specific for Check-It use.

6.2 CHECK-IT

This subsection will provide an answer to the sixth subquestion: 'What are the intended goals of Check-It, a CPM software program, and how does it work?'.

As stated in Section 2.2 is Check-It a CPM software program developed by the DIT which is a part of the order management system clause in EZIS. It supports healthcare professionals with the execution phase of CPM. Check-It is developed based on the vision that patients with the same healthcare problems and care needs have the rights to be treated with same quality of care within the UMCU (Martens & Vissers, n.d.). To reach this vision, Check-It has four objectives:

1. To improve protocol-based working
2. To improve the monitoring of this protocol-based working
3. To ease administrative workload
4. To reach a more efficient workflow, among others by reducing consultation preparation time

Together these objectives will not only lead to a more uniform care quality, but it is also hypothesized that it leads to a better collaboration between healthcare professionals within and between divisions and departments. This improved collaboration is because Check-It enables the UMCU's clinical pathways to be documented in a uniform way and it makes it clear for all involved parties who should do what.

Check-It does not only document how the care should be delivered for a patient in a particular clinical pathway, but also whether a specific patient actually receives that care. It visualizes what is done and what should be done next per patient. It enables healthcare professionals to see how a patients has gone through a clinical pathway and where in the clinical pathway he is now, by letting healthcare professionals navigate between clinical pathway activities of the past, the present, and the future.

In order to clarify this, a series of screenshots are shown next. To start a Check-It procedure for a patient a healthcare professional has to create the clinical pathway for this patient. The healthcare professional is presented with a list of standard clinical pathway activities and has the opportunity to deselect activities if they are not applicable for a particular patient. This can be seen in Figure 24. When the healthcare professional approves the activities, these are added as separate tab in the patient's dossier, as seen in Figure25.

Check-It shows an overview of the clinical pathway activities for a specific patient at a specific time, which can be seen in Figure 26. At the top of the figure the different moments of contact (i.e. appointment to be made with the patient) are shown. It lists 'actueel' (current) which lists all pending activities, '3 maanden' (3 months) which list the activities to be completed in the first appointment after a patient started in this clinical pathway, in this case after three months, '6 maanden' (6 months) which list the activities to be completed in the second appointment after a patient started in this clinical pathway, in this case after six months, '9 maanden' (9 months), and '12 maanden' (12 months). It can be seen that a patient in this particular clinical pathway has to come back every 3 months for a year. In this particular clinical pathway, a healthcare professional has to access after a year if the patient should come back for another year of tests. In that case the clinical pathway starts from the beginning. The '(V)' before the three and 6 months appointment means that all activities in this moment of contact are completed ('voltooid'). Below the moments of contact it can be seen what

should be done at a specific appointment. For the '9th month appointment', which should be around 26-10-2015, there are different activities described. In the second column ('uitvoerder') can be seen which type of healthcare specialist should perform the particular activity in the third column ('omschrijving'). For example planning a new Check-It and an Optical Coherence tomography ('Check-It plannen + OCT') should be done by a secretary ('SEC'), a request for a Fluorescein angiography or Indocyanine green ('order FAG/ICG) should be conducted by a specialist ('SPE'), and a nurse practitioner ('NUP') should do a lab request for a blood sample to check for Pyruvate kinase ('labaanvraag bloed (PK)'). After the type of specialist and the activity to be completed, the status of that activity is shown. The status shows whether an activity is to be completed or is already completed. The name of the healthcare professional who conducted or declined a specific activity is shown in the last column. Which consequently means that when there is no name, the activity is not conducted yet.

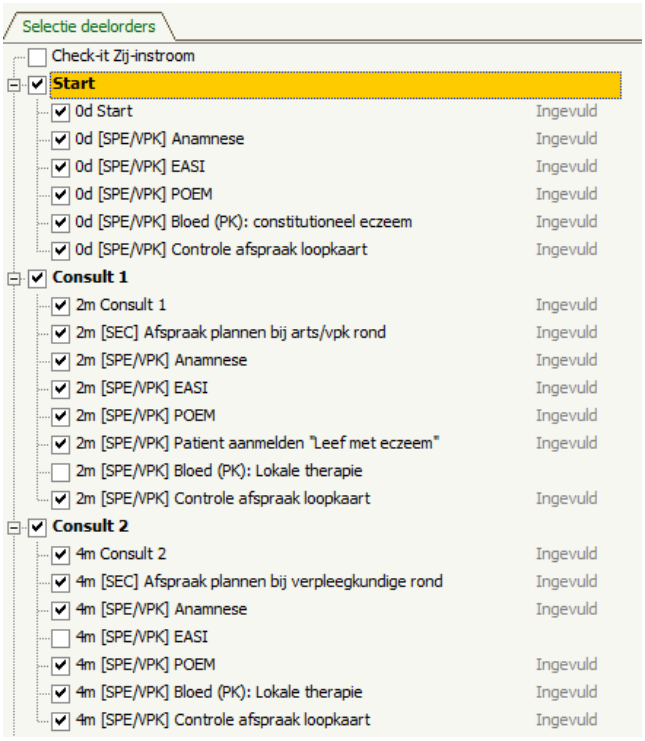

FIGURE 24: CHECK-IT SCREENSHOT: GETTING STARTED

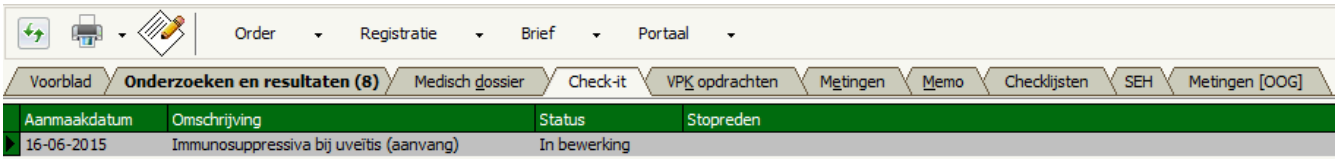

FIGURE25: CHECK-IT SCREENSHOT: CHECK-IT TAB

FIGURE 26: CHECK-IT SCREENSHOT: PATIENT DOSSIER

Now it is known what Check-It looks like, it is important to sketch the UMCU's hospital environment in relation to Check-It in order to create a more comprehensive understanding about the system and the complex environment the system has to operate in. Just like in the previous section, this hospital environment will be based on the ISO standard of 'context of use (ISO Standard, 1998) and Viitanen's work on the hospital specific context of use (Viitanen, 2010), which list users, tasks, equipment, and environment.

1. Users: the users of Check-It are healthcare professionals, support personnel, and researchers. For all three groups Check-It serves as a guidance in their work with patients who are in a clinical pathway. They interact with the system by documenting which activities are completed, at what time, and by whom. In addition, particular activities can be completed via this system. Examples of this are lab requests, which are prefilled and can be submitted with one mouse click, and standardized patient letters which can be sent to the patients' home. Researchers can have an additional benefit from Check-It, since they can obtain aggregated data about the individual activities in a clinical pathway and clinical pathways as a whole. This makes it for example possible to check if protocol-based working improved or whether the lab results for a particular patient group improve over the years.

2. Tasks: Check-It has different tasks, which are listed as functionalities next:
    - Users (excluding researchers) can document whether they completed a clinical pathway activity or not. When it is chosen not to conduct an activity, an explanation has to be filled in.
    - For every activity it can be seen whether or not that activity is completed and by whom.
    - Measurements can be filled in in Check-It, where after it is automatically communicated with EZIS.
    - (Standardized) Lab requests can be sent.
    - (Standardized) Radiology requests can be sent.
    - (Standardized) Patient letters can be sent.
    - A new appointment can be made, which ensures that all activities for that particular appointment will appear automatically on the task lists of the healthcare professionals.

- A ‘moment of contact’ (at the top of the screen in Figure 26) can be linked to an (already made) outpatient clinic appointment.
- An OR date or inpatient admission can be linked to a ‘moment of contact’.
- Questionnaires can be documented.
- Free text can be added.
- Extra activities can be added for a particular patient.
- Based on the active tab it can be seen where a patient is in a particular clinical pathway.
- The clinical pathway can be printed for the patient.
- Data about individual activities, as well as the clinical pathway as a whole can be aggregated.

3. Equipment: the equipment of Check-It is straightforward. It’s the system itself and EZIS. It can communicate with other systems (e.g. PDMS MV where all patient data is integrated) via their shared link with EZIS. Figure 27 shows how Check-It relates to the other most used systems of the UMCU in the domain reference model of the i-Ziekenhuis. It can be seen that Check-It supports the UMCU in their plans of care, treatment process, nursing and care, care planning, care logistics, and (care) billing. Something that is also related to Check-It’s equipment in the relation of Check-It to the conceptual model of HISs. This will be explained after the i-Ziekenhuis figure.

4. Environment: the environment of Check-It at the UMCU consists of a physical environment and technical environment, as well as a social and cultural environment. The latter two are studied in the case study of this research and are currently not known. The physical environment mainly consists of computers located outpatient clinics. However, some inpatient departments also use Check-It, which consequences that it is also used in wards. The technical environment differs per user, however, in general it can be stated that Check-It is only used at computers located in the UMCU operated by users during their workday. Even though it is possible to access it via a VPN connection from other locations.

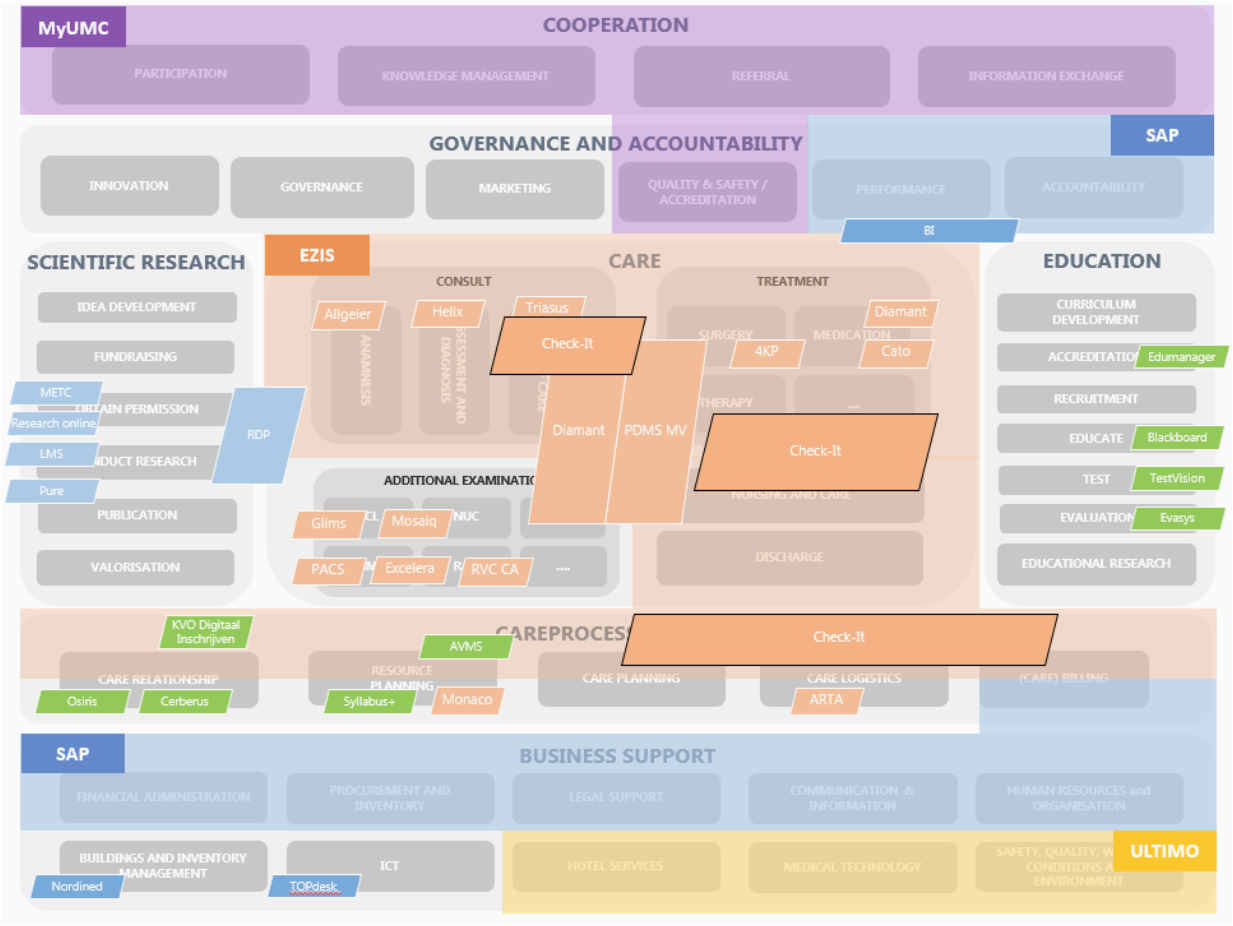

FIGURE 27: CHECK-IT MAPPED TO THE IT SYSTEMS OVERVIEW OF THE UMCU

The final thing to know about Check-It is how it relates to HISs in general. When mapping Check-It on the conceptual model of HISs from Reichertz (2006) as discussed in Section 4.6, it can be seen that Check-It is placed at the horizontal service layer as well as the vertical departmental layer of the patient management side. A graphical representation of this can be found in Figure 28. Check-It is built as a part of the order management system clause in EZIS, which in its whole serves as the core (i.e. it serves as a central database and central communication system). Check-It is placed at the patient management side instead of the hospital management side since the system supports healthcare professional in their work with clinical pathways for patients. Check-It operates in the horizontal service layer since it provides means for daily operations for patient care. It is linked directly to the core (i.e. EZIS) and exchanges data in a frequent and high volume. It can be stated that this horizontal layer are all the functionalities of the program itself. Check-It is in addition also mapped as a vertical departmental layer, since it supports the functions of individual departments. Before departments can begin using Check-It, the system has to be operationalized by inserting the clinical pathway and consequently making sure that all activities, roles, and moments of contact are specified. This leads to Check-It being the same program for all departments, but having different content for each clinical pathway.

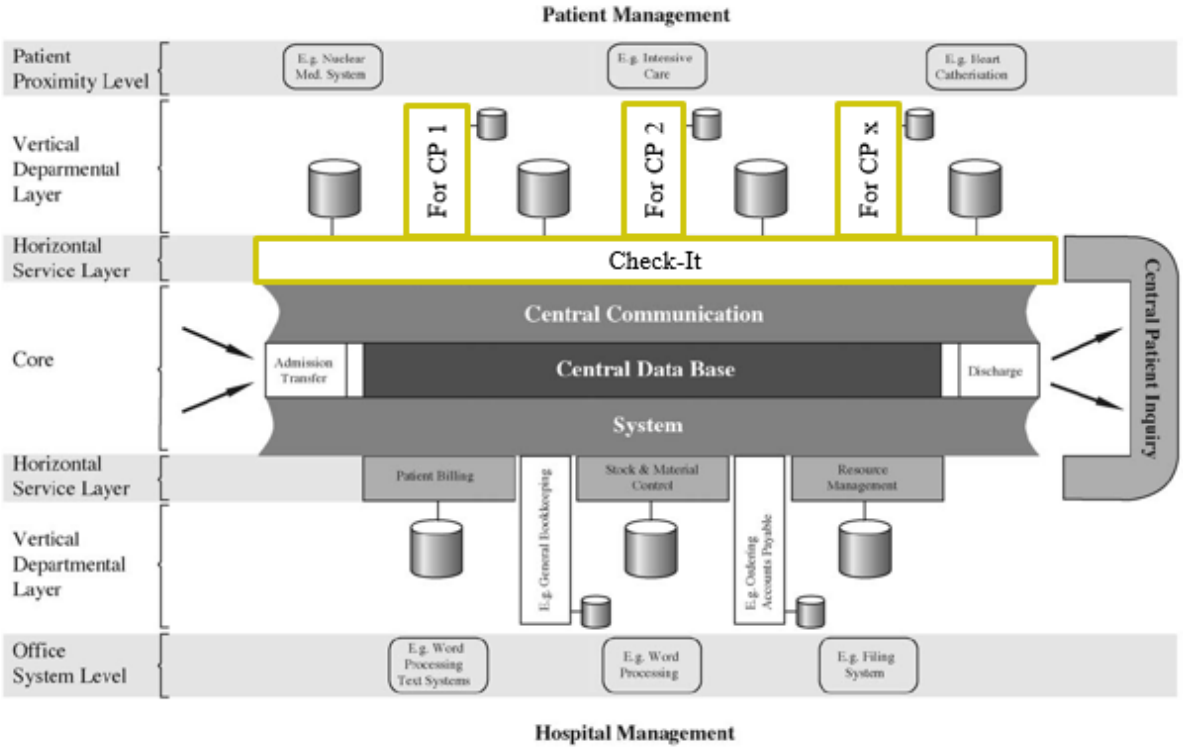

FIGURE 28: CHECK-IT IN THE CONCEPTUAL MODEL OF HISS

To conclude this section and consequently chapter, it can be stated that the UMCU with all its different divisions, departments, focus areas, jobs, domains, systems, and sub systems, is a complex environment. This is the environment Check-It has to interact with. It has to deal with different users and tasks, in addition to the available equipment, and physical and technical environment. It covers multiple domain categories and serves in the horizontal as well as vertical departmental layer of patient management when looking at the conceptual model of HISs.

Now it is known what the hospital environment of the UMCU is, which IT systems they use, how Check-It works, and what the intended goals are, enough background information is available to place this research in perspective. The next chapters will elaborate on the case study performed on Check-It.

7. CASE STUDY OPERATIONALIZATION

This and following five chapters will elaborate on the case study on the CPM software program Check-It, conducted at the UMCU. Together they will answer the seventh subquestion: 'Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?'. Since this question is focused on the opinions of healthcare professionals, it is seen as the final undiscussed element in the Venn diagram, which is used to visualize this research, as can be seen in Figure 29.

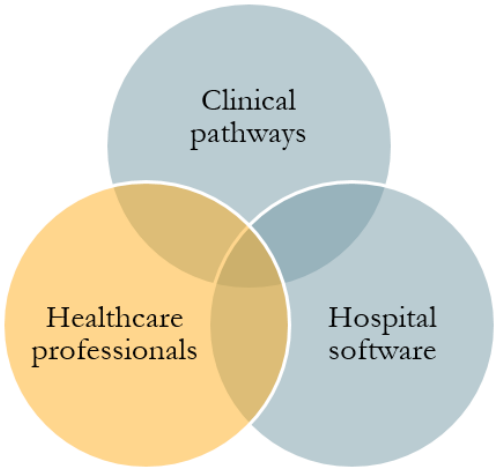

FIGURE 29: VENN DIAGRAM FOCUSED ON HEALTHCARE PROFESSIONALS

In this chapter the method of analysis for healthcare professionals who work with Check-It are object of study. The objective of this case study is to determine the perceived effectiveness of Check-It. As stated in the first chapter, 'effectiveness' is defined as the degree to which objectives are achieved and the extent to which targeted problems are solved. In other words; does Check-It what it promises to do? These targeted problems are solved with the objectives of Check-It, which are:

1. To improve protocol-based working
2. To improve the monitoring of this protocol-based working
3. To ease administrative workload
4. To reach a more efficient workflow, among others by reducing consultation preparation time

As stated in Section 2.2 the Check-It user analysis consists of three points of measurement for the department of pediatric pulmonology and the department of vascular surgery:

1. A pretest before the departments start using Check-It
2. A first posttest (referred to as posttest 1) two months after the departments started using Check-It
3. A second posttest (referred to as posttest 2) four months after the departments started using Check-It

By having a point of measurement before a department starts using Check-It, and one after the fact, a comparison can be made between the expectations and outcomes of the system. This is of

importance because it will give insight in how well the objectives of Check-It are achieved and how big the impact of the system is. By including not one, but two points of measurement after the department starts using Check-It, it can be seen what the influence of time and therefore familiarity with the system, is on the perceived effectiveness.

For the department of dermatology and allergology, and the department of ophthalmology only a posttest is conducted, since no baseline (i.e. pretest) could be determined. This is the case because these two departments already started using Check-It before this research was conducted. Therefore they serve as an example of departments who use Check-It more than six months. By adding these two departments in the case study the probative value of the conclusions is increased.

The healthcare professionals participating in this study have different function throughout the hospital. In order to better understand the underlying similarities between these functions a three-layered division is made. The three distinct groups are:

1. Physicians & medical specialists
2. Nurses & paramedics
3. (Medical) support personnel

These levels are explained in more detail in Table 13.

TABLE 13: HEALTHCARE PROFESSIONAL DIVISION

Physicians & medical specialists	Nurses & paramedics	(Medical) support personnel
The physicians and medical specialist are, as the name would suggest the physicians, nurse practitioners, and residencies[2]. They decide how to treat a patient and/or make (final) diagnoses. This group also has executive tasks; they see patients in the inpatient and outpatient clinics and perform an array of medical tasks. They have at least a master's degree from a university.	The nurses and paramedic group, is the group of healthcare professionals who have mostly executive medical tasks. Often they have a degree from the university of applied sciences, however, some can have an intermediate vocational education. Healthcare professionals from this group who participated in this study have the following functions:	The (medical) support personnel are the secretaries and medical assistants. The majority of their tasks are administrative, even though medical assistants are allowed to conduct minor medical tasks, like giving injections, create cultures, and do blood pressure controls. These employees have completed intermediate vocational education.

[2] Residency is a stage of graduate medical training. A resident is a physician (holding either a M.D., D.O., or MBBS, MBChB, BMed degree) who practices medicine usually in a hospital or clinic (Santiago, n.d.).

	Nurse, clinical research nurse[3], optometrist[4], and optometrist's technical assistant	

Two different research methods are used for the analysis among these Check-It users, i.e. surveys and interviews. By conducting a mixed method approach, numerical data as well as an understanding about the underlying reasons, opinions, and motivations of healthcare professionals who work with Check-It can be obtained. Section 7.1 elaborates on the structure of the surveys used in this case study, while Section 7.2 reports on the interview protocols.

7.1 SURVEYS

As stated in Section 2.2, the surveys of this study consist of questions which are either based on the goals of Check-It, or the TAM model as proposed in Wu, Li, and Fu (2011). The reason why there is chosen to extent the questions beyond the effectiveness measurement alone, is because it is reasoned that without the healthcare professionals accepting Check-It, it will not reach its full potential. Even if Check-It is (perceived) effective itself, if healthcare professionals do not accept it, and are therefore hesitant to use it, the system loses its effectiveness on the work floor. As the following quote illustrates *"Whether or not a system is successful or not is decided on the work floor"* (Berg, 2001). For this reason there is chosen to addition the effectiveness measurement set with a TAM question set.

Three survey questions however, do neither belong to the effectiveness measurement nor the TAM questions. These three questions are solely added for the purposes of the researcher. These questions are:

1. The participant's name, in order to compare specific answers of persons
2. The participant's department, so that it was absolutely sure to which group the participant belongs
3. Whether or not the participant is interested in the results of the study, so the final document can be sent to the interested parties

The surveys are in Dutch and can be found in Appendix H. The two question sets will be discussed next. Each question set is discussed per survey (i.e. pretest and posttest for pediatric pulmonology and vascular surgery, and only a posttest for dermatology and allergology, and the department of ophthalmology).

[3] Clinical research nursing is a nursing practice with a specialty focus on the care of research participants (NIH Clinical Center & Hastings, 2009).

[4] Optometrists are healthcare professionals who provide primary vision care ranging from sight testing and correction to the diagnosis, treatment, and management of vision changes. An optometrist is not a medical doctor (American Academy of Ophthalmology, 2011).

7.1.1 Effectiveness measurement

In order to determine whether Check-It is perceived effective there are several questions which ask the healthcare professionals about the goals of check it. These will be discussed per survey.

Pretest (only for the departments of pediatric pulmonology and vascular surgery)
Each healthcare professional is asked to rate his/her department on the four objectives at a scale of 1 to 10. This is done in order to see if there is a difference between the overall ratings in the pre- and posttest at the departments.

In addition to this, each participant is also asked how long they spend on consultation preparation time, where they can answer: not applicable, 0-30 minutes, 30-60 minutes, 1-1.5 hour, 1.5-2 hours, more than 2 hours. This done in order to see whether the time spend on consultation preparation time is reduced after the departments start using Check-It. The response options are formed based on the opinion of two different healthcare professionals in two different department which came to light in the scoping review.

The last category of questions in the pretest are based on a five-point Likert scale. The participants are asked to indicate to what extent they agree with several statements. For the sake of clarity, these statements are divided in four sets, in accordance to the four objectives of Check-It. The first set is about protocol-based working:

- I sometimes tell colleagues that they do not work according to protocol
- Sometimes colleagues tell me that I do not work according to protocol
- I think protocol-based working is of importance
- I think Check-It will ensure I that I increasingly work according to protocol

The second set is about monitoring of this protocol-based working:

- I think it is easy to monitor if others work according protocol
- I think it is easy to monitor if I work according to protocol
- I think Check-It will ensure that it is easier to monitor protocol-based working

The third set is about the administrative load the healthcare professionals' experience:

- I think it is easy to do administrative tasks
- I think Check-It will ease my administrative workload

The fourth and last set is about the efficiency of the workflow:

- I think that I currently work efficient
- I think Check-It will increase my efficiency

Posttests

Each participant is asked for how many patients they worked with Check-It. This is done in order to determine whether this healthcare has a lot of experience with Check-It.

As stated in the pretest version of the effectiveness questions each healthcare professional is also asked to rate his/her department on the four objectives at a scale of 1 to 10, in order to see if there is a different between the overall ratings in the pre- and posttest at the departments. In addition it is

also asked to give a number based on a five-point Likert scale whether they think Check-It has an influence of these four objectives. This is done to filter any (known) external influences on the objective's score for the department.

In addition to this, is each participant in the departments of pediatric pulmonology and vascular surgery (i.e. pretest, posttest 1 & posttest 2) asked how long they spend on consultation preparation time, where they can answer: not applicable, 0-30 minutes, 30-60 minutes, 1-1.5 hour, 1.5-2 hours, more than 2 hours. This done in order to see whether the time spend on consultation preparation time is reduced after the departments started using Check-It. In addition also a question is posed about whether the healthcare professional is of opinion that Check-It has an influence on the consultation preparation time. This is done because it can be the case that the consultation preparation time is increased/decreased due to external influences. For the departments of dermatology and allergology, and ophthalmology these questions are omitted, since the exact consultation preparation time before they started using Check-It is no known. Therefore the two questions are replaced by the question what the degree of change is for the consultation preparation time due to Check-It. Healthcare professionals can answer this question based on a five-point Likert scale.

The last category of questions in the posttest are based on a five-point Likert scale. The participants are asked to indicate to what extent they agree with several statements. Of which the first set is about protocol-based working:

- I think that it is easier to work according protocol since we are using Check-It
- Since we are using Check-It I tell colleagues more often that they should work according to protocol
- Since we are using Check-It collogues tell me more often that I should work according to protocol

The second set is about monitoring of this protocol-based working:

- I think that it is easier to monitor protocol-based working since we are using Check-It
- Since we are using Check-It, I think it is easier to check if other work according to protocol
- Since we are using Check-It, I think it is easier to check if I work according to protocol

The third set is about the administrative load the healthcare professionals' experience:

- I think my administrative load is decreased since we are using Check-It

The fourth and last set is about the efficiency of the workflow:

- I think I work more efficient since we started using Check-It

The complete survey can be found in Appendix I.

7.1.2 TAM QUESTIONS

Next to these 'effectiveness' questions, several TAM questions are posed in order to determine the acceptance of the healthcare professionals of Check-It. As stated in Section 2.2, the TAM model of Wu, Li, and Fu (2011) is used for this research. They combined TAM (i.e. Perceived Usefulness, Perceived Ease of Use, Attitude, and Behavioral Intention) and TPB (i.e. Perceived Behavioral

Control, Subjective Norm, Attitude, and Behavioral Intention) and add the constructs 'Perceived Service Availability' and 'Personal Innovativeness in IT', as can be seen in Figure 7 in Section 2.2. The questions for each construct can be found in Appendix C. All questions are translated in Dutch, while changing the words 'mobile device for wireless healthcare' to 'Check-It'. These questions are asked in future tense in the survey for the pretest, and in the past tense for the posttest surveys. The operationalized survey questions can be found in Appendix I. In addition to this translation, a few other adjustments to the questions in the model are made. One question is added in the 'Personal Innovativeness in IT' section: 'I know my way around computers'. This question is added because Check-It can only be used on a computer. It can be the case that if a healthcare professionals is not used to work with computers, Check-It will be perceived less effective, because the lack of computer skills prevent the healthcare professional to work with the system as proposed.

In addition to this added question, several standard TAM questions are omitted. First of all the questions about the type of hospital and bed size are omitted since all participants come from the same hospital. Therefore this will not affect the mutual similarities or differences in the opinions about Check-It. Furthermore, three questions are omitted since they are too focused on mobile healthcare. One of which is posed to measure the 'Perceived Ease of Use' ('it is easy to use mobile devices for wireless healthcare'), while the other two are posed to measure 'Perceived Service Availability' ('I would find mobile devices for wireless healthcare easily accessible and portable' and 'mobile devices for wireless healthcare would be available to use whenever I need it'). Two other questions in the 'behavioral intention' construct ('given that I have access to mobile devices for wireless healthcare, I predict that I would use it' and 'if I have access to mobile devices for wireless healthcare, I want to use it as much as possible') are omitted since the use of Check-It is not on a voluntary basis. If a patient is marked as a Check-It patient, all involved healthcare professionals have to work with Check-It in order to keep the chain working. The last omitted question is of the 'Attitude' construct ('I like the idea of using mobile devices for wireless healthcare') since the English word 'like' does not has a synonym in Dutch. Trying to translate it would result in a question that is similar to another question of the same construct ('using mobile devices for wireless healthcare would be a good idea').

7.2 INTERVIEWS

In addition to the surveys discussed in the previous section, interviews are held with all healthcare professionals who participate in this study. These semi-structured interviews give more insight in the thoughts and opinions of healthcare professionals about the subject. Whereas surveys only show numeric data, interviews can deepen the understanding and explain this statistical data. Since the participants can choose their own words, instead of scoring standardized statements, interviews are useful to obtain information about personal feelings, perceptions, and opinions. They also allow the interviewer to ask more detailed questions, when an interviewee says something worth elaborating on, and ambiguities in the questions can be clarified on the spot.

Each interview is recorded on a mobile device, after which it is transcribed in order to extract the exact wording of the participants. However, since the interviews are in Dutch, the quotes which are shown in Chapter 8 are freely translated. In order to structure the transcribed text, different coding

techniques from grounded theory are used, as can be seen in Figure 30. This process ensures that the created categories are directly 'grounded' in the data.

First open coding is used. Open coding is the part of the analysis concerned with identifying, naming, categorizing, and describing phenomena found in the text (Charmaz, 2008). All relevant 'chunks' of data are labelled. After this process is completed, the axial coding begins, which relates the codes (i.e. labelled categories) to each other. The last step is the selective coding. By looking at the created categories of the axial coding phase an adequate wording for that category is chosen, which covers all that belongs to that code. When this process is finished the whole document is reread to see if all labels belong to a category.

FIGURE 30: CODING PROCESS

There is chosen to keep the number of interview questions to a minimum in order to keep participating in the study as accessible as possible for the healthcare professionals. There is a difference between the interview questions for the pretest and for the posttests. Each of them will be discussed next.

Pretest

The interview questions for the pretest are formed in order to get an understanding about the expectations of the participants about Check-It. The pretest questions are:

1. Do you have positive expectations about Check-It?
2. Do you have negative expectations about Check-It?
3. Do you have any other kind of expectation about Check-It?

There is chosen to specifically ask the healthcare professionals about their positive as well as negative expectations in order for them to consciously think about all aspects of their expectations. The third and last question is posed in order to give the participants an opportunity to elaborate more on the subject if they feel the need. There is chosen not to ask specific questions about the four objectives of Check-It, because that could steer the interviewees in a particular direction.

Posttest

The interview questions for the posttests are formed in order to get an understanding about the perceived effects of Check-It and the process around it.

1. Do you think Check-It increased your effectivity? And how come?
2. Did you notice any (other) positive effects of Check-It?
3. Did you notice any (other) negative effects of Check-It?

4. What did you think about Check-It's transition phase?
5. Do you have any improvement points for Check-It?

The first question is asked in order to get a direct answer about the subquestion answered by this case study (i.e. what is the perceived effectiveness of Check-It?). In the survey this is measured based on the different components this questions entails, while here this construct is asked as-is. Making sure the participating healthcare professionals can elaborate why they think Check-It increases their effectivity or not, results in a deeper understanding about the subject. Questions 2 and 3 are posed in order to see which effects may be influencing this perceived effectiveness of Check-It. Since these questions are also asked in the pretest, a comparison can be made between the expectations and outcomes for the system at the two involved departments. Question 4 asks the healthcare professionals what they think of the transition to Check-It. This question is posed in order to see if the process involving the implementation of Check-It could be optimized and maybe has an influence on the perceived effectiveness of the system. The fifth and last question is there to see whether participants see improvements points for Check-It. Improving the system might possibly lead to a better perceived effectiveness.

7.3 Structure case study reports

As already elaborated on, each test (i.e. pretest as well as posttests) consist of a survey and an interview. The surveys consist of an effectiveness question set and a TAM question set. The interviews revolve around positive and negative expectations and effects, in addition to opinions about the transition phase and improvement points.

In the following five chapters, the case study results per department will be elaborated on. First the two departments which underwent a pretest as well as two posttests (i.e. pediatric pulmonology and vascular surgery), and after that the department which only participate in the posttest (i.e. dermatology and allergology and ophthalmology).

Each chapter starts with a general description of the department and its clinical pathway and shows which types and how many healthcare professionals participated. After that the most revealing results of the survey are elaborated on. This is done by giving an overview of the mean scores and standard deviation for the questions about Check-It's objectives in several figures and additional value adding results in the text. The results of the TAM questions are shown after that in a separate figure. This figure is divided in three stages, which roughly equal the influence the different TAM constructs have on each other as explained in section 2.2.1. For each TAM construct the mean score and standard deviation is given. An overview of the figure template for the TAM questions can be found in Figure 31. As the figure shows, Perceived Service Availability, Perceived Ease of Use, and Personal Innovativeness in IT are grouped as the first cluster. These constructs are proven to have an influence on each other and/or the constructs in the next phase. The same holds true for the second cluster which consists of Personal Usefulness, Attitude, Perceived Behavioral Control, and Subjective Norm; these constructs have an influence on each other and/or on Behavioral Intention. Behavioral Intention is the only construct in the last cluster. This construct can be seen as the most important construct of the TAM model, it directly indicates the acceptance of technology by indicating to what extent the healthcare professionals are intending to use a system.

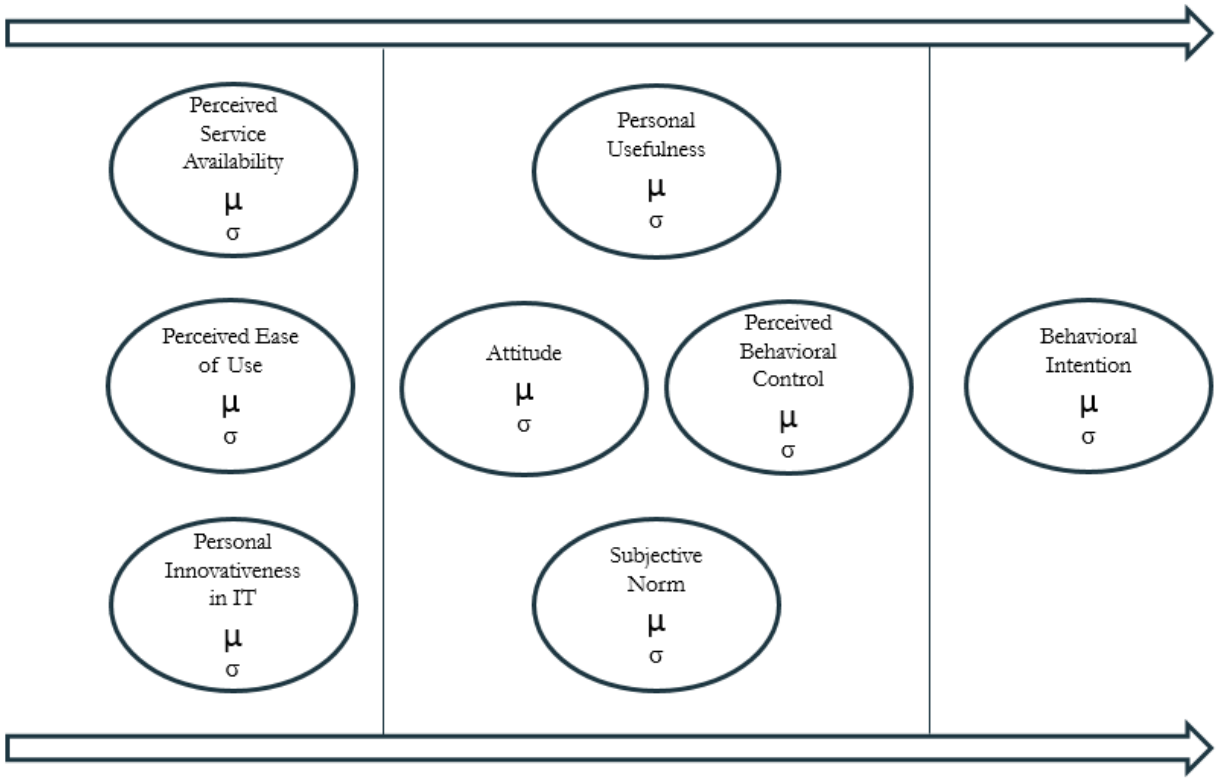

FIGURE 31: FIGURE TEMPLATE TAM QUESTIONS

After the surveys are reported, the interview results are elaborated on. The interview results consist of one or two tables: one with the mentioned Check-It expectations or effects and depending on the test, one table with the mentioned improvement points. Quotes are added to explain several statements and create a more in-depth understanding of the sentiment in a department.

Each chapter ends with a conclusion for that particular department. The last chapter of this section will merge all sub conclusions and calculate the differences between the departments in order to answer the seventh subquestion of this study: 'is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?'.

8. Case study results: Pediatric pulmonology

8.1 Introduction

The department of pediatric pulmonology of the WKZ has a clinical pathway in use for children with Cystic fibrosis (CF). CF, also known as mucoviscidosis, is an incurable, inherited disease, in which people's mucus becomes thick and sticky, instead of a watery substance. Mucus is a substance made by tissue that line some organs and body cavities, such as the lungs, nose, liver, intestines, and sex organs. It keeps the lining of these organs and body cavities moist and prevents them from drying out or getting infected (Bush, Alton, Davies, Griesenbach, & Jaffe, 2006). As stated, the mucus of people with CF becomes thick and sticky and builds up in the lungs which causes a blockage of the airways. In addition, it can also block the pancreas, which causes the body to be unable to digest food and make the patient sweat away too much salt for the body to function properly (WebMD, 2014b). CF can be life-threatening, and the average life expectancy of someone with CF is around forty years (MacKenzie et al., 2014). While there are no cures for CF, there are several treatment methods. These treatments are aimed at making living with the decease bearable and the control of the symptoms. It is for patients with CF of importance to be checked on a regular basis, in order to adjust the treatment to the current state of the patient.

A paper-based version of the clinical pathway for CF was already in use before the department started using Check-It. Three clinical pathways are realized in Check-It: the clinical pathway for babies from 0-1 years old, a clinical pathway for children aged 1-4, and a clinical pathway for children aged 4-5. This is because the treatment and treatment frequencies differ between these groups. In order to completely digitalize the clinical pathway, separate clinical pathway parts should also be realized for children aged 6-12, and 12-18.

The department of pediatric pulmonology started piloting Check-It in the second week of March 2015. Before this time the pre-test was conducted. At the two month mark (i.e. the second week of May) and the four month mark (i.e. the second week of September) the two pretests were conducted. A total of eight healthcare professionals started using Check-It, all of them participated in this study. This results in a participation rate of 100%. The division of the healthcare professionals per function can be seen in Figure 32. The first number in each wedge shows the absolute number of participants in that function, the second number shows the percentage of that function when comparting it to all functions in the department. As can be derived from this figure, no nurses and paramedics are included in this study. However, long-function analysts, who belong to the 'nurses and paramedics' group, are going to work with the system in the near future if the pilot yields positive results. They do not work with Check-It just yet, because children aged below 6 cannot participate in an independent long function examination. If the clinical pathway is expanded to children aged 6-12, and 12-18, these healthcare professionals will also work with the system.

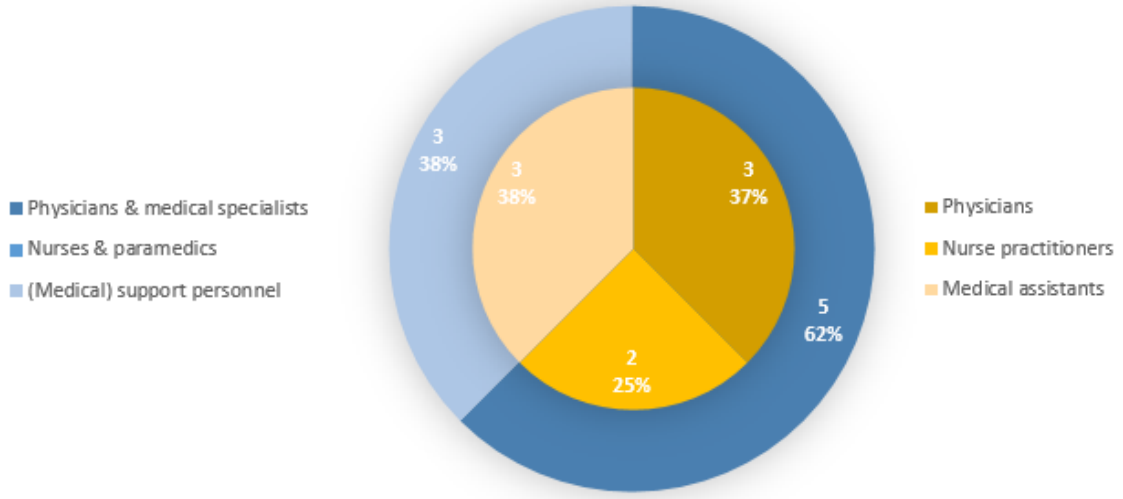

FIGURE 32: PARTICIPANT'S FUNCTIONS AT PEDIATRIC PULMONOLOGY

The department of pediatric pulmonology is one of the two department which underwent a pretest as well as two posttests about Check-It. These test will be discussed respectively.

8.2 PRETEST

Surveys

The first survey is conducted two weeks before the healthcare professionals start to work with Check-It. In the survey all eight participants are asked to rate the current situation in their department on a ten-point scale as regard to the different objectives of Check-It.

Department grade. Scale: 1-10			
Protocol-based working	Monitoring protocol-based working	Ease of administrative workload	Efficiency
7.43 σ = 0.53	5.86 σ = 1.21	7.00 σ = 0.82	7.14 σ = 0.38

FIGURE 33: MEAN OBJECTIVE GRADES PRETEST - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

Figure 33 shows that the healthcare professionals at the department of pediatric pulmonology who are going to work with Check-It are above average satisfied with three of the four objectives of Check-It in their department, which is indicated by the grade of 7. However, the monitoring of protocol-based working score is just sufficient (i.e. > 5.5). Something which is reflected in the average scores of the perceived ease of monitoring oneself ($\mu = 3.38$, $\sigma = 0.92$) and monitoring others ($\mu = 2.88$, $\sigma = 0.83$) which are both answered based on a five-point Likert scale. Efficiency is believed to be achieved among others by reducing the consultation preparation time, therefore the healthcare professionals are also asked to indicate how long they take to prepare their consultation time, allowing comparison to be made over the months this study is conducted. Before the department started using Check-It, the healthcare professionals need on average (rounded to) 0-30 minutes ($\mu = 2.14$, $\sigma = 0.38$) to prepare themselves.

Since none of the objectives scores an eight or higher, which indicate 'good' to 'outstanding', there is room for improvement. This room for improvement is ought to be filled by Check-It. Therefore the healthcare professionals are also asked to indicate how much they think Check-It would improve these objectives in their department. They could indicate this on a five-point Likert scale. These scores can be found in Figure 34.

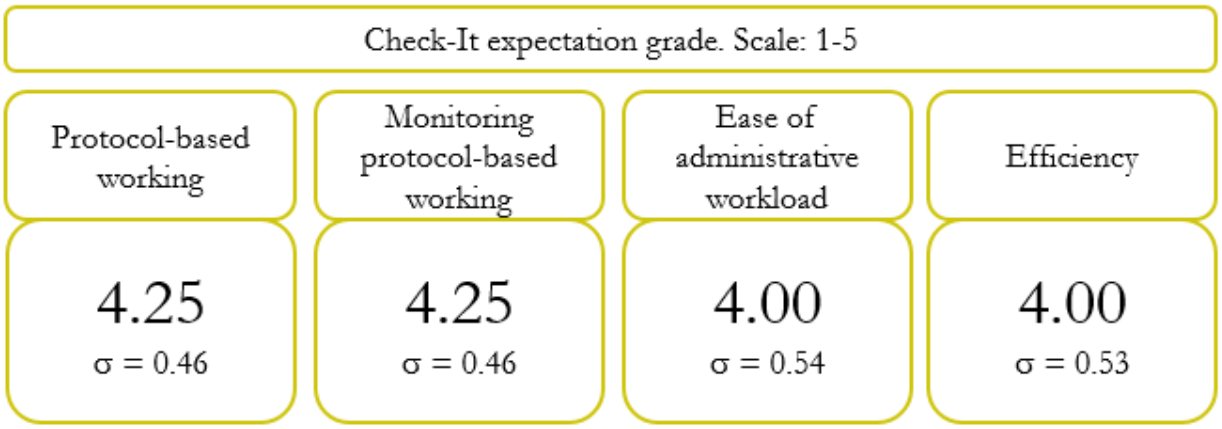

FIGURE 34: MEAN CHECK-IT EXPECTATION GRADE PRETEST - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

As can be seen in the figure above, the healthcare professionals of the department of pediatric pulmonology are of opinion that Check-It has the potential to influence the department considerably. Especially protocol-based working, and the monitoring of protocol-based working is seen as certain to undergo a positive change after the introduction of Check-It. Nevertheless the differences are small and also the ease of administrative workload and efficiency is thought to improve.

Summarizing the results of this part of the surveys, it can be stated that the participants satisfied with the protocol-based working, ease of administrative workload, and efficiency in their department, however they also see that there is room for improvement. They are of opinion that at least a part of this improvement can start with the implementation of Check-It in their department. Monitoring

of protocol-based working has the most to gain from Check-It, for which the healthcare also believe that it can bring a positive change.

As discussed in Sections 2.2 and 7.1 the surveys consist of both effectiveness questions and TAM questions. The result of these TAM questions can be seen in Figure 35.

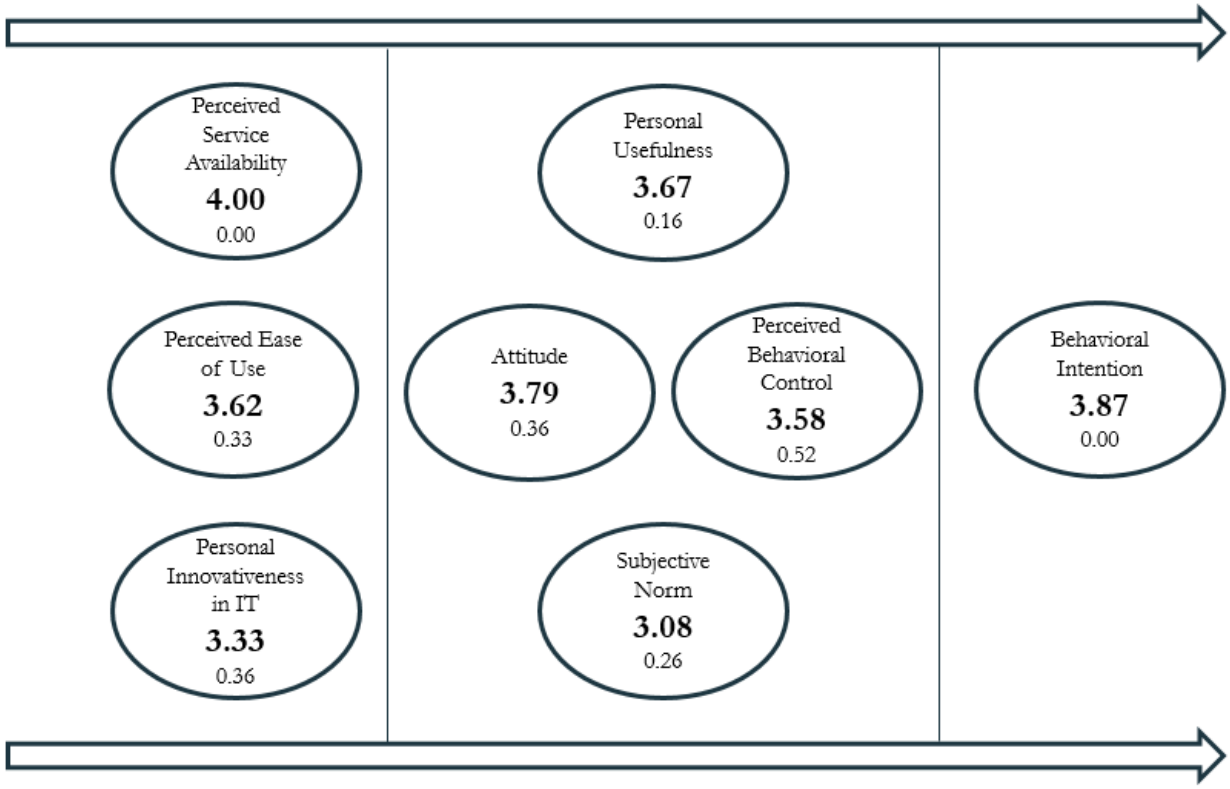

FIGURE 35: MEAN TAM RESULTS PRETEST - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

As can be seen in the figure above, Perceived Service Availability as well as Behavioral Intention have a standard deviation of 0. This is because the construct is measured by a single question, which means there is no deviation as is the case with constructs measured with multiple questions. Overall the standard deviations of the other TAM question sets are perceived as low, which indicates that the mean set scores represent the means of the individual questions quite well.

Based on the mean scores of the TAM sets, it can be stated that the healthcare professionals of pediatric pulmonology have reacted positive on the TAM statements. This indicates that Check-It is likely to be accepted on the work floor, which is also indicated by the high score of Behavioral Intention (i.e. $\mu = 3.87$). Something which is noteworthy is the large differences of scores within the question sets of Attitude and Perceived Behavioral Control. Where the healthcare professionals are asked to indicate whether they think the use of Check-It is a good idea and a wise idea, they assign both with an mean score of 4 ($\sigma = 0.76$ and $\sigma = 0.54$). However, when they are asked to indicate if they also think Check-It will be nice to use, they assign a 3.38 ($\sigma = 0.74$), which is considerably lower. In addition, in order to measure the construct Perceived Behavioral Control, three other questions

are asked. The healthcare professionals think they can use Check-It well for their job ($\mu = 4.00$, $\sigma = 0.76$), think they would probably have the knowledge sources, and opportunities to do so ($\mu = 3.75$, $\sigma = 0.71$), but are not convinced they would have total control over the system ($\mu = 3.00$, $\sigma = 0.93$).

Interviews

The stated results of the survey are supported by the statements the healthcare professionals made in the interviews. In these interviews each participant is asked whether they have any positive or negative expectations concerning Check-It. The results can be seen in Table 14

TABLE 14: INTERVIEW RESULTS CHECK-IT EFFECTS PRETEST – DEPARTMENT OF PEDIATRIC PULMONOLOGY

Number of mentions	Positive/ negative?	Expectation
7/8	+	Improved protocol-based working
3/8	-	High learning curve
3/8	+	Less forgotten tasks
3/8	-	Difficult when not according to protocol
3/8	+	Increased efficiency
2/8	+	Improved monitoring of protocol-based working
2/8	+	Decreased cognitive workload
2/8	-	Decreased cognitive workload
2/8	+	Better patient care
1/8	+	Ease of administrative workload
1/8	+	Increased protocol insight

The table on the shows that seven out of eight healthcare professionals state that they expect that Check-It ensures an increase of protocol-based working. Especially so, because not everyone is following the paper-based clinical pathway, which is among others expressed by one of the healthcare professionals in the 'physicians and medical specialists' group.

> ***"There are a lot of different people working with these patients. However, not everyone can find the right papers [the paper-based clinical pathway] or choses to work with it. This will change when we are going to use Check-It"***
>
> Physicians and medical specialists

The second most named expectation about Check-It is the learning curve it is expected to entail. Several participants indicate that especially in the beginning it will probably take time to get accustomed with the system and therefore foresee some murmurs from the work floor. Another negative formulated expectation which is mentioned thrice, is the foreseen difficulty when the

process deviates from the clinical pathway as structured in Check-It. This can for example occur when a patient is not able to come back for a follow-up appointment within the defined timeframe. For now the participants who named this expectation, do not know how to deal with these expectations. Two other expectation which are named thrice are that Check-It will ensures that less tasks in the clinical pathway are forgotten and that the efficiency in their daily routines is increased.

Even though the expectation that Check-It will lead to an improvement as regards to protocol-based working is mentioned by eight participants, that Check-It will also lead to an improvement for the monitoring of this protocol-based working is only mentioned twice. The same is true for the following train of thought; by improving this protocol-based working and the monitoring of it, a standardization of care is realized, something which is beneficiary for the patients of this department.

Something that stands out is the expectation that Check-It will lead to a decrease in cognitive workload, something which is mentioned twice is positive context and twice in a negative one. The following two quotes will illustrate the differences between these expectations.

> ***"It is of importance to keep thinking for ourselves. Maybe a patient benefits more from not following the protocol, while we are only busy with ticking the boxes"***
> Physicians and medical specialists

> ***"It's easier since I won't have to think all the time. I can just easily see what has to be done for a patient at a particular time and what is yet to come"***
> (Medical) support personnel

The remaining two expectation are both just mentioned once. The first is about the expectation that it leads to an ease of administrative workload, which is mentioned by one of the participants in the 'physician and medical' specialists group. The other, and last, expectation is that Check-It will lead to an increased protocol insight, since all involved employees have more insight in what the other healthcare professionals are doing.

8.3 POSTTEST 1

The second posttest is conducted after the healthcare professionals at the department of pediatric pulmonology used the system for two months. The results of this posttest are discussed next.

Surveys

First of all it is of importance to assess the experience of the healthcare professionals with Check-It. On average the healthcare professionals of pediatric pulmonology have worked with (rounded to) 5-10 patients ($\sigma = 0.59$). It can therefore be concluded that the participants do not have very much experience with the system yet.

Just like in the pretest, in the survey all eight participants are asked to rate the current situation in their department on a ten-point scale as regard to the different objectives of Check-It, the results of this can be found in Figure 36.

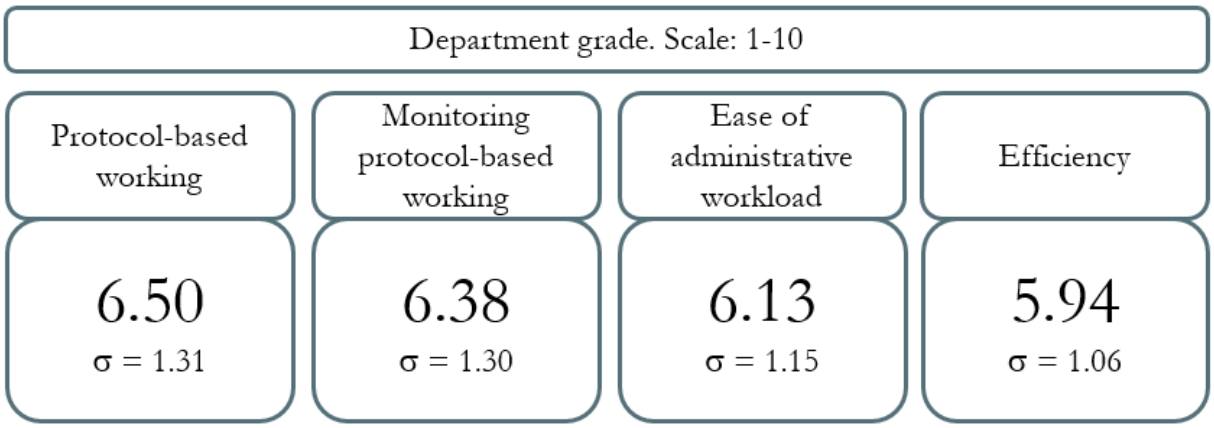

FIGURE 36: MEAN OBJECTIVE GRADE POSTTEST 1 – DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

As can be seen in the figure above the healthcare professionals see that there is a lot of room for improvement for the four different objective of Check-It. When comparing it with the results of the pretest, it can be seen that the mean score for the monitoring of protocol-based working is increased, while all other scores decreased. Also the standard deviations of all scores is higher, which means that the healthcare professionals spread out the data points over a wider range of values. In order to know whether these scores dropped because of Check-It or because of external influences, the participants are asked to rate to what extent Check-It improved the situation of these four objectives in the department. The results of this question can be found in Figure 37.

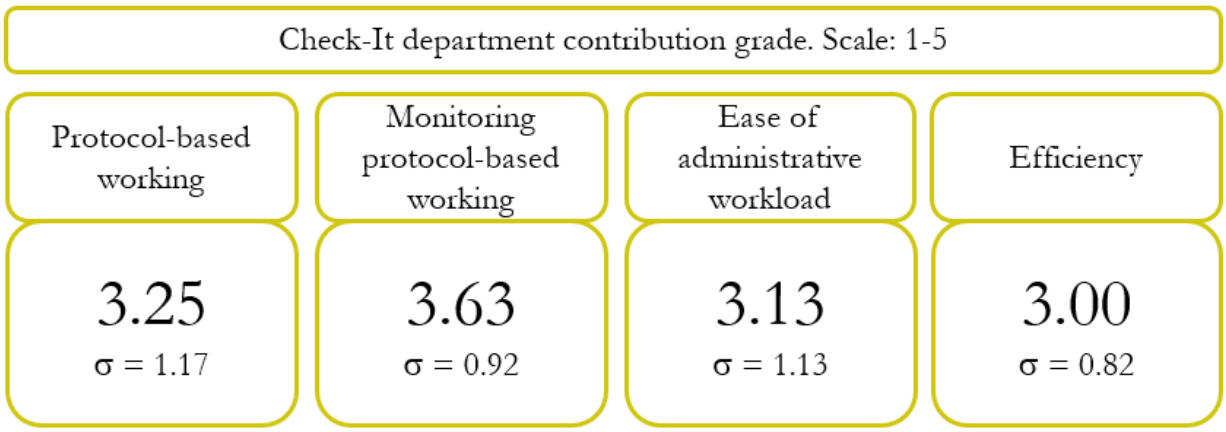

FIGURE 37: MEAN CHECK-IT DEPARTMENT CONTRIBUTION GRADE POSTTEST 1 - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

As can be seen, Check-It scores three or higher on all four objectives of Check-It. Where 1 means Check-It did not change anything, and 5 means Check-It really changed a lot. Something that stands out is that while the average scores for the department are generally speaking declining, the healthcare professionals think that Check-It does have a positive influence on these objectives. In other words; if Check-It would not be introduced, the participants believe that the department would do worse on these four objectives. Especially the monitoring of protocol-based working -the only department score that increased-, is thought to have benefitted the most from Check-It over the two month use.

When comparing these numbers with the numbers the healthcare professionals expected Check-It to contribute (Figure 34) it can be stated that even though Check-It brings a positive change to the department after two months, the change was believed to be bigger before the department started using Check-It. In other words; Check-It does what it promises to do, however, in a lesser extent than expected.

In addition to the questions to what extent Check-It contributes to the four objectives in the department, the participants are also asked to indicate to what extent Check-It influences their own work as regards to these objectives. The result of these questions can be found in Figure 38. The numbers in this figure show that the department as a whole (i.e. their colleagues who also work with Check-It) is thought to improve more on three of the four objectives of Check-It, than the individual healthcare professional. However, the healthcare professionals do think Check-It is as efficient for them as for their colleagues. This efficiency is believed to be achieved among others by reducing the consultation preparation time, therefore the healthcare professionals are also asked to indicate how long they take to prepare their consultation time. After two months of Check-It use, the healthcare professionals still need on average (rounded to) 0-30 minutes ($\mu = 2.13$, $\sigma = 0.35$) to prepare themselves. This number did not change changed of the course of two months, something which is also indicated by the relatively low score the participants assign Check-It to be of influence on consultation preparation time ($\mu = 2.38$, $\sigma = 0.74$).

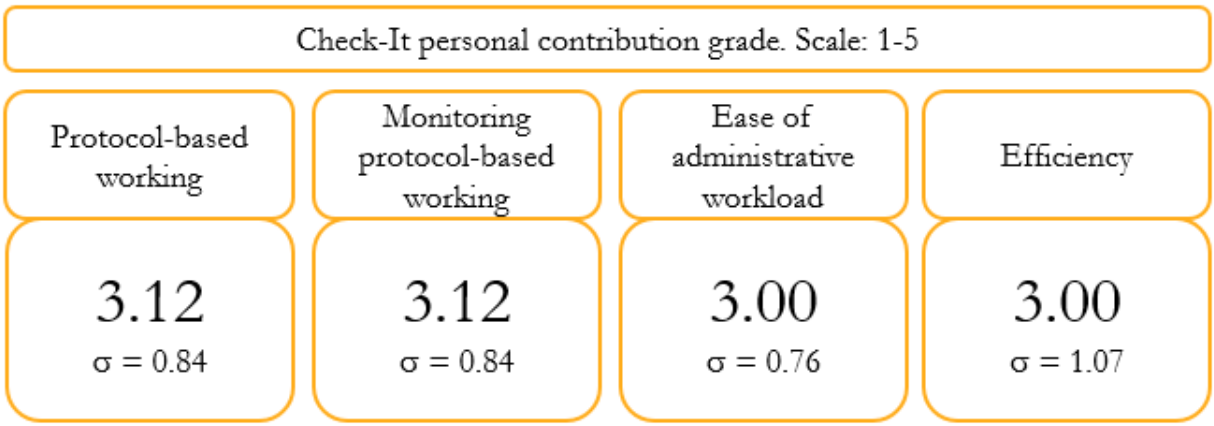

FIGURE 38: MEAN CHECK-IT PERSONAL CONTRIBUTION GRADE POSTTEST 1- DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

There are two noteworthy facts that add to this data set. The first is that while there were no remarkable differences between the healthcare professional groups in the pretest, there is in the first posttest. For all four objectives for the Check-It personal grade as well as the Check-It department influence grade, the '(medical) support personnel' scores at least 0.7 (to 1.4) higher. This means that the medical assistants at this department seem to get more out of Check-It, but also think the department as a whole profits more, than the 'physicians and medical specialists'. In addition, as stated in the results of the pretest, the healthcare professionals expected Check-It to increase the ease of monitoring themselves more, than monitoring others. Something which came true after the department started using Check-It. Nevertheless the differences between self-monitoring ($\mu = 3.50$, $\sigma = 1.31$) and monitoring others ($\mu = 3.25$, $\sigma = 1.04$), are smaller than expected.

Next to these effectiveness questions, the healthcare professionals are also asked to fill-out the TAM questions, of which the results can be seen in Figure 39. The mean score of the question set is the first bold figure. Below that the standard deviation of the question set is shown. This means that it shows the amount of variation between the questions in the question set, instead of showing how the standard deviation is within a question.

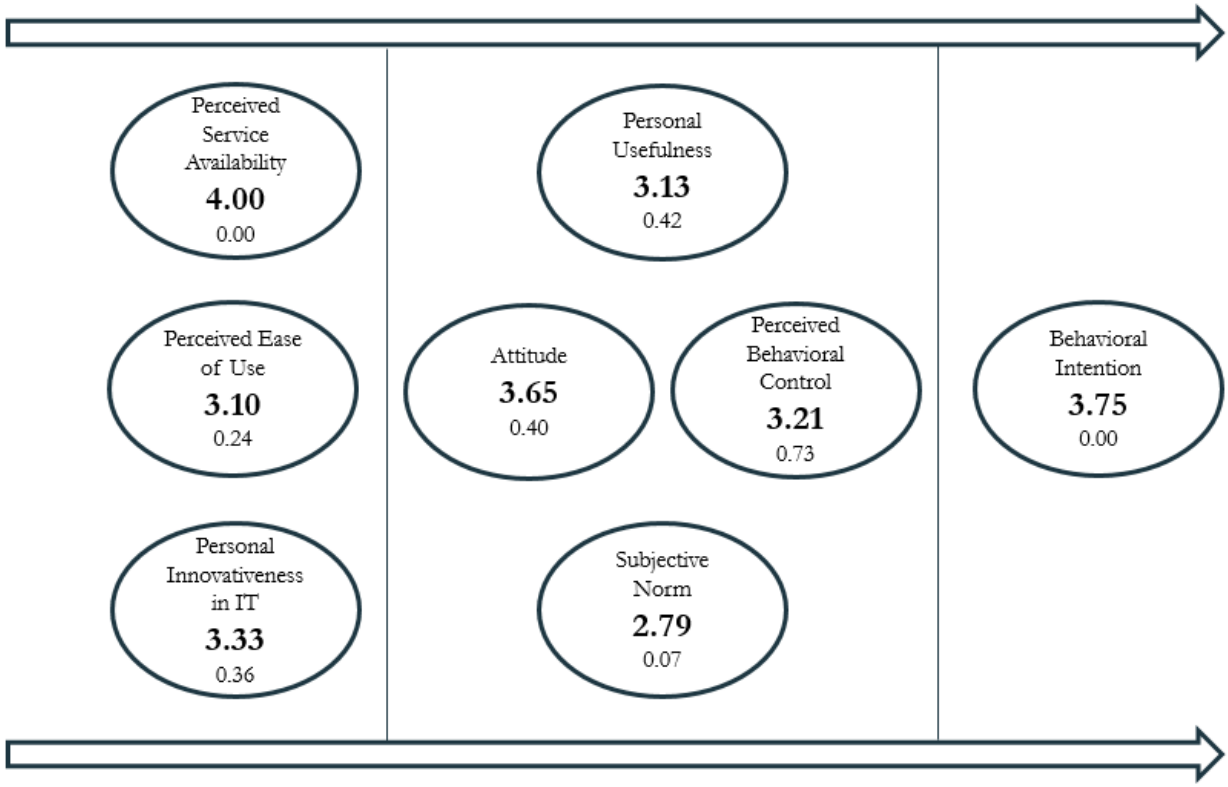

FIGURE 39: MEAN TAM RESULTS POSTTEST 1 - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=8)

As can be seen in the figure, Perceived Service Availability as well as Behavioral Intention have a standard deviation of 0. This is because the construct is measured by a single question, which means there is no deviation as is the case with constructs measured with multiple questions. Overall the standard deviations of the other TAM question sets are perceived as low, which indicates that the

mean set scores represent the means of the individual questions quite well. Since the Personal Innovativeness in IT is a construct that is not influenced by Check-It use, the healthcare professionals are not asked to fill in the corresponding questions again. The number in this figure therefore copied from the result in the pretest.

Based on the mean scores of the TAM constructs, it can be stated that generally speaking healthcare professionals at the department of pediatric pulmonology have reacted positively on the TAM statements after two months of Check-It use. This indicates that the system is accepted on the work floor. However, the scores can range from 1 to 5, in which 1 means that the healthcare professionals reject the system, 3 that they are neutral as regard to the system, and 5 that they accept it. Scores between 3 and 4 (i.e. the results of this test) means that the healthcare professionals lean towards the acceptance. Something noteworthy is that while the different questions in most constructs are in accordance with each other, at the constructs Perceived Behavioral Control and Personal Usefulness there are remarkable differences. For Perceived Behavioral Control the healthcare professional are quite positive about how well the system can be used ($\mu = 3.75$, $\sigma = 0.89$) and that they have the knowledge, sources, and opportunities to use the system ($\mu = 3.50$, $\sigma = 1.07$). However, they are considerably less positive about their control of the system ($\mu = 2.38$, $\sigma = 0.92$). In addition, for Personal usefulness the healthcare professional approximately on the same page about the influence of Check-It on their work execution ($\mu = 3.00$, $\sigma = 0.53$), productivity ($\mu = 2.88$, $\sigma = 0.64$), and effectiveness ($\mu = 2.88$, $\sigma = 0.64$). However, they are far more positive about how usable the system is ($\mu = 3.75$, $\sigma = 0.71$).

Something else that stands out, is that just like the department and Check-It contribution grades, the scores for all TAM constructs have declined. Again, this indicates that Check-It does what is promises to do, however, in a lesser extent than what is expected prior to the use of the system. In addition, most of the standard deviations have increased, which means that the participant's agree less with each other.

Interviews

The stated results of the survey are supported by the statements the healthcare professionals made in the interviews. Five out of eight healthcare professionals indicated in the interviews that Check-It did not increase the work effectivity over the last two months. Two of the three participants who did answer this question positively, are of the '(medical) support personnel' group. Which supports the numbers discussed previously, in which this group scored the influence of Check-It for their own work and for the department as a whole, higher.

In the interviews each participant is also asked whether they have seen any positive or negative effects concerning Check-It. Four out of eight participants stated that they thought the question was difficult to answer, since they don't have much experience with the system. This results in a low amount of statement concerning Check-It, which can be found in Table 15.

TABLE 15: INTERVIEW RESULTS CHECK-IT EFFECTS POSTTEST 1 – DEPARTMENT OF PEDIATRIC PULMONOLOGY

Number of mentions	Positive/ negative?	Statement
3/8	-	Lack of clarity
3/8	+	Improved protocol-based working
3/8	-	More work
2/8	+	Less forgotten tasks
2/8	+	Pre filled orders and letters
2/8	-	Difficult when not according to protocol

Since the healthcare professionals don't have a lot of experience with the system, it still lacks clarity for some of them. This has probably also to do with the learning curve several participant expected beforehand. This is related to the difficulty healthcare professionals face, when the process deviates from protocol, something which is mentioned twice. When the healthcare professionals work for a more extended period of time with the system, it is expected that they know better how to deal with these situations. Besides this lack of clarity and difficulty when something differs from protocol, more work is also mentioned trice as a negative effect of Check-It. Once by a participant from the '(medical) support personnel' group, who indicated that she got extra responsibilities (e.g. measuring the head circumference). However, she wasn't sure if it was really a new task, or something they just didn't do because they did not check the paper-based clinical pathway. The other two mentions come from the fact that it took a lot of time to initiate a Check-It patient, since schemes and schedules should be adjusted and new appointments should be made. Therefore Check-It was not yet seen as effective for the healthcare professionals appointed to this task. However, they are optimistic for the future, something which is illustrated by the following quote.

> ***"I still expect that it will be alright in the end. However, we still need to get used to the system, which takes more time and creativity than expected"***
>
> Physicians and medical specialists

The increase of protocol-based working is also mentioned trice. This increase of protocol-based working is among others mentioned by one of the participants in the 'physician and medical specialists' group, who indicated that she got fewer questions about what do next from her colleagues, which in turn causes her to have more time for other tasks. This increase in protocol-based working is closely related to the statement that less tasks are forgotten since the use of Check-It. Also the use of pre filled orders and letters, which saves the healthcare professional time and mental effort, is seen as a positive effect of Check-It.

In addition to these questions about effectiveness, positive, and negative effects the participants are also asked if they have improvement points for Check-It. Since the use of the system is still low, most healthcare professionals though it was a difficult question to answer. One of the healthcare

professionals in the '(medical) support personnel' group however, did see in improvement point as regards to patients who deviate from the clinical pathway. She thinks it would help if Check-It would offer the possibility to add tasks for a particular patient.

8.4 POSTTEST 2

The second posttest is conducted after the healthcare professionals at the department of pediatric pulmonology used the system for four months. In the meantime two medical assistant, which participated in the previous two test, left the department. This results in a participant group of:

- three physicians
- two nurse practitioners
- one medical assistant

Since the divisions between groups is too low (five 'physicians & medical specialists' and one '(medical) support personnel) no comparisons between these groups is made in the coverage of the results.

Surveys

In the four months the participants use Check-It, they have worked on average with (rounded to) 10-20 (σ = 1.37) Check-It patients. Just as with the two other test, in the survey all (remaining) participants are asked to rate the current situation in their department on a ten-point scale as regard to the different objectives of Check-It. The result of this can be seen in Figure 40.

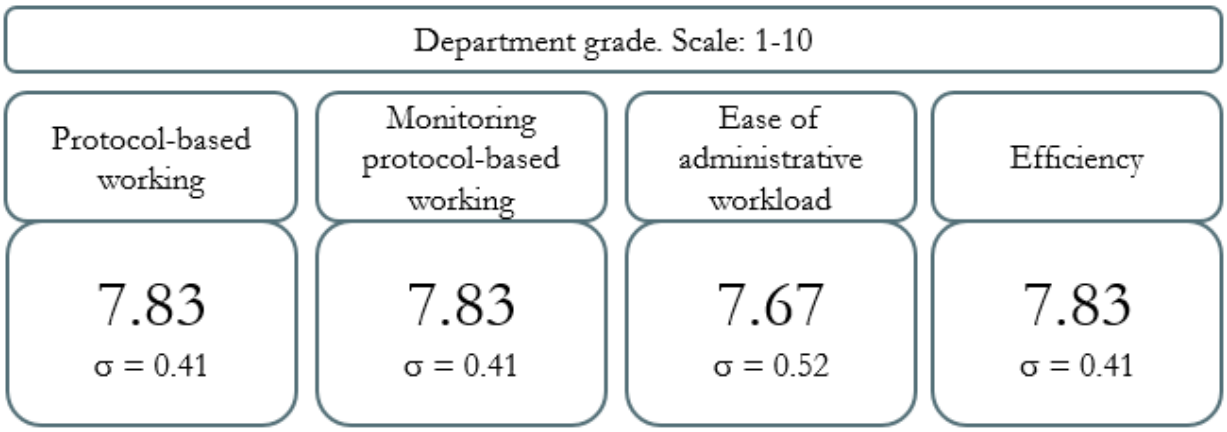

FIGURE 40: MEAN OBJECTIVE GRADE POSTTEST 2 – DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=6)

As can be seen in the figure above the healthcare professionals who work for four months with Check-It rate their department 'above average' (i.e. a seven) to 'good' (i.e. an eight) on all four objectives of Check-It. As opposed to posttest 1, all objectives have improved. Especially the effectivity, which gained 1.89, has gained a lot over the two months between the posttests. This may imply that it takes time for Check-It to fully take effect, and while the protocol-based working improves the fastest, increased efficiency takes longer. Noteworthy is that while all average grades

have improved, all standard deviations declined, something which is caused by healthcare professionals being more in agreement with each other. In order to know if this positive change can be attributed to Check-It, or that external influences are in play, the healthcare professionals are also asked to grade the influence of Check-It on these objectives on a five-point Likert scale. The result of this can be found in Figure 41.

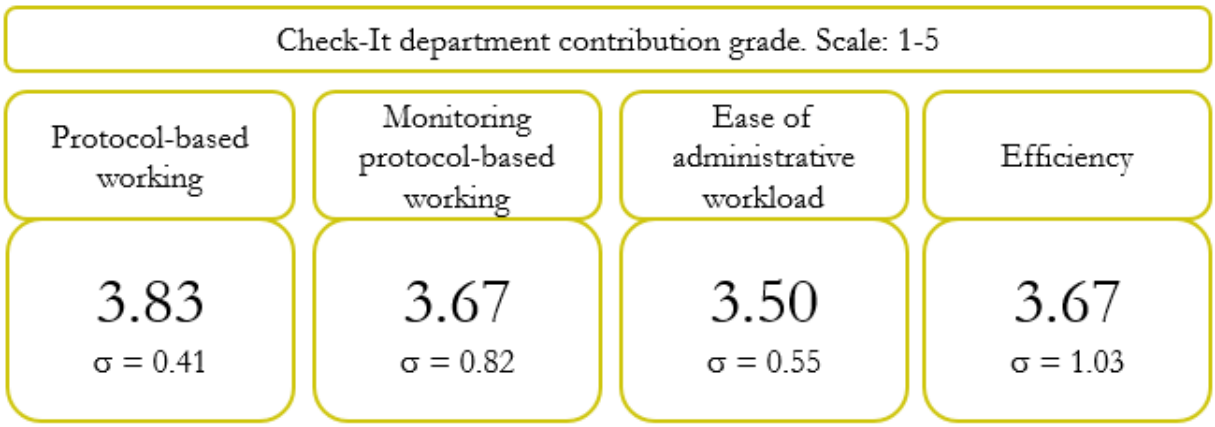

FIGURE 41: MEAN CHECK-IT DEPARTMENT CONTRIBUTION GRADE POSTTEST 2 - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=6)

As can be seen, the positive change in the department of pediatric pulmonology is from a moderate to considerable extent due to Check-It. The differences between the scores for these objectives are small, something which indicates that after four months, Check-It contributes almost the same for all objectives. These differences between the scores where somewhat larger after two months of Check-It use. Again, all objectives scores are higher and all standard deviations lower, than in the second posttest. This supports the statement that it takes time for Check-It to fully take effect. This also holds true for the monitoring of others. Where in the first posttest there was a small difference between the influence of Check-It on self-monitoring and monitoring others, after four months of use these are rated just as positive ($\mu = 3.67$, $\sigma = 1.03$). In addition to the questions to what extent Check-It contributes to the four objectives in the department, the participants are also asked to indicate to what extent Check-It influences their own work as regards to these objectives. The result of these questions can be found in Figure 42.

This figure shows that the participants are of opinion that individually benefit more from Check-It than the department as a whole does. Especially protocol-based working is seen to be influenced the most, however, the differences are small. In line with the other results of the second posttest, these scores are higher for every objective than in the first posttest. Efficiency is believed to be obtained among others by reducing consultation preparation time. Each healthcare professional is therefore asked what their average consultation preparation time is, and how Check-It influences this. After four months of Check-It use, the healthcare professionals still need on average (rounded to) 0-30 minutes ($\mu = 2.17$, $\sigma = 0.41$) to prepare themselves. This number does not seem to have changed, something which is also indicated by the relatively low score the participants assign Check-It to be

of influence on consultation preparation time ($\mu = 2.67$, $\sigma = 0.52$). Therefore it can be concluded that Check-It has a positive effect on the efficiency for the healthcare professionals of pediatric pulmonology, however, this is for a large extent not attributable to the reduction of consultation preparation time.

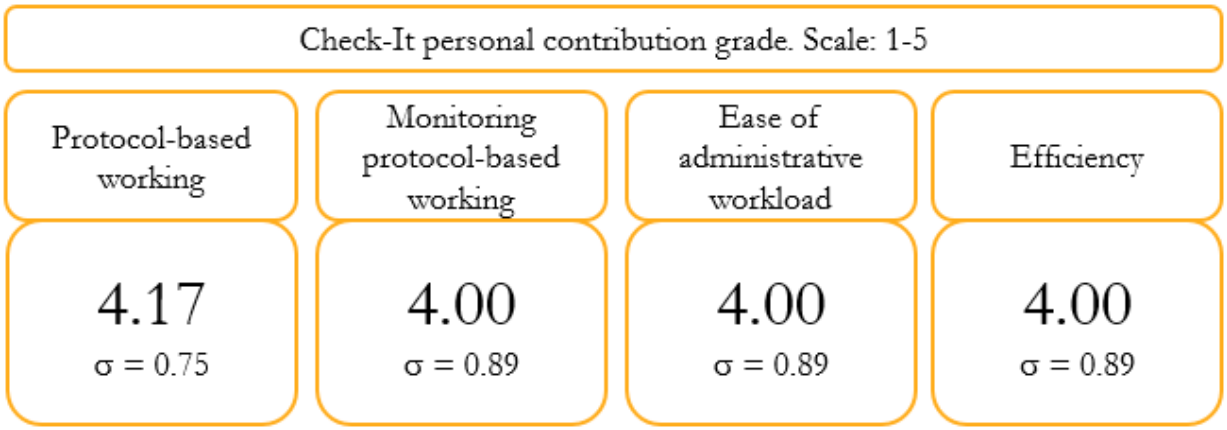

FIGURE 42: MEAN CHECK-IT PERSONAL CONTRIBUTION GRADE POSTTEST 2- DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=6)

A side note has to be made about the covered scores in relation to the two medical assistants who were not able to participate in the second posttest. While it could be argued that these number would be different if they would have participated, looking their results of the first posttest it can be seen that they answered relatively high on the different questions. This means that if there scores would be omitted from the first posttest, those scores would be lower, and the gap between the scores of the first and second posttest larger. The conclusion that Check-It becomes more effective over the months, therefore holds.

In addition to the effectiveness questions, the healthcare professionals are also asked to fill-out the TAM questions, of which the results can be found in Figure 43. The mean score of the question set is the first bold figure. Below that the standard deviation of the question set is shown. This means that it shows the amount of variation between the questions in the question set, instead of showing how the standard deviation is within a question.

As can be seen in the figure, Perceived Service Availability as well as Behavioral Intention have a standard deviation of 0. This is because the construct is measured by a single question, which means there is no deviation as is the case with constructs measured with multiple questions. Overall the standard deviations of the other TAM question sets are perceived as low, which indicates that the mean set scores represent the means of the individual questions quite well. Again, since the Personal Innovativeness in IT is a construct that is not influenced by Check-It use, the healthcare professionals are not asked to fill in the corresponding questions again. The number in this figure therefore copied from the result in the pretest.

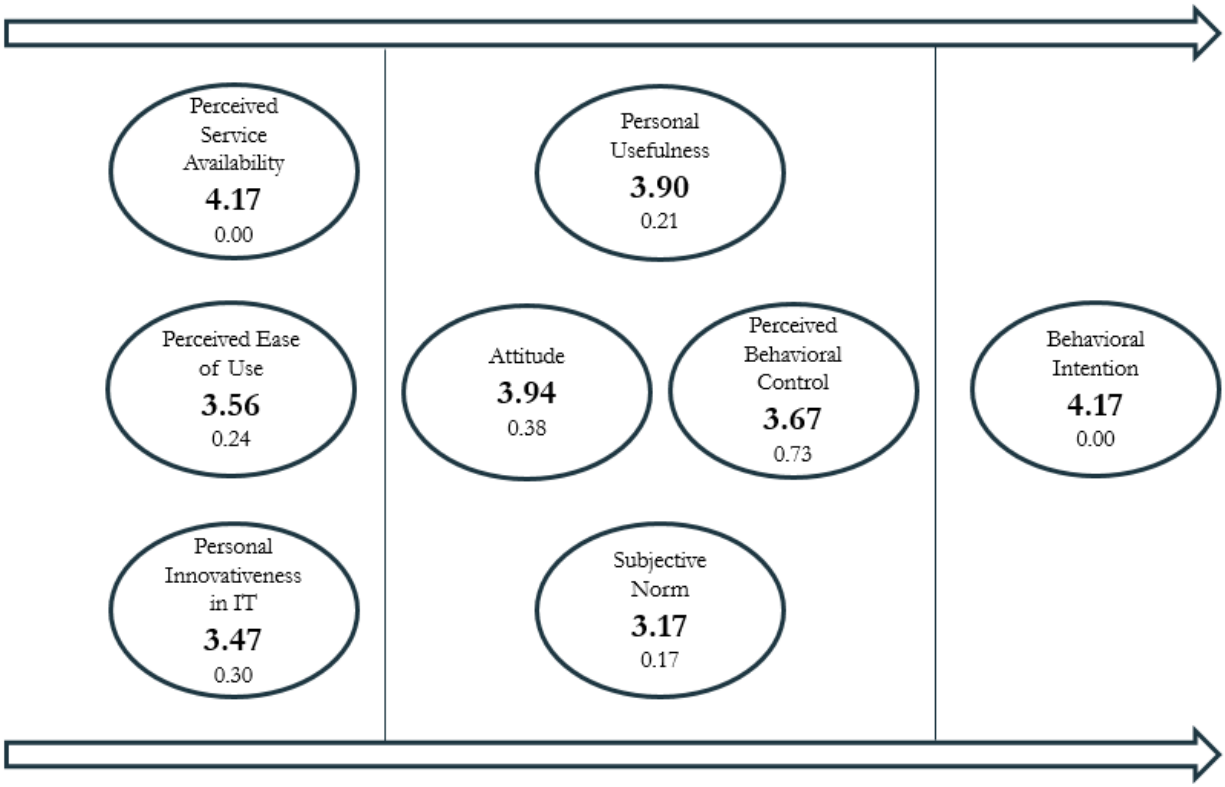

FIGURE 43: MEAN TAM RESULTS POSTTEST 2 - DEPARTMENT OF PEDIATRIC PULMONOLOGY (N=6)

Based on the mean scores of the TAM constructs, it can be stated that generally speaking healthcare professionals at the department of pediatric pulmonology have reacted positively on the TAM statements after four months of Check-It use. This indicates that the system is accepted on the work floor. Just like the objective scores of this second posttest discussed previously, the scores of all TAM construct have increased (except for Personal Innovativeness in IT, since that score is copied). Nevertheless the standard deviation stayed the same for Perceived Behavioral Control, and increased for Perceived Ease of Use, Subjective Norm, and Behavioral Intention. This reveals that even though the participants are more open to accepting the system, they are also less in accordance with each other. Despite the standard deviations increasing, overall they still can be considered as low.

Noteworthy is the difference between mean question scores (i.e. as opposed to mean question set scores, as shown in the figure) for Perceived Behavioral Control and Perceived Ease of Use. For Perceived Behavioral Control the healthcare professional are quite positive about how well the system can be used ($\mu = 4.17$, $\sigma = 0.41$) and that they have the knowledge, sources, and opportunities to use the system ($\mu = 4.00$, $\sigma = 0.60$). However, they are considerably less positive about their control of the system ($\mu = 2.83$, $\sigma = 1.47$). In addition, for Perceived Ease of Use the healthcare professional agreed the most with the low amount of mental effort it takes to use Check-It ($\mu = 4.17$, $\sigma = 0.75$), and the clearness and understandability of the system ($\mu = 3.67$, $\sigma = 1.37$). However, for the easiness to get Check-It to do what they want it to do, Check-It score a meagre 2.83 ($\sigma = 1.33$), a substantial difference with the two other results.

Interviews

The stated results of the survey are supported by the statements the healthcare professionals made in the interviews. Four out of six healthcare professionals indicate that Check-It increased their work effectivity over the last four months. Interesting to note is that only the two nurse practitioners answered this question negatively. However, both indicated that they do see this improving in the (near) future.

In the interviews each participant is asked whether they experienced any positive or negative effects concerning Check-It. The results are summarized in Table 16.

TABLE 16: INTERVIEW RESULTS CHECK-IT EFFECTS POSTTEST 2 – DEPARTMENT OF PEDIATRIC PULMONOLOGY

Number of mentions	Positive/ negative?	Statement
4/6	+	Improved protocol-based working
4/6	+	Increased efficiency
3/6	-	High learning curve
3/6	+	Pre filled orders and letters
2/6	+	Decreased cognitive workload
1/6	+	Increased patient care
1/6	+	Less forgotten tasks
1/6	-	Not flexible enough
1/6	+	Increased protocol insight
1/6	-	Lack of usability
1/6	+	Decreased orientation time
1/6	-	Not aligned with other programs
1/6	-	Difficult when not according to protocol

As can be seen in the table, a lot of different statements about the positive and negative effects of Check-It are made. However, while there are a lot of statements, only five of them are mentioned by more than one healthcare professional.

The most named statement about Check-It use after four months in this department is the increase of protocol-based working and the increase of efficiency it entails. This increase in effectivity is mentioned due to:

- Having a list of tasks in front of them, that they can use as guidance (mentioned twice)
- Not having to explain to others what their task is, and
- Not having to fill out the forms and letters themselves

These pre filled orders and letters is something that is mentioned by three separate healthcare professionals. However, only one of them mentioned it in combination with an increased efficiency.

The other two participants mentioned it as something which makes working with the system a pleasant experience. Also mentioned trice is the learning curve Check-It entails. The healthcare professionals stated that they had to get used to the system (one of them still does), and that it therefore lacked effectiveness in the months leading to the second posttest. Nevertheless, two of them felt they had overcome this learning curve, and it increased effectivity ever since. A comprehensive quote about this subject comes from one of the participants in the 'physicians and medical specialist' group.

> ***"In the beginning I was too focused on the Check-It list during my consultation time. This caused the spontaneity in my talks to vanish, it became too formal. But when I felt this, I changed my use. I did not let Check-It guide my consultation time anymore, but just checked [with the patient still present] at the end of the appointment if I did everything."***
>
> Physicians and medical specialists

The decrease of mental effort is something that is mentioned by two healthcare professionals, both in a positive annotation. All other statements are just mentioned once. Where increased patient care due to standardization, less forgotten tasks due to checklists, increased protocol insight due to the overview of all tasks, and decreased orientation time are mentioned as positive effects. This decreased orientation time is caused by the fact that over the four months several new medical assistants were hired. They had to be trained to be able to perform their responsibilities. Because Check-It shows an overview of the clinical pathway and all tasks involved, the new employees were told to use it as a guidance which decreased the time needed to train them.

In addition also four other statement were mentioned once, all negatively annotation. First of all Check-It is believed to be not usable enough when it comes to showing the exact appointment for a patient. In the in-use version of Check-It, the healthcare professionals have to click on the appropriate tab in order to see the check-list for a particular patient, instead of automatically showing where the patient is in the clinical pathway. In addition the difficulty of dealing with patient who deviate from the clinical pathway is mentioned, and the missing link between Check-It and other programs. For example the OR-program the department uses has relevant information about dates and times, which cannot be found through Check-It. Lastly, Check-It is believed to be not flexible enough since healthcare professionals cannot modify the clinical pathway for a single patient after the clinical pathway is in use. This is illustrated by the following quote.

> ***"If a child is in a wheelchair and cannot get out, we are unable to measure the exact length of this patient. Check-It keeps reminding me every time that I need to measure the length. I would like to turn of this tasks for this particular patient."***
>
> Physicians and medical specialists

Next to the questions about the effectivity, positive, and negative effects of Check-It, the participants are also asked to give their view on the transition phase and potential improvement points.

All healthcare professionals agreed that the transition phase was fine as is. However, two of them also noted that it would be better not to start with a new system when a lot of people are on summer holiday. This caused some colleagues to miss the training session, and a reduced availability from the DIT when there were questions.

The mentioned improvement points are summarized in Table 17. As is seen in this table the incorporation of other programs with Check-It, is mentioned by half of the participants. This would result in Check-It being the leading program from which everything can be documented and requested. Also making the clinical pathway customizable for individual patients is something that is mentioned, which consequentially would increase the use of the system, since it would be possible to use it for every patient. An improvement point which would also lead to an increase of use of the system, is the expansion of clinical pathway parts to all children with CF in the department of pediatric pulmonology. The last mentioned improvement point is about the current tab of a patient being highlighter, something which is also stated as a negative effect in Table 16.

TABLE 17: INTERVIEW RESULTS IMPROVEMENT POINTS POSTTEST 2 – DEPARTMENT OF PEDIATRIC PULMONOLOGY

Number of mentions	Improvement
3/6	Incorporate other programs with Check-It
1/6	Include clinical pathway parts 6-12 and 12-18
1/6	Make it possible to add, remove, and postpone tasks for a particular patient
1/6	Highlight the current tab

8.5 DIFFERENCES BETWEEN TESTS

In order to answer the subquestion 'Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?', the interviews and Check-It departmental contribution grade and personal Check-It grade are of importance. This is because the effectiveness of Check-It is defined as the as the degree to which the four objectives are improved by Check-It. As is discussed in the previous subsections it can be stated that Check-It is indeed perceived effective, since it is believed to bring a positive change to all these objectives for the department as a whole as well as the healthcare professionals themselves. The combined results of the survey can be found in Appendix J. In addition to these results, it is also interesting to know whether there is a significant difference between the tests. Not only the differences between the separate scores of the objectives are calculated, a 'perceived effectiveness score' is also constructed. This perceived effectiveness score is the mean score of the outcomes of the four objectives. This score can be calculated four all three tests, which means that also the difference between these perceived effectiveness scores can be calculated, of which the result is shown in Figure 44.

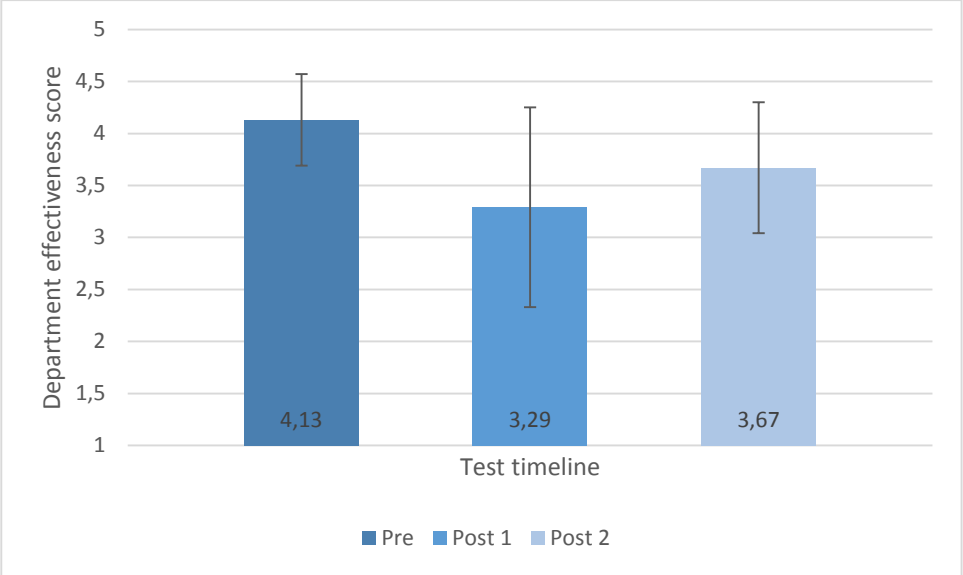

FIGURE 44: DEPARTMENT EFFECTIVENESS SCORE – DEPARTMENT OF PEDIATRIC PULMONOLOGY

This figure shows the results of these effectiveness scores and the responding standard deviations (respectively 0.44, 0.96, and 0.63) for the department contribution grades. It shows that while the healthcare professionals had high expectations before they started using Check-It, these expectations were not completely met after two months. Even though Check-It brought a positive change, it was not as high as expected. When looking at the scores in the second posttest, after four months, the effectiveness score is higher than in the first posttest, but still smaller than expected beforehand. In order to calculate if the results between these scores are also significantly different paired-sample t-tests are used.

Based on the calculations of these t-test, of which the SPSS output can be found in Table 36 in Appendix K, it can be stated that on average the participants expected significantly more of Check-It ($M = 4.13$, $SE = 0.16$) than is perceived true after two months ($M = 3.29$, $SE = 0.34$), $t(7) = 2.40$, $p = 0.048$. In addition, there are no significant differences between the first posttest ($M = 3.10$, $SE = 0.43$) and the second posttest ($M = 3.67$, $SE = 0.26$), $t(5) = -1.75$, $p = 0.140$, and between the pretest ($M = 4.17$, $SE = 0.21$) and the second posttest ($M = 3.67$, $SE = 0.26$), $t(5) = 2.15$, $p = 0.084$.

When taking a closer look to the scores of the separate objectives within this effectiveness score, as shown in Figure 45, it can be seen that this motion of high expectations, a lower score after two months, and an intermediate score after four months is the case for every objective.

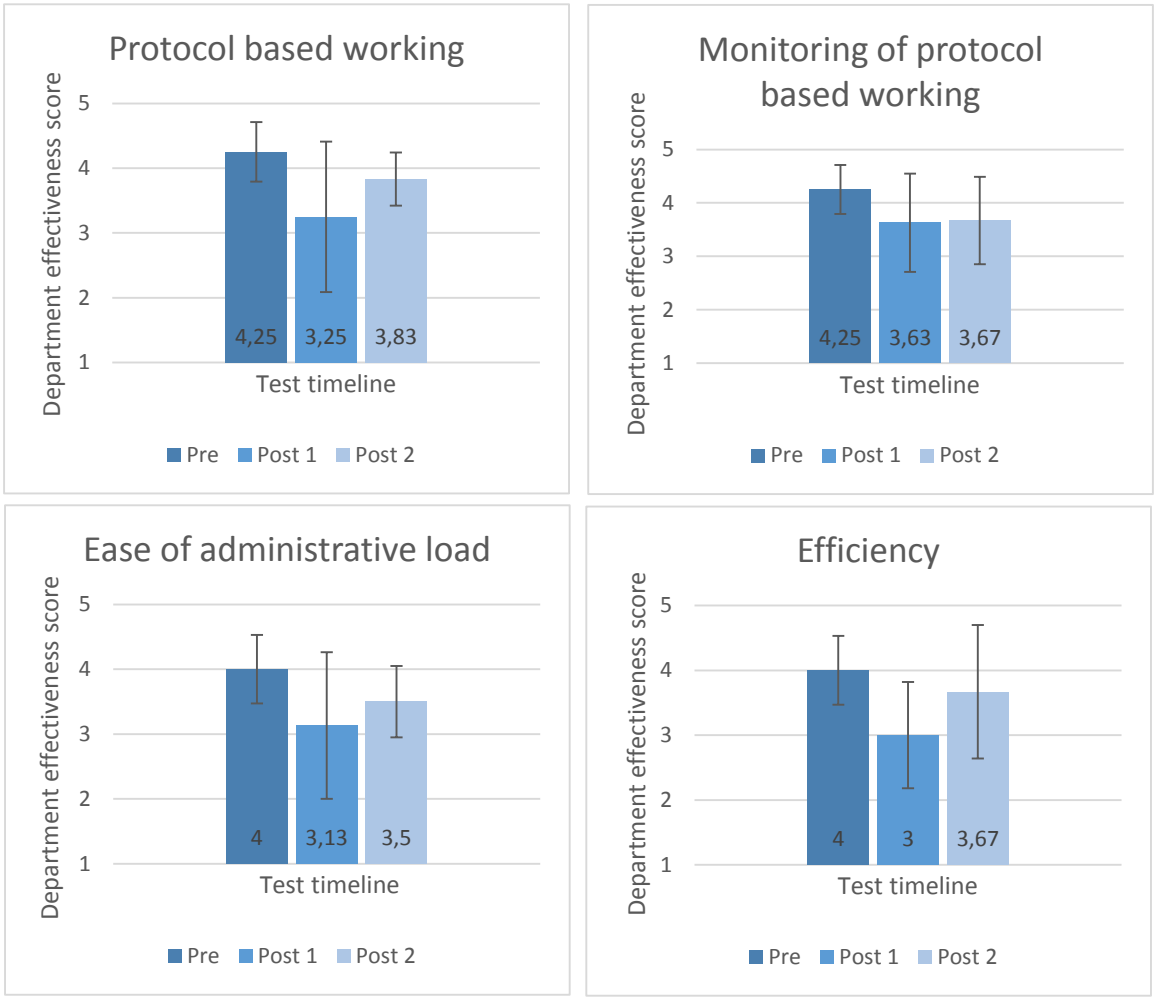

FIGURE 45: DEPARTMENT GRADE PER OBJECTIVE – DEPARTMENT OF PEDIATRIC PULMONOLOGY

Next to Check-It's (expected) influence on the department as a whole, also Check-It's influence for the individual healthcare professional is measured in the two posttests. Something which add to the perceived effectiveness. The effectiveness score and the responding standard deviations (respectively 0.85 and 0.80) of these personal influence score can be found in Figure 46.

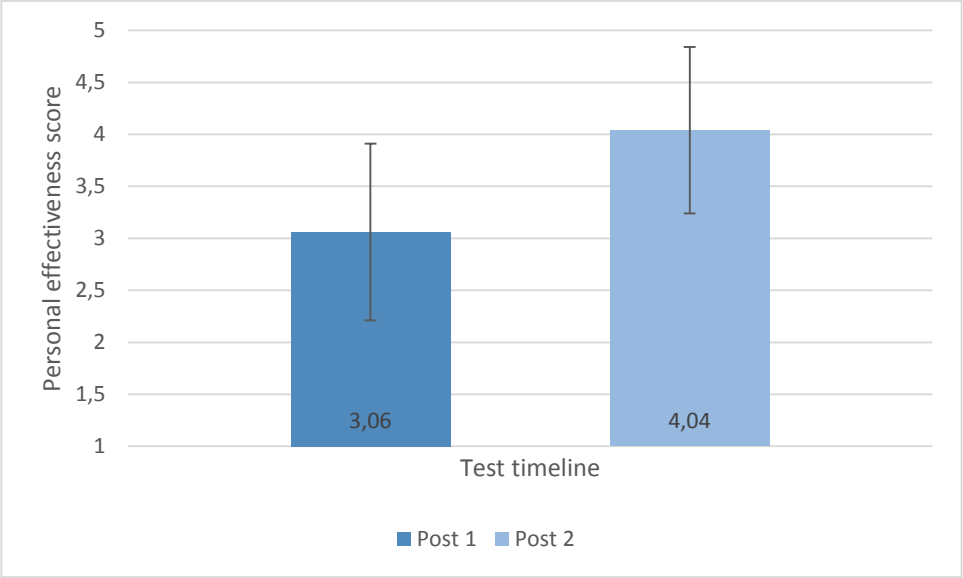

FIGURE 46: PERSONAL EFFECTIVENESS SCORE – DEPARTMENT OF PEDIATRIC PULMONOLOGY

As the figure indicates, there is a positive change in Check-It's influence on the individual healthcare professionals between two and four months of use. This shows that the same holds true as for the perceived effectiveness for the department as a whole as discussed in the previous pages. However, while the change in the departmental effectiveness score was not significant between the two posttest, Check-It's effectiveness score of the individual healthcare professional between the first posttest ($M = 2.92$, $SE = 0.37$) and the second posttest ($M = 4.04$, $SE = 0.33$), $t(5) = -4.54$, $p = 0.006$ is significant. The exact SPSS output can be found in Table 37 in Appendix K.

When taking a closer look to the scores of the separate objectives within this effectiveness score, as shown in Figure 47, it can be seen that this motion of a lower scored first posttest and higher second posttest is the case for every objective.

When comparing the interview results to each other a more comprehensive understanding of the perceived effectiveness can be created. An overview of the expectations and statements about Check-It and the intermediate differences can be found in Table 50 in Appendix L. This table shows that the statements the healthcare professionals make are supporting the numbers discussed in this subsection. Even though the differences are small and the healthcare professionals are not steered in any direction, which can cause them to forget to mention previous mentioned expectations and/or effects, the overall motion seen in the surveys (i.e. it starts with high expectations, the results after two months are not as high, but it improves in four months) also emerges in the interviews. Five statements do not change in frequency between the pretest and posttest, however, ten change for the worse, and only three for the better. This improves substantially when taking a closer look to the differences between the two posttests; three statements do not change in frequency, nine change for the better, and six for the worse. This shows that while the expectations were not completely met in the first posttest, it improved again between the first and the second posttest. In the second posttest the increase of efficiency and decrease of orientation time are even named more often than was expected in the pretest. In addition, working with Check-It is increasingly less difficult when the process does not go according to protocol. In other words, it takes time to get used to the system.

Nevertheless, it should be noted that only absolute numbers are used for these calculations, which means that there is no normalization of the results, of which in the first two tests eight healthcare professionals participated, and the last test only six.

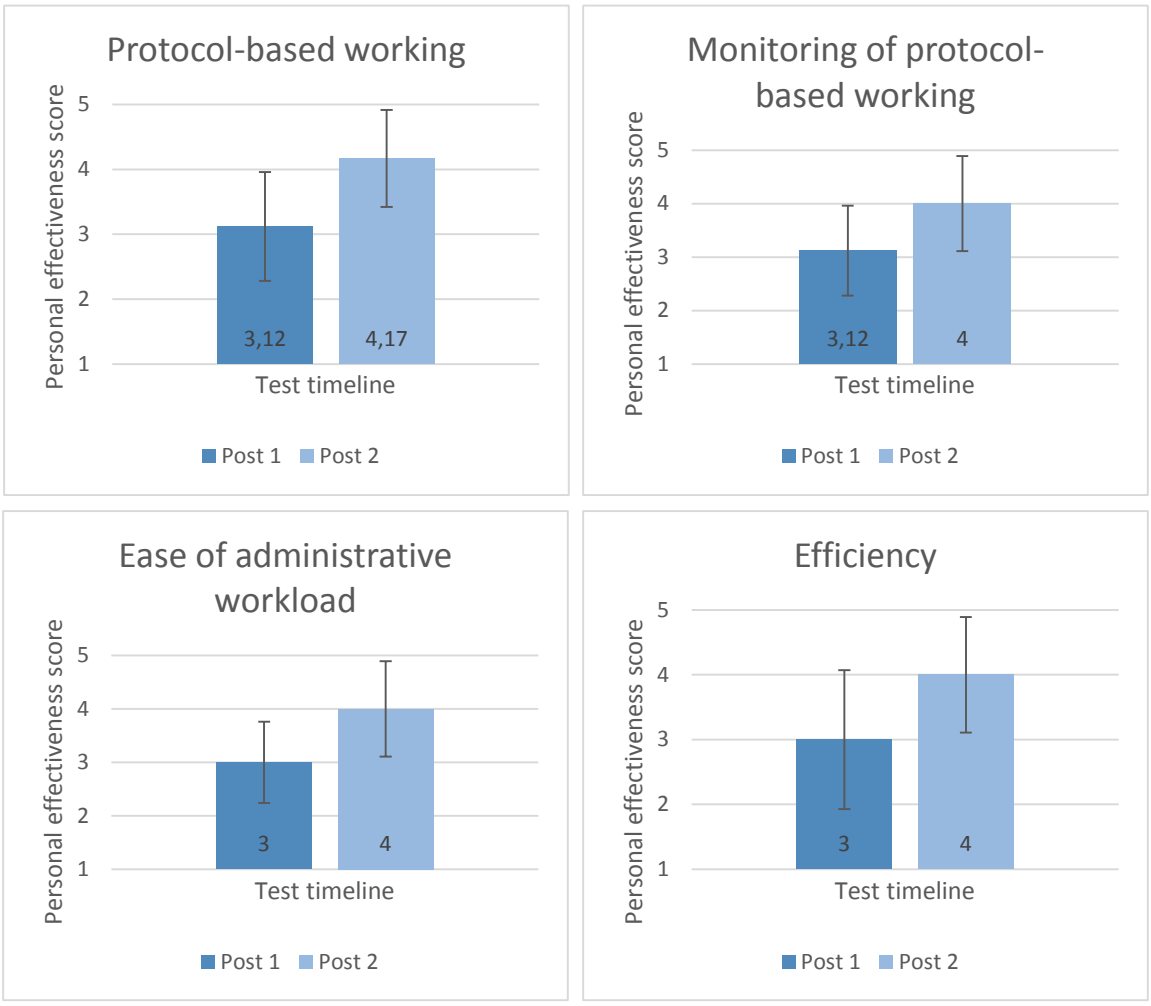

FIGURE 47: PERSONAL GRADE PER OBJECTIVE – DEPARTMENT OF PEDIATRIC PULMONOLOGY

8.6 CONCLUSION FOR PEDIATRIC PULMONOLOGY

To conclude this chapter a merged summarization of the covered results will be given. These results are presented in list-form to keep it organized. The points are all linked together and can't be seen as completely disjoint conclusions.

- The healthcare professionals at the department of pediatric pulmonology have after four months of use, a moderately low experience with Check-It.
- Check-It is perceived effective for the department of pediatric pulmonology as a whole, but even more so for the healthcare professional's personal work environment. This indicates that the healthcare professional think they gain more of the system than their colleagues do.

- Even though Check-It positively influences the effectiveness of the healthcare professionals, this is not the case due to a major reduction of consultation preparation time.
- The effectiveness expectations were high before the healthcare professionals started using the system. After two months of use, the real effectiveness score were significantly lower. However, these numbers improved after four months of use.
- The previous point indicates that the high learning curve some healthcare professionals initially expected, indeed has an influence on how effective the users think the system is.
- The overall department grades first dropped after two months, in order to rise over its initial level after four months. This increase in satisfaction with the four objectives can probably be attributed to Check-It. However, external influences also played a role.
- Except for the Perceived Ease of Use, all TAM construct score higher after four months of use, than after two months or before the healthcare professionals started using Check-It. This indicates that the healthcare professionals accept Check-It more as time continues.
- Beforehand Check-It is expected to increase protocol-based working the most, something which is indeed relatively often mentioned in the two posttests.
- The healthcare professionals initially thought that monitoring themselves with Check-It would be easier than monitoring others, something that seemed to be true after two months of use. However, after four months of use the healthcare professionals were so familiar with the system that they perceive them as just as easy.
- In order to create a higher perceived effectiveness and acceptance of the system, the DIT should align and incorporate Check-It with other programs in use at the UMCU.
- Changing the transition phase in the department would probably not change the outcomes of the results.

9. CASE STUDY RESULTS: VASCULAR SURGERY

9.1 INTRODUCTION

The department of vascular surgery uses a clinical pathway for patients with an abdominal aortic aneurysm. An abdominal aortic aneurysm is an enlarged area in the lower part of the aorta, which can cause the aorta to rupture, resulting in a life-threatening bleeding (MedlinePlus, 2013). Depending on the size and rate the abdominal aortic aneurysm is growing, treatment varies from careful monitoring to (ultimately) emergency surgery. This monitoring process with its accompanied tests and checks is defined in a clinical pathway. The clinical pathway was paper-based until the department started using Check-It.

The department of vascular surgery started piloting Check-It in the third week of March 2015. Before this time the pre-test was conducted. At the two month mark (i.e. the third week of May) and the four month mark (i.e. the third week of September) the two pretests were conducted. A total of eleven healthcare professionals started using Check-It, ten of whom participated in this study. This results in a participation rate of 90.9%. The only secretary who did not participate worked for two weeks at the department of vascular surgery before the pretest started. For this, she did not had the time and know-how to adequately fill out the survey or answer the interview questions. The division of the healthcare professionals who did participate per function can be seen in Figure 48. The first number in each wedge shows the absolute number of participants in that function, the second number shows the percentage of that function when comparting it to all functions in the department. For the outpatient clinical all secretaries had to get certified to become medical assistants. For the inpatient clinical however, the secretaries did not have to retrain. Since Check-It is focused on the outpatient clinic, more medical assistants than secretaries work with the system. As can be seen in the figure, just like the department of pediatric pulmonology no nurses and paramedics work with Check-It in this department.

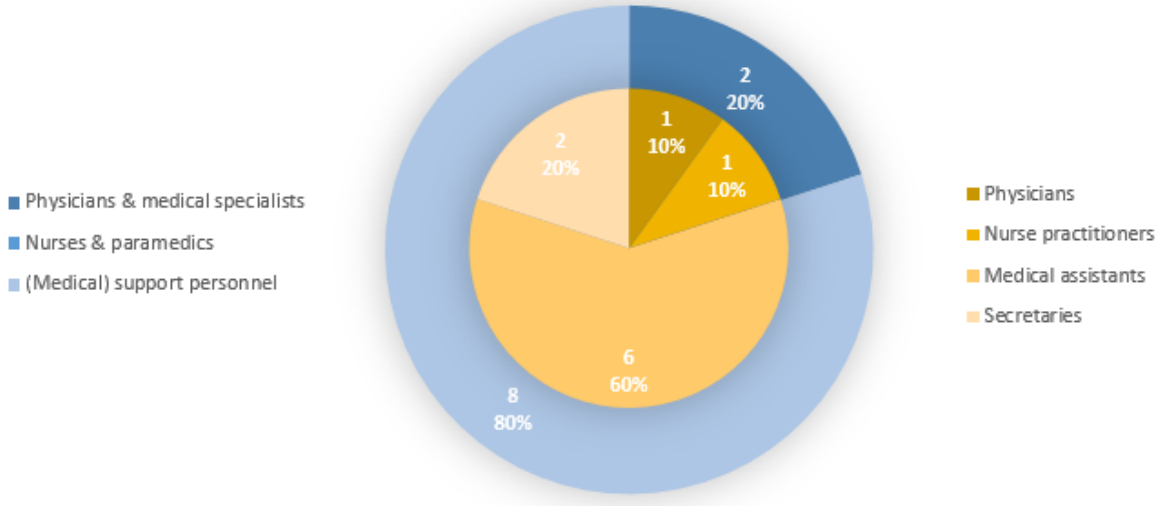

FIGURE 48: PARTICIPANT'S FUNCTIONS AT VASCULAR SURGERY

The department of vascular surgery is one of the two department which underwent a pretest as well as two posttests about Check-It. These test will be discussed respectively.

9.2 PRETEST

Surveys

In the survey all ten participants are asked to rate the current situation in their department on a ten-point scale as regard to the different objectives of Check-It.

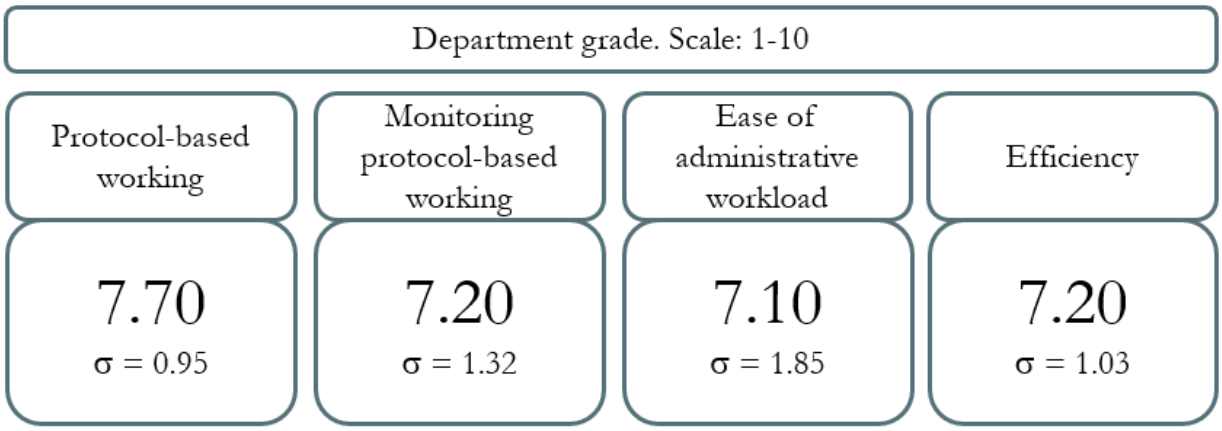

FIGURE 49: MEAN OBJECTIVE GRADES PRETEST - DEPARTMENT OF VASCULAR SURGERY (N=10)

Figure 49 show that the healthcare professionals at the department of vascular surgery who are going to work with Check-It are generally speaking quite positive about the four different objectives in their department. This indicates that the need for a clinical pathway management software program is not particularly big for vascular surgery. A seven is generally seen as above average. However, since none of the objectives scores an eight or higher, which indicate 'good' to 'outstanding', there is some room for improvement. The healthcare professionals at the departments are also asked to score this room for improvement on a five-point Likert scale, by indicating whether they think Check-It will improve the objectives. Even though the participants at vascular surgery score themselves above average on all elements, they are also of opinion that Check-It has the potential to improve the department (when working with patients in the Uveitis clinical pathway) on these points even more. The scores of this expectation can be seen in Figure 50.

As the figure shows, the healthcare professionals see potential in Check-It. Even tough Efficiency is expected to improve just a little (3 = neutral), while the Monitoring of protocol-based working is expected to profit the most of Check-It. This is even though the participants indicate that they already sometimes tell colleagues ($\mu = 4.00$, $\sigma = 1.16$), or are told themselves that they do no work according to protocol ($\mu = 3.40$, $\sigma = 1.26$), which is in accordance to the perceived ease of monitoring others ($\mu = 3.50$, $\sigma = 1.08$), and themselves ($\mu = 4.00$, $\sigma = 0.47$). Another striking point is that the participants expect that the efficiency will be improved only slightly due to Check-It, even though they score themselves just above neutral ($\mu = 3.2$, $\sigma = 1.03$), which would indicate that there

is relatively much room for improvement. In addition, while Check-It is expected to bring some change to the ease of administrative workload, this is not considered very difficult without Check-It ($\mu = 3.70$, $\sigma = 0.82$).

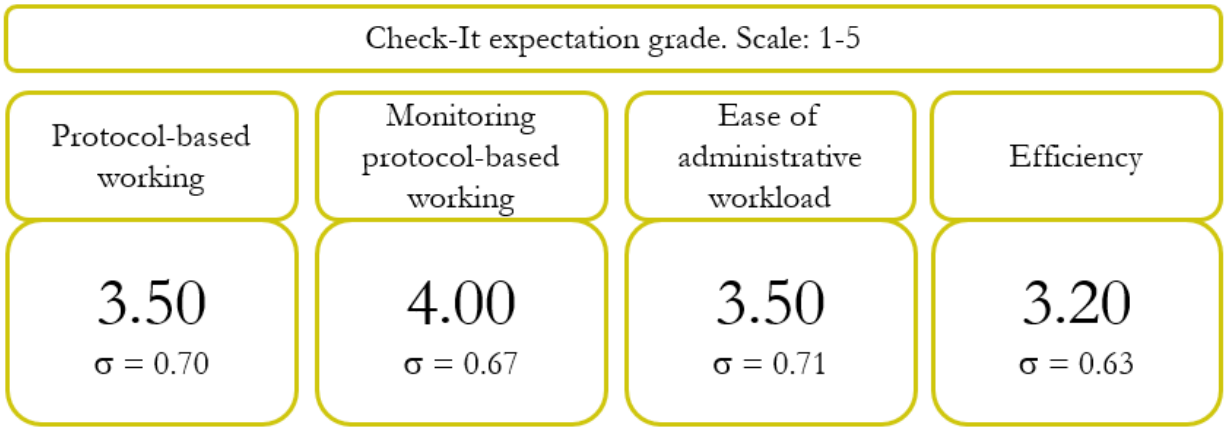

FIGURE 50: MEAN CHECK-IT EXPECTATION GRADE PRETEST - DEPARTMENT OF VASCULAR SURGERY (N=10)

Summarizing the results of this part of the surveys, it can be stated that the participants score the department well above average in their work with protocols, indicate that on individual basis they work very well with these protocols, and are convinced of their importance. According to them Check-It can improve this protocol-based working some more. In addition, the participants score the department a little above average on Monitoring protocol-based working, they foresee that Check-It can improve this considerably, even though it is perceived as relatively easy without using Check-It. Furthermore, the participants think the ease of administrative workload can be improved by Check-It, and score themselves on individual basis currently slightly above average, which is the same score they award the department as a whole. Lastly, the participants score the department a little above average on Efficiency, they think Check-It will bring a very small positive change in this, even though they can improve considerably on individual basis on this point. Thus is can be stated that the participants see that they can improve on efficiency, but are not convinced Check-It is the means to do this.

Beside the objective questions the survey also consists of TAM questions. The result of these questions can be seen in Figure 51. The mean score of the question set is the first bold figure. Below that the standard deviation of the question set is shown. This means that it shows the amount of variation between the questions in the question set, instead of showing how the standard deviation is within a question.

As can be seen in the figure, Perceived Service Availability as well as Behavioral Intention have a standard deviation of 0. This is because the construct is measured by a single question, which means there is no deviation as is the case with constructs measured with multiple questions. Overall the standard deviations of the other TAM question sets are perceived as low, which indicates that the mean set scores represent the means of the individual questions quite well.

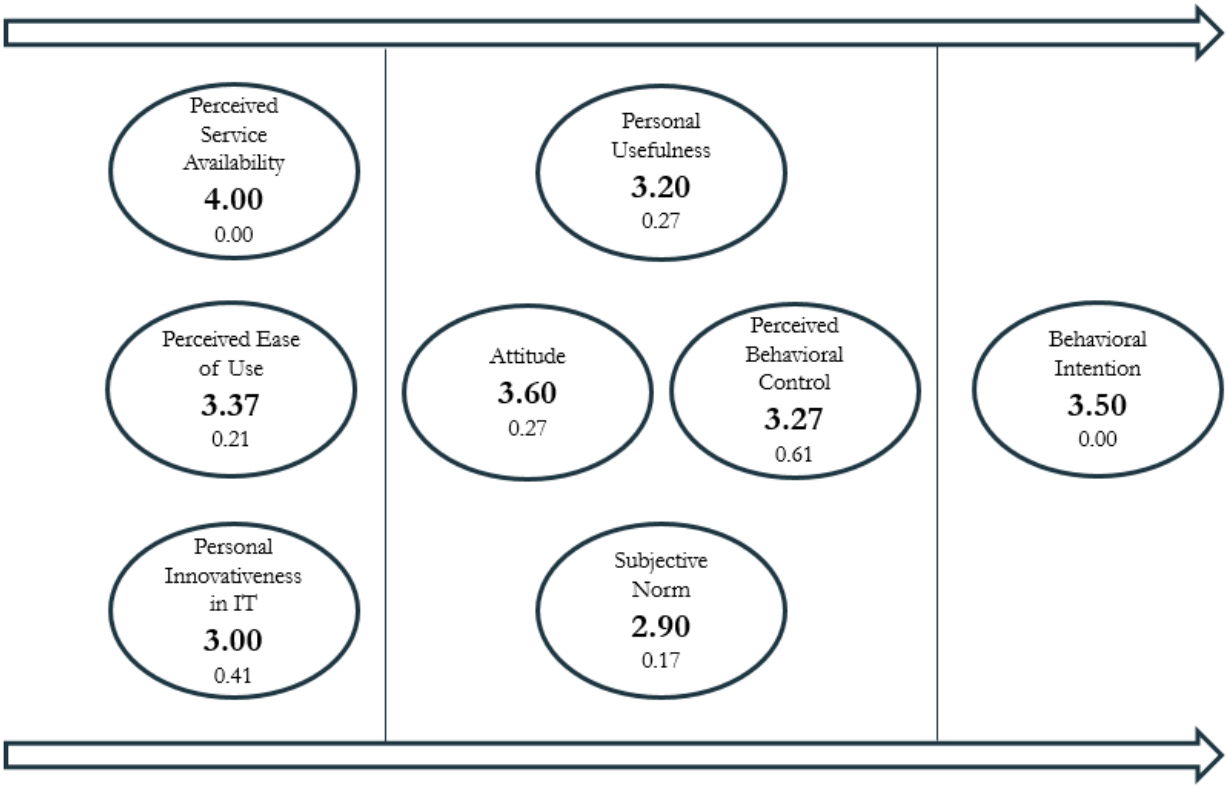

FIGURE 51: MEAN TAM RESULTS PRETEST - DEPARTMENT OF VASCULAR SURGERY (N=10)

Based on the mean scores of the TAM sets, it can be stated that generally speaking the healthcare professionals at vascular surgery have reacted positive on the TAM statements. This improves the chances for Check-It to be accepted on the work floor. Even though the healthcare professionals have a neutral Personal Innovativeness in IT and have scored slightly negative on Subjective norm. This score for Subjective norm is negative since the participants are not told by people who are important to them ($\mu = 2.80$, $\sigma = 1.14$), or people who influence them ($\mu = 2.80$, $\sigma = 1.03$) that they should use Check-It. However, people whose opinion they value ($\mu = 3.10$, $\sigma = 0.99$) did tell them that they should use Check-It.

Interviews

The stated results of the survey are supported by the statements the healthcare professionals made in the interviews. In these interviews each participant is asked whether they had any positive or negative expectations concerning Check-It. The results can be seen in Table 18.

TABLE 18: INTERVIEW RESULTS CHECK-IT EFFECTS PRETEST – DEPARTMENT OF VASCULAR SURGERY

Number of mentions	Positive/ negative?	Expectation
6/10	+	Improved protocol-based working
4/10	+	Improved efficiency
4/10	-	Declined efficiency
3/10	+	Improved effectiveness
2/10	-	Unclear when not according to protocol
1/10	+	Ease of administrative load
1/10	-	More administrative load
1/10	+	Improved patient care
1/10	+	Better comparison between patients

As can be seen the improvement of protocol-based working is named the most. Especially the word 'uniformity' is used in this context. A striking point is that just as many healthcare professionals named an improved efficiency as a declined efficiency. This improved efficiency is expected among others due to the fact that Check-It already pre-fills the lab orders, which saves healthcare professionals time. The declined efficiency is named by four persons of the medical support personnel group, who foresee that Check-It will only costs time. One of them stated:

> ***"I fear that we are going to check, because we need to check, not because we need it"*** (Medical) support personnel

This corresponds with the statement of another person in the medical support personnel group, who is of opinion that the effectiveness of her work declined, due to the need to administrate more. Something which is opposed by one of the persons in the physicians & medical specialist group. He thinks Check-It will make the administrative load easier for him and improve patient care due to the standardization. In addition, two of the healthcare professionals in the medical support group think it will be difficult to deal with people who can't follow protocol, for example when a person can't come back in three months, but only in four. According to one of them, this could possibly lead to less efficiency in their work. Lacking in the responses of the healthcare professionals at vascular surgery is the monitoring of protocol-based working, even though they indicate in the survey that that is the point where Check-It will support the most.

Beside these positive and negative statements, there was something else that stood out. Three (out of eight) of the healthcare professionals in the medical support personnel group indicated that they see more benefits for the physician and medical specialist than for their own daily activities. This can indicate that they see the need for this system, even though they think they will not be the beneficiaries, or that they only going to work with it since they are obliged to do so.

9.3 POSTTEST 1

Two months after the going live date, the department of vascular surgery does not work with Check-It. For this the surveys are omitted, since they would measure the exact same as the pretest. Unstructured interviews with all involved healthcare professionals are held in order to deduce why the department has not worked with Check-It.

One of the participants in the '(medical) support personnel' group stated that it took a while for all involved healthcare professionals to get on the same page. This was because the two healthcare professionals in the 'physician and medical specialists' group has decided to work with the system, without involving the healthcare professionals in the '(medical) support personnel' group in this decision. Without seeing it clearly in the results of the pretest, looking back at least three of the '(medical) support personnel' employees felt a little hesitant to use the system, this is also illustrated with the next quote.

> ***"If I'm honest, I think there was too much pressure on us. It was something the physician clearly wanted, but we have to deal with. However, that's part of the job, so it's ok I guess"***
>
> (Medical) support personnel

The support of all healthcare professionals involved is one of the most named critical success factors for implementing (digital) clinical pathways, as stated in Section 5.4.3. It is also critical to meet multiple agenda's: at organizational level, at team level, as well as at personal level. At the start of the Check-It project this is not complied with.

Next to not being on the same page, several healthcare professionals indicated that the transition phase was a little chaotic, something which is also marked to have an influence on Check-It not being used. Especially since the system wasn't used directly after this the training and other instruction material the healthcare professionals received, the knowledge how to use the system was sunk by the time they wanted to use Check-It. This is illustrated with the following quote, which is an answer to the question 'How come you don't work with Check-It just yet?'.

> ***"Because I do not know how it works anymore. It's still a little too complex for me"***
>
> Physicians and medical specialists

In addition to these two factors, there is a last factor which has an influence on Check-It not being used. The employees in the '(medical) support personnel' group were responsible for converting the files of the current patients to Check-It, in order for them to become 'Check-It patients'. This process is thought to take up too much time for them to combine with their normal job responsibilities. Again, a known critical success factor is that the project has to meet multiple agenda's, something which is not complied with.

A week before this first posttest is conducted the healthcare professionals of both groups had a meeting, in which they decided only to use Check-It for new appointments, which would ease the

workload for the healthcare professionals in the '(medical) support personnel' group. Because of this decision the involved employees are optimistic about the use of the system in the future, as is illustrated in the following quote.

> ***"Yes, we will surely use it in the future, now we really know what to do"***
> (Medical) support personnel

9.4 POSTTEST 2

Four months after the going live date, the department of vascular surgery does not work with Check-It, even though clear arrangements were made two months prior. Also for this posttest the surveys are omitted, since they would measure the exact same as the pretest. Unstructured interviews with the involved healthcare professionals are held in order to deduce why the department has not worked with Check-It.

As one of the participants in the '(medical) support personnel' group indicated:

> ***"It seemed to go well for a while, but in reality nothing is done with it"***
> (Medical) support personnel

As arranged two months prior, only for new appointments Check-It would be used. This comes down to two types of appointments:

1. New patients. New patients have to be seen by the physician, an operation follows, and six weeks after operation there is an appointment at the outpatient clinic to check-up. At the first appointment the physician should initiate Check-It, in order to make the patient a 'Check-It patient' and, for all other healthcare professionals and appointments to follow, to work with the system.
2. Follow-up patients. Every year a patient has to come back for a check-up. Since the healthcare professionals agreed not to change existing appointments, when the physician or nurse practitioner sees a patients, they should initiate Check-It for the appointment a year later.

Check-It is initiated by the nurse practitioner for some of the follow-up patients. Since the next appointment is over a year later, nobody works with Check-It for these patients until then.

In addition to these follow-up patients, there are also new patients. Several healthcare professional indicate that there were almost no (i.e. five to ten) new patient between the first and second posttest. They do not know why there is a sudden stagnation in patients with abdominal aortic aneurysm in their hospital. The new patients who did seek treatment at the UMCU, are not marked as 'Check-It patients' by the physician, who has the responsibility to initiate this. In the interview he is asked why he did not manage to initiate Check-It. First of all, as the next quote illustrates, Check-It was still not clear to him.

> ***"Maybe it sounds strange, but I'm still not sure which steps I have to take to initiate Check-It for a patient"***
>
> Physicians and medical specialists

As also stated in the results of the first posttest, the employees of the department of vascular surgery have a very busy schedule. For this, the physician found it hard to seek time to ask for help with the system. Especially when he tried to use Check-It during the consultation time (as Check-It is intended), he couldn't let the patients wait too long. Eventually this lack of time has proven to be one of the main contributors for him not to completely understand the system and thus not using it. This is also illustrated in the following quote.

> ***"Check-It is designed to relieve some of the time pressure, but it is exactly this time pressure that is the reason Check-It is not used!"***
>
> Physicians and medical specialists

In addition to not completely understanding Check-It, the physician also did not feel the need to use the system. This is in contradiction with two critical success factors described in Section 5.4.3, which state that leaders should express a strong believe in the value of the clinical pathway (management software) and by having no strong guiding coalition to fall back on, which could help him see the need of a CPM system. This lack of understanding the necessary of Check-It is shown in the next quote.

> ***"Check-It shows the steps to be performed in an appointment, but I know them by heart already, so I think I don't miss the checklist"***
>
> Physicians and medical specialists

Even though Check-It is not used after four months, some of the healthcare professionals are still optimistic. A meeting is scheduled with several physicians at the department of vascular surgery in order to see if they can start to work with the system together in the future.

9.5 CONCLUSION FOR VASCULAR SURGERY

To conclude this chapter a merged summarization of the covered results will be given. These results are presented in list-form to keep it organized. The points are all linked together and can't be seen as completely disjoint conclusions.

- No conclusion can be drawn about the perceived effectiveness of Check-It for the department of vascular surgery since no system use is realized.
- The participant score the department above average on all objectives before they start using Check-It, which indicates that there is no urgent need to change.

- Even though the department scores above average on all objectives, the participant do think Check-It can bring a positive change and are willing to accept the system.
- Several factors have an influence on Check-It not being used after two and four months:
    - The healthcare professionals are not on the same page at the start of the project.
    - The system is not used directly after training, which causes the know-how about the system to sink.
    - It is chosen to only use Check-It for new appointments, which are either over a year or have to be initiated by a single person. This person has a busy schedule, does not completely understand the system, and the need to use it.
- In order for the system to be effective, the department should have the support of all involved healthcare professionals, and thus meet all agenda's, have leaders express a strong believe in the value of Check-It, and have a strong guiding coalition to fall back on.
- Changing the transition phase itself would probably not change the outcomes of the results. Changing the timing of the transition phase to a less busy month after which the healthcare professional can directly start using it, would probably have resulted in more know-how about the use of the system and thus actual use.

10. Case study results: Dermatology and allergology

10.1 Introduction

For the outpatient clinical of dermatology and allergology a clinical pathway is in use for patients with atopic dermatitis, which is also known as atopic eczema. Atopic dermatitis is a common, often long-lasting skin disease, which results an itchy, red, swollen, and cracked skin (WebMD, 2014a). There is no known cure for AD, although treatments may reduce the severity and frequency of it (Berke, Singh, & Guralnick, 2012). These treatments are adjusted based on the severity of a patient's atopic dermatitis. It is of importance to check-up with the patients on a regular basis in order to see whether treatment should be adjusted. A paper-based clinical pathway was in use before the department started using Check-It. The clinical pathway itself is not as ridged as the clinical pathways of the other departments which participated in the case study. The clinical pathway starts the same for every patient, however after that it depends on the course of the decease and the patient his own preferences how many times he comes back.

The department of dermatology and allergology started using Check-It in the second week of November 2014. At the moment this study is conducted they worked for nine months with the system. In total nine healthcare professionals work with the system, whom all participated in this research. The division of those participants per function can be seen in Figure 52. The first number in the wedges show the absolute number of participants with that particular function, and the second what the percentage of the total amount of participants in the department is.

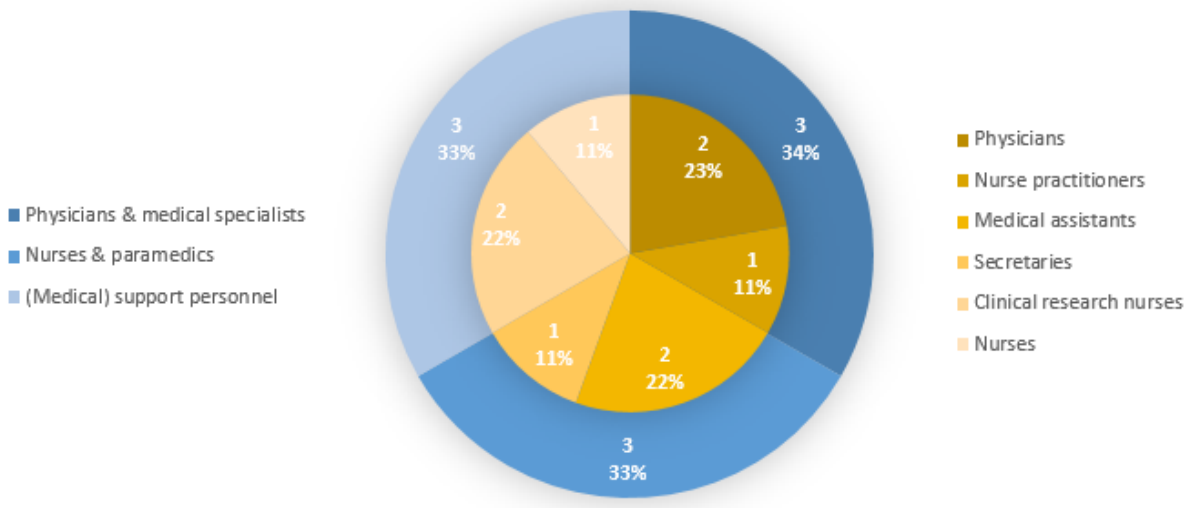

Figure 52: Participant's functions at dermatology and allergology

Currently the department uses one of the more basic versions of Check-It, since they are one of the first department that started used it. This means that all basic functionalities like showing what should be done by whom, and prefilled lab forms are there. However, something which is not

realized in the in-use version of Check-It is automatic linking options. This means that the healthcare professionals can only register in Check-It if something is completed or not, but for the actual task they have to work from EZIS. For example conducting a questionnaire, this questionnaire has to be opened and filled-out via EZIS after which the healthcare professionals has to go to the Check-It tab in order to register that the activity is completed. The new version of Check-It, including this functionality is planned to go live in the department a couple of weeks after the conduction of this study. This fact is likely to affect the perceived effectiveness results elaborated on in the next subsection.

The department of dermatology and allergology is one of the two department which only underwent a posttests about Check-It. The results of this posttest are discussed next.

10.2 POSTTEST

Surveys

In the nine months the healthcare professionals of dermatology and allergology who work with Check-It, they have worked on average with 30-40 Check-It patients (σ= 1.87). Something that stands out is that this mean varies considerably between the three healthcare professional groups. While the 'physicians and medical specialists' worked on average with (rounded to) 20-30 patients (μ= 2.67, σ = 2.08), 'nurses and paramedics' worked with (rounded to) 40-50 patients (μ= 3.67, σ = 1.53), and '(medical) support personnel' with (rounded to) >50 patients (μ = 5.67, σ = 0.58).

Just as with the two other departments, in the survey all nine participants are asked to rate the current situation in their department on a ten-point scale as regard to the different objectives of Check-It. The result of this can be seen in Figure 53.

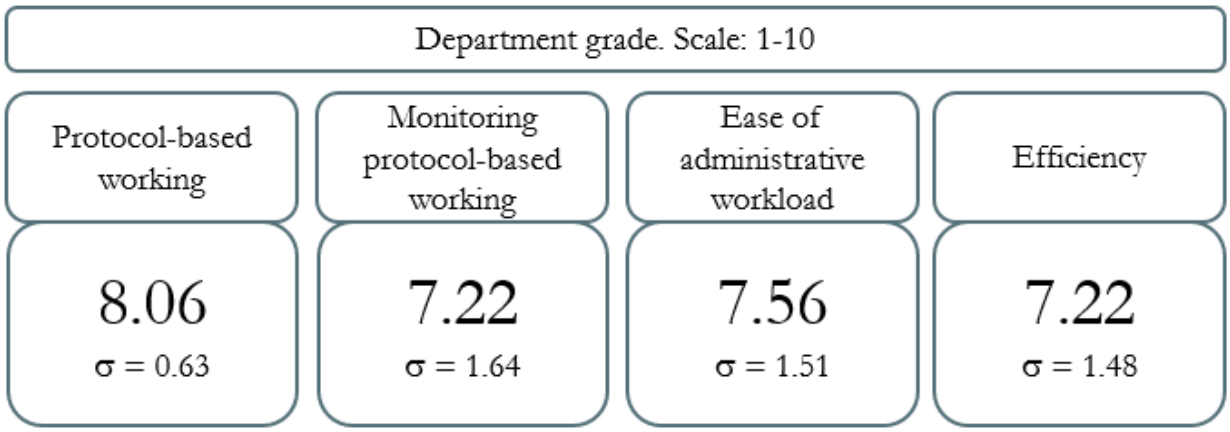

FIGURE 53: MEAN OBJECTIVE GRADES PRETEST - DEPARTMENT OF DERMATOLOGY AND ALLERGOLOGY (N=9)

As can be seen in the figure above, the healthcare professionals of the department of dermatology and allergology who work with Check-It rate their department well above average on the four objectives of Check-It. They are especially satisfied with the protocol-based working in their department. The low standard deviation of that score indicates that the healthcare professionals all

scored the department close to this mean, so they are in accordance to each other. The healthcare professionals are also asked to indicate to which extent Check-It contributed to these objectives in their department. The answers options for this question are based on a five-point Likert scale, where 1 means 'Check-It had no influence on this objective' and 5 means 'Check-It had a lot of influence on this objective'. The results can be seen in Figure 54. Even though the healthcare professionals score themselves at least above average on all objectives, this score is according to them just moderately this high due to Check-It. Some change is strictly speaking enough to talk about effectiveness, however, this effectiveness is relatively meagre. If we assume the threshold of three on a scale of one to five, everything below the mean in regard to the complete scale is considered not effective (enough).

Something that is noteworthy is that the mean scores for the Check-It department contribution grade are close to each other for the 'physicians and medical specialists' and 'nurses and paramedics' groups. The '(medical) support personnel' group however, score these objective considerably lower (ranked by the order in the figure: $\mu = 1.00$, $\mu = 1.00$, $\mu = 1.67$, $\mu = 2.33$). Again, the healthcare are not only asked to rate the influence of Check-It on the efficiency, but also on the consultation preparation time. Something which is believed to increase this effectivity for the healthcare professionals. On average the healthcare professionals score this with a mean of 1.44 ($\sigma = 0.73$). This implies that even though the efficiency is not seen to improve very much due to Check-It, the consultation preparation time has been influenced less.

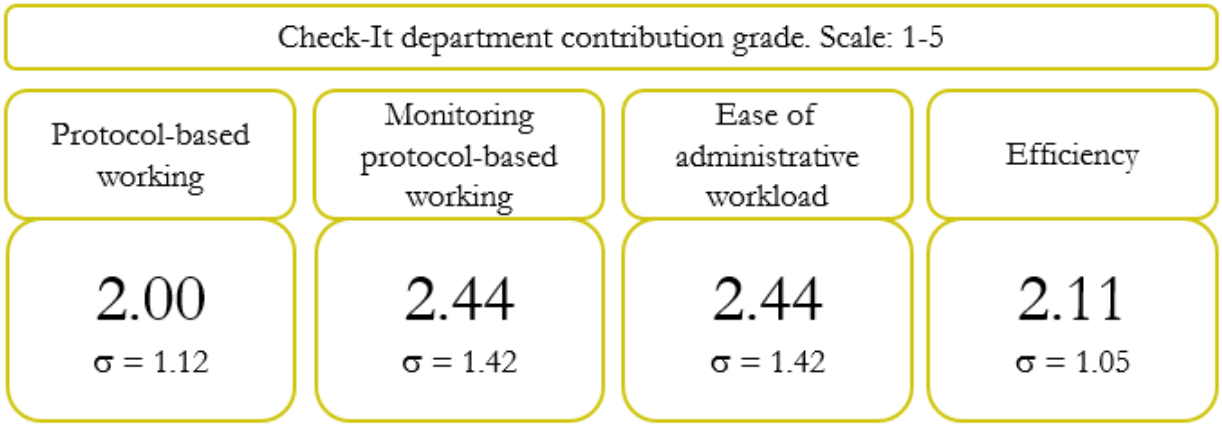

FIGURE 54: MEAN CHECK-IT DEPARTMENT CONTRIBUTION GRADE - DEPARTMENT OF DERMATOLOGY AND ALLERGOLOGY (N=9)

Next to Check-It's influence on the department, the healthcare professionals are also asked to rate the influence of Check-It on their own work. The results of this question can be found in Figure 55. Interesting to see is that protocol-based working and monitoring of this protocol-based working is deemed to have a larger influence on the personal work environment, than on the department as a whole. This means that healthcare professionals think they have gained more from it themselves than their colleagues (i.e. the rest of the department healthcare professionals who work with Check-It) do. A side note has to be made to the score of monitoring of protocol-based working. Based on the additional questions it has become clear that healthcare professionals think it is easier to monitor themselves with Check-It ($\mu = 3.22$, $\sigma = 1.56$), than others ($\mu = 2.67$, $\sigma = 1.73$). Opposite from the

scores for protocol-based working, and the monitoring of protocol-based working, are the score for the ease of administrative workload and efficiency. While the healthcare professionals think they have gained less from the use of Check-It themselves, their colleagues have gained more from it on these points. Nevertheless all scores stay below average (i.e. a score of 3), which indicates that Check-It is perceived to have a at best a moderate influence on the personal work environment. This is in accordance with the moderate influence Check-It is perceived to have on the department as a whole. Just as the grades for Check-It's contribution to the department, there is an outstanding difference between the personal influence grades per healthcare professional group. The '(medical) support personnel' group give the score lowest to all objectives (a $\mu = 1.33$ for all objectives). The 'nurses and paramedics group' score every objective in the middle (ranked by the order in the figure: $\mu = 2.00$, $\mu = 3.33$, $\mu = 2.00$, $\mu = 1.67$) and the 'physicians and medical specialists' give the highest score to all objectives (ranked by the order in the figure: $\mu = 4.00$, $\mu = 3.67$, $\mu = 2.67$, $\mu = 3.00$). These scores indicate that 'physicians and medical specialists' group gains the most from the use of Check-It.

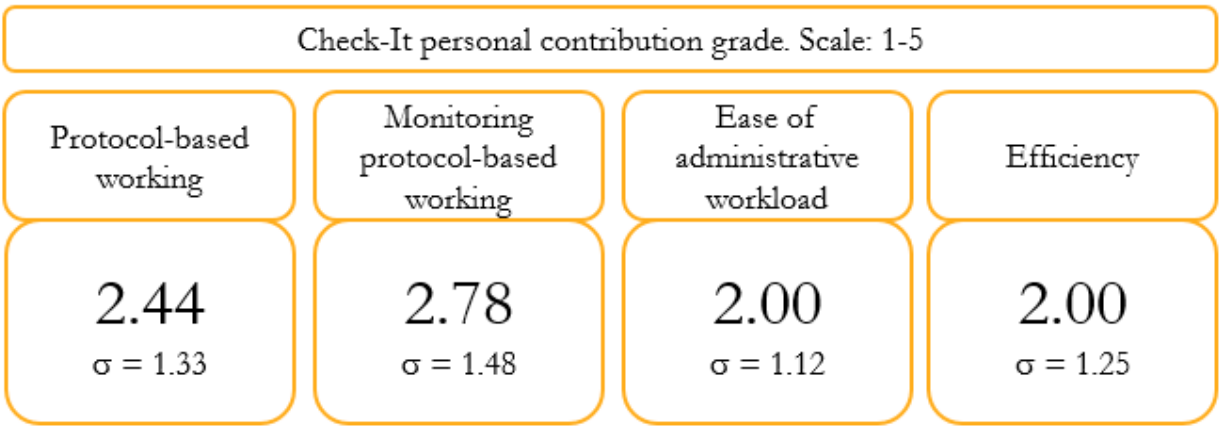

FIGURE 55: MEAN CHECK-IT PERSONAL CONTRIBUTION GRADE - DEPARTMENT OF DERMATOLOGY AND ALLERGOLOGY (N=9)

Next to these effectiveness questions, the healthcare professionals are also asked to fill-out the TAM questions, of which the results can be seen in Figure 56. The mean score of the question set is the first bold figure. Below that the standard deviation of the question set is shown. This means that it shows the amount of variation between the questions in the question set, instead of showing how the standard deviation is within a question.

As can be seen in the figure, Perceived Service Availability as well as Behavioral Intention have a standard deviation of 0. This is because, just like the TAM questions for the departments of vascular surgery and pediatric pulmonology, the construct is measured by a single question, which means there is no deviation as is the case with constructs measured with multiple questions. Overall the standard deviations of the other TAM constructs are perceived as low, which indicates that the mean set scores represent the means of the individual questions quite well.

Based on the mean scores of the TAM constructs, it can be stated that the healthcare professionals at the department of dermatology and allergology have reacted neutral to a little positive on the TAM

statements. This indicates that the healthcare professionals do not actively accept nor reject Check-It. This is also reflected in the final Behavioral Intention score of 3.11. The healthcare professionals are particularly satisfied with the Perceived Service Availability. People around the healthcare professionals do not often not influence them to use the system, which is indicated by the 2.50 score for Subjective Norm. In accordance to the Check-It contribution grades for the department and the healthcare professionals themselves as discussed in the previous pages, the participants disagree that Check-It is useful for them, which is indicated by the score of 2.19 for personal usefulness. A side note has to be made that this construct consists of relatively low scores for the questions about the contribution of Check-It for the work performance ($\mu = 2.00$, $\sigma = 1.00$), work productivity ($\mu = 2.00$, $\sigma = 1.00$), and work effectiveness ($\mu = 2.11$, $\sigma = 1.17$). While the usefulness for the job is scored with a slightly higher grade ($\mu = 2.67$, $\sigma = 1.23$)

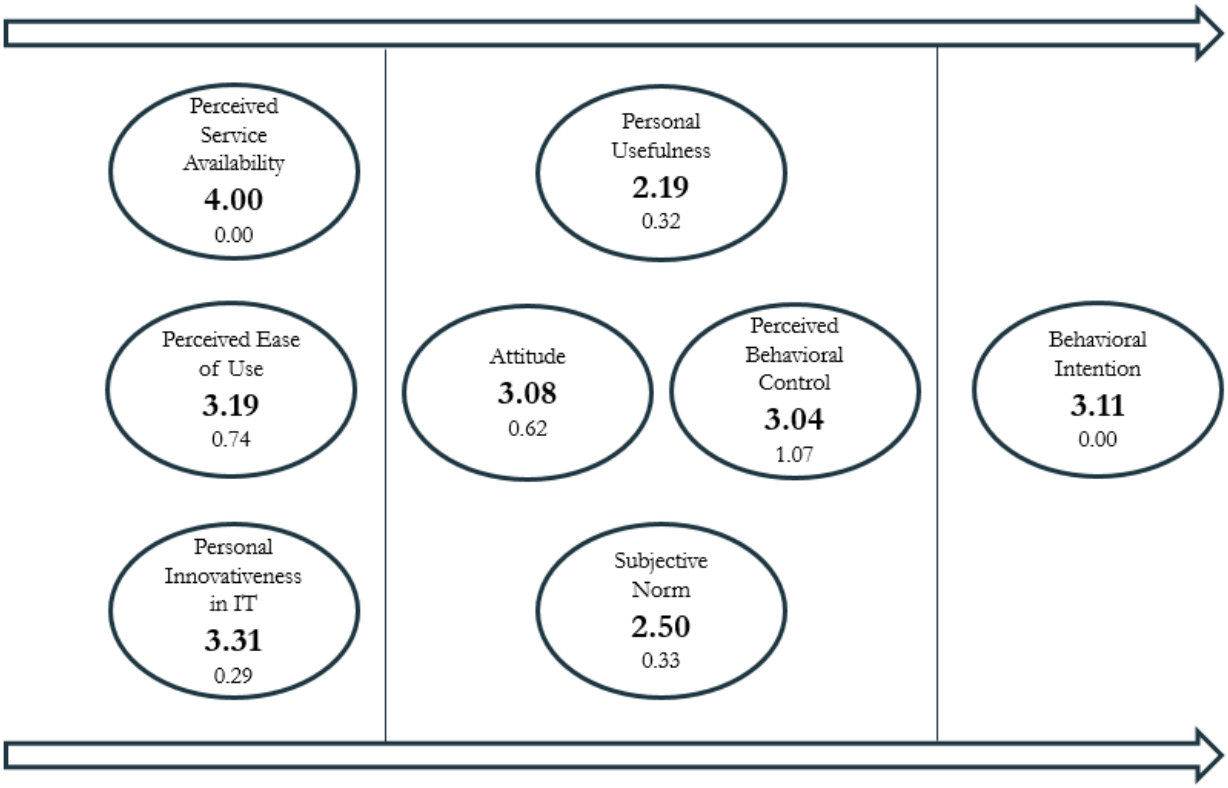

FIGURE 56: MEAN TAM RESULTS PRETEST - DEPARTMENT OF DERMATOLOGY AND ALLERGOLOGY (N=9)

Interviews

The stated results of the survey are supported by the statements the healthcare professionals made in the interviews. Seven out of nine healthcare professionals indicated in the interviews that Check-It did not increased the work effectivity over the last nine months. The remaining two healthcare professionals, who are the only two physicians who participated in this study, indicated that Check-It did increase the effectivity. This indicates that Check-It is perceived as more effective for the healthcare professional group 'physicians and medical specialists', than for the other two healthcare professional groups (i.e. 'nurses and paramedics' and '(medical) support personnel'). Two of the three participants in the 'nurses and paramedics' group however, did indicate that while their own

effectivity did not increase they could see it helped the physicians in their work effectivity. Therefore they did not mind working with the system. Combining this outcome with the low scores for the influence of Check-It on the four different objectives, in can be concluded that Check-It is not effective in this department.

In the interviews each participant is asked whether they experienced any positive or negative effects concerning Check-It. The results are summarized in Table 19.

TABLE 19: INTERVIEW RESULTS CHECK-IT EFFECTS – DEPARTMENT OF DERMATOLOGY AND ALLERGOLOGY

Number of mentions	Positive/ negative?	Statement
6/9	-	Lack of flexibility
4/9	-	Lack of use
3/9	+	Less forgotten tasks
3/9	+	Prefilled orders and letters
1/9	-	Unclear
1/9	-	Declined learning ability
1/9	+	Increased protocol understanding
1/9	+	More accurate administration

As can be seen in this table is the lack of flexibility the most named statement about Check-It in this department. Four participants indicate that this lack of flexibility is because the reality is less rigor than the clinical pathway in use, as is indicated with the quote below this paragraph. This can occur when for example a patient cannot come back after three weeks due to his own schedule, or a consultation day that is already completely booked which causes the patient's appointment to be moved by one or two weeks. Even though the clinical pathway was already in use before the department started using Check-It, this strictness surfaces now because it is much easier to deviate from a paper-based clinical pathway than an electronic one. Two other healthcare professionals, both in the 'nurses and paramedics' group state that this strictness is due to the fact that Check-It does not allow free text for some of the activities in the clinical pathway. They would benefit from this free text, because than they can leave notes for the person who deals with the patient next. The last argument that is named in this lack of flexibility category (but only mentioned once) is due to the fact that after filling in a Check-It activity, these activities cannot be updated or changed anymore.

> ***"The clinical pathway is based on an average patient, only the average patient doesn't exist in our department"***
>
> (Medical) support personnel

The statement that is named the second most is the lack of use of Check-It, since several participants indicate that some of their colleagues sometimes forget to indicate whether they completed an activity or not. This makes working with the system less effective because there is missing

information. The healthcare professionals either remind each other that they should fill it in, or it is filled in for them (after consultation) by on the medical support employees.

Opposite from these two negative statements, the next two most mentioned statements are both positive about Check-It. Three healthcare professionals indicate that Check-It helps them to complete all activities (i.e. forget less). In addition, all healthcare professionals in the 'physicians and medical specialists' indicate that are helped with the prefilled forms and letters.

The remaining statements are all mentioned just once. While the statements that the system is unclear, leads to an increase of protocol understanding, and a more accurate administration are all straightforward and don't need any clarification, the declined learning ability however, does need some additional explanation. As the UMCU is an academic hospital, several healthcare professionals on every medical department are physicians-in-training. By automating part of the process (i.e. prefilled lab requests and letters) the healthcare professional doesn't learn to do it himself, which can be an obstacle when starting a job in another hospital where this part of the process isn't automated. This is also illustrated with the following quote:

> ***"Prefilled forms are great, however you get a little lazy by using those. When I ever leave the UMCU I need to do my best to remember which lab-orders to request and why."***
>
> Physicians and medical specialists

In addition to the questions about the effectiveness and effects of Check-It, the healthcare professionals are also asked what they think of the transition phase and whether they have any recommendations for Check-It. Two healthcare professionals would have liked to have more personal contact in the transition phase with the DIT, however, the rest of the participants stated that they thought it was just right. This indicates that changing the transition phase for this department would probably not affect the understanding of the system and thus the perceived effectiveness of it.

Based on the effects of Check-It discussed in this section, several improvement points are suggested by the healthcare participants. These improvement points are summarized in Table 20. Two of these improvement points are mentioned more than once; in order to overcome the strictness of the system, it should be made easier to plan appointments on different dates, while keeping them matched to the correct Check-It 'moment of contact' (see Section 6.2). In addition, healthcare professionals should be reminded when a patient is a 'Check-It patient', in order to overcome the lack of use of the system.

TABLE 20: INTERVIEW RESULTS IMPROVEMENT POINTS – DEPARTMENT OF DERMATOLOGY AND ALLERGOLOGY

Number of mentions	Improvement
3/9	Make it easier to change appointments
2/9	Show a reminder when a patient has a Check-It file
1/9	Highlight the current tab
1/9	Make it possible to do changes to an activity afterwards
1/9	Make an telephone-consult also an activity
1/9	Add free text to all activities

10.3 CONCLUSION FOR DERMATOLOGY AND ALLERGOLOGY

To conclude this chapter a merged summarization of the covered results will be given. These results are presented in list-form to keep it organized. The points are all linked together and can't be seen as completely disjoint conclusions.

- Check-It is seen to have a relatively meagre influence on the objectives in the department according to the healthcare professionals at the department of dermatology and allergology.
- This influence is too low in order for the healthcare professionals to speak of perceived effectivity.
- The department scores are at least above average on every objective of Check-It. However, this is considered just moderately to be the case due to Check-It. Other influences like intrinsic motivation, strong management, and other systems may play a larger role in these high scores.
- The moderate contribution of Check-It to the department scores is mainly due to the lack of flexibility and lack of use of the system. However, the systems does make sure less tasks are forgotten and that the healthcare professionals can work with prefilled orders and letters.
- The lack of flexibility and lack of use of the system are both partly caused by the flexible nature the clinical pathway in use.
- The '(medical) support personnel' group works the most with Check-It, while seeing the least change due to the system in their own work effectiveness, as well as the department's effectiveness.
- The 'physicians and medical specialists' group works the least with Check-It, while seeing the most positive effects on their own work environment.
- The healthcare professionals from the department of dermatology and allergology do not actively reject or accept Check-It.
- In order to create a higher perceived effectiveness and acceptance of the system, the DIT should at least make it easier to change appointments in Check-It and show reminders when a patient has a Check-It file for this department.
- Changing the transition phase in the department would probably not change the outcomes of the results.

11. Case study results: Ophthalmology

11.1 Introduction

For the outpatient clinic of ophthalmology a clinical pathway is in use for patients with Uveitis. Uveitis is an inflammation of the uveal tract, which lines the inside of the eye behind the cornea (Medical Dictionary, 2015). To treat Uveitis patients have to take immunosuppressive drugs, which inhibit or prevent activity of the immune system. Because of the effects of these drugs, it is important that the patients are checked regularly. All that should be done when a patient comes in with Uveitis is documented in a clinical pathway. This clinical pathway was paper-based until the department started the Check-It pilot.

The department of ophthalmology started piloting Check-It in the second week of October 2014. At the moment this study was conducted they worked for ten months with the system. In total 16 healthcare professionals work with Check-It. Of which 15 participated in this study. This results in a participation rate of 93.75%. The division of those participants per function can be seen in Figure 57. In which the first numbers shows the absolute number of participants with that particular function, and the second one what the percentage of the total amount of participants in the department is.

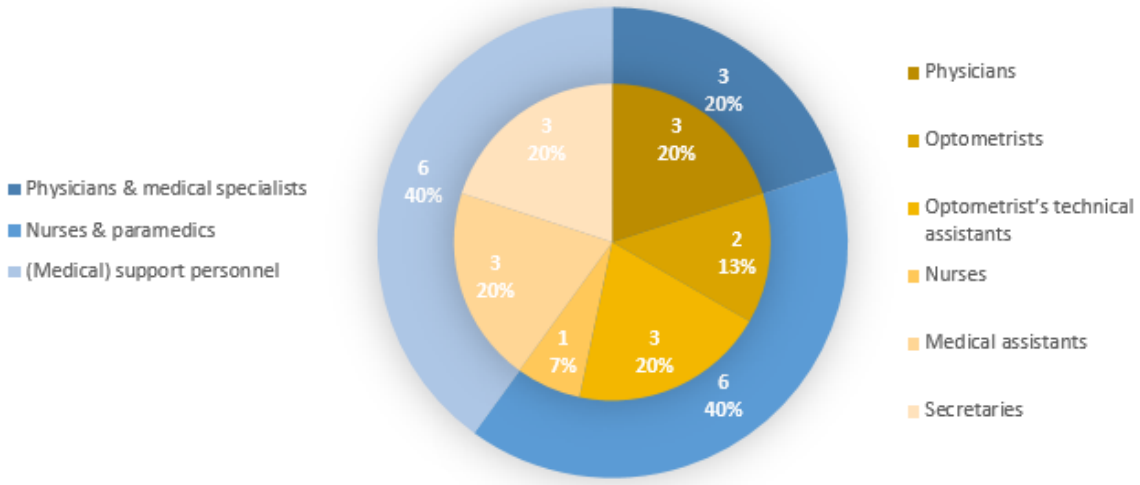

Figure 57: Participant's functions at ophthalmology

The department of ophthalmology is the second department which only underwent a posttests about Check-It. The results of this posttest are discussed next.

11.2 POSTTEST

Surveys

In the ten months the healthcare professionals of ophthalmology who work with Check-It, they have worked on average with more than fifty Check-It patients (μ= 5.64, σ= 0.63), which is the highest value they could indicate in the survey. There is no noteworthy difference in Check-It use between the healthcare professional groups.

Just as with the healthcare professionals of the three other departments, the participants are asked 15 to rate the current situation in their department on ten-point scale as regard to the different objectives of Check-It. The results of this can be seen in Figure 58.

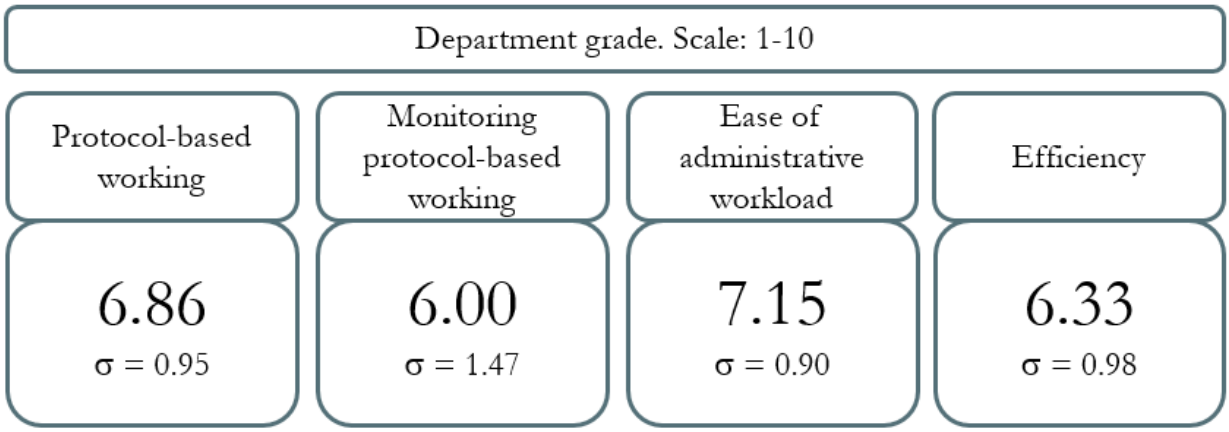

FIGURE 58: MEAN OBJECTIVE GRADES PRETEST - DEPARTMENT OF OPHTHALMOLOGY (N=15)

As can be seen in the figure above, the healthcare professionals of the department of ophthalmology who work with Check-It, rate their department as average to a little above average on the four objectives of Check-It. They are least satisfied with the monitoring of protocol based working, from which the opinions of the participants vary the most, while they are most satisfied with the ease of administrative workload, for which the answers of the healthcare professionals vary the least. A noteworthy difference between the healthcare professional groups can be found in the answers about monitoring of protocol based working. While 'physicians and medical specialists' rate this in their department with a mean of 7.33 (σ= 1.53), the other two groups grade this considerably lower (μ= 5.33, σ= 1.51 and μ= 6.00, σ= 1.00). It should be kept in mind that Check-It is used for a portion of the total amount of patient of this department. Therefore the numbers above cannot directly be linked to Check-It, since it reflects the views of the participant of the department as a whole (i.e. their work with Check-It patients as well as non-Check-It patients). For this the healthcare professionals are also asked to indicate to which extent Check-It contributed to these objectives in their department. The answers options for this question are based on a five-point Likert scale, where 1 means 'Check-It had no influence on this objective' and 5 means 'Check-It had a lot of influence on this objective'. The results can be seen in Figure 59.

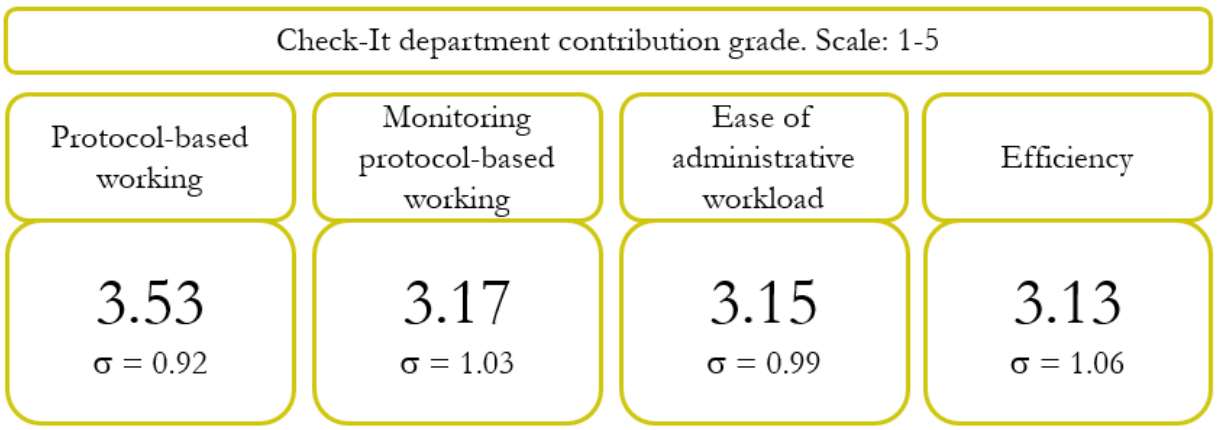

FIGURE 59: MEAN CHECK-IT DEPARTMENT CONTRIBUTION GRADE - DEPARTMENT OF OPHTHALMOLOGY (N=15)

As can be derived from these numbers Check-It has made a difference on all four objectives. Especially the protocol-based working for Check-It patients improved considerable since the use of Check-It. Even though Check-It is seen to have a solid contribution to the monitoring of this protocol-based working, this grade would be higher when only looking at the self-monitoring of healthcare professionals. This self-monitoring is seen as easier due to Check-It (μ= 3.67, σ= 1.18), than monitoring others (μ= 2.80, σ= 1.21). Just as with the department grades, the grade for monitoring of protocol-based working has a noteworthy difference between the healthcare professional groups. Where the 'physicians and medical specialists' grade this with a mean score of 4.00 (σ= 1.53), the two other healthcare professional groups grade this both with a 3.00 (σ= 1.27 and σ= 0.00). This means that the healthcare professionals in the 'physicians and medical specialists' group have a more positive view on monitoring of protocol-based working in the department as a whole, as well as attributing Check-It more to this change. In addition, efficiency is believed to be achieved among others by reducing the consultation preparation time, therefore the healthcare professionals are also asked to indicate the influence of Check-It on this. The healthcare professionals score this influence with a mean of 4.33 (σ= 1.80). This implies that the efficiency is indeed improved by reducing consultation preparation time.

The healthcare professionals are not only asked to rate the influence of Check-It on their department grade, but also the extent of influence from Check-It on their own work. The results of this question can be found in Figure 60. As can be seen, the results of Check-It's influence on the department and the healthcare professionals' own work do no differ much. This indicates that in general the healthcare professionals think Check-It is just as useful for themselves as for the rest of the department. Something that does stand out however, is the difference in mean scores of the healthcare professional groups for protocol-based working as well as work efficiency. 'Physicians and medical specialists' group grade protocol-based working with a mean score of 4.67 (σ= 0.58), while the 'nurses and paramedics' score this on average a 3.17 (σ= 0.75) and '(medical) support personnel' a 3.50 (σ= 0.84). This same order of scores can be seen with the average scores of efficiency. This is graded with a 4.00 (σ= 1.00) by the 'physicians and medical specialists' group,

followed by a 2.67 (σ= 1.03) by the 'nurses and paramedics', and a 3.00 (σ= 0.63) by the '(medical) support personnel'.

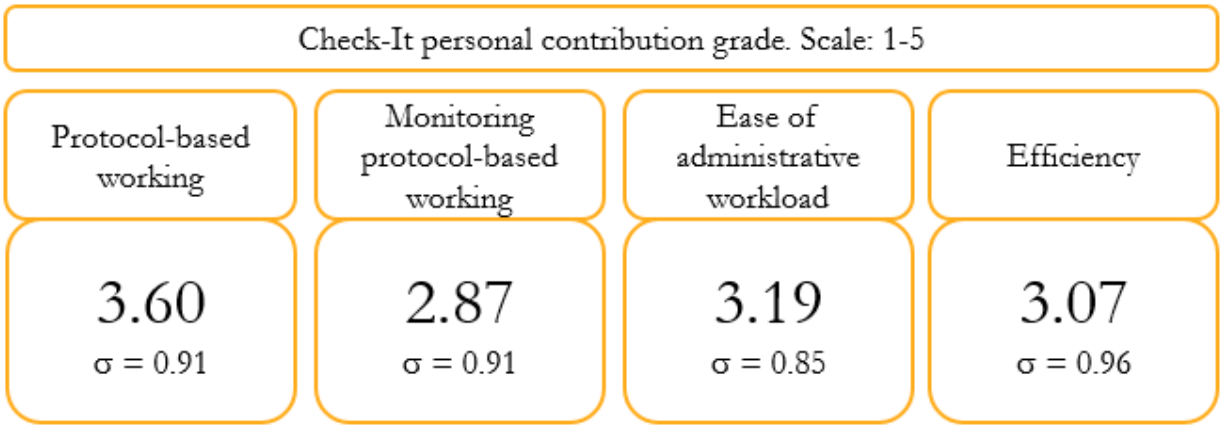

FIGURE 60: MEAN CHECK-IT PERSONAL CONTRIBUTION GRADE - DEPARTMENT OF OPHTHALMOLOGY (N=15)

Next to these effectiveness questions, the healthcare professionals are also asked to fill-out the TAM questions, of which the results can be found in Figure 61. The mean score of the question set is the first bold figure. Below that the standard deviation of the question set is shown. This means that it shows the amount of variation between the questions in the question set, instead of showing how the standard deviation is within a question.

As can be seen in the figure, Perceived Service Availability as well as Behavioral Intention have a standard deviation of 0. This is because, just like the TAM questions for the other departments, the construct is measured by a single question, which means there is no deviation as is the case with constructs measured with multiple questions. Overall the standard deviations of the other TAM constructs are perceived as low, which indicates that the mean set scores represent the means of the individual questions quite well.

Based on the mean scores of the TAM constructs, it can be stated that the healthcare professionals at the department of ophthalmology have reacted slightly positive on the TAM statements. This indicates that the healthcare professionals accept Check-It. This is also reflected in the final Behavioral Intention score of 3.47. In addition, also the Attitude of the healthcare professionals towards Check-It is positive. Just as the other departments the Perceived Service Availability is awarded with the highest score. This means that generally speaking Check-It can be used, when a healthcare professional wants to use it. The lowest TAM score is given to the questions in the Subjective Norm construct. A mean score of 2.76 indicates that people around the healthcare professional do not often not influence them to use the system. In accordance to the Check-It contribution grades for the department and the healthcare professionals themselves as discussed in the previous pages, the participants agree that Check-It is useful for them, which is indicated by the score of 3.27 for personal usefulness. This Personal Usefulness is influenced by the positive scores for Perceived Ease of Use and Personal Innovativeness in IT. Which indicate that the healthcare

professionals think Check-It is fairly easy to use, which can be caused due to their fair computer skills. The last TAM construct to be discussed is Perceived Behavioral Control. This construct with a mean score of 3.47, is the only score in which one of the mean scores of the question differs substantially from the grand mean. While Check-It is seen to be useful for the jobs of the healthcare professionals (μ = 3.73, σ = 0.80), and they have reacted positive about having the resources, knowledge and ability to use Check-It (μ = 3.87, σ = 0.64), they also indicate to be lacking total control of the system (μ = 2.80, σ = 0.94).

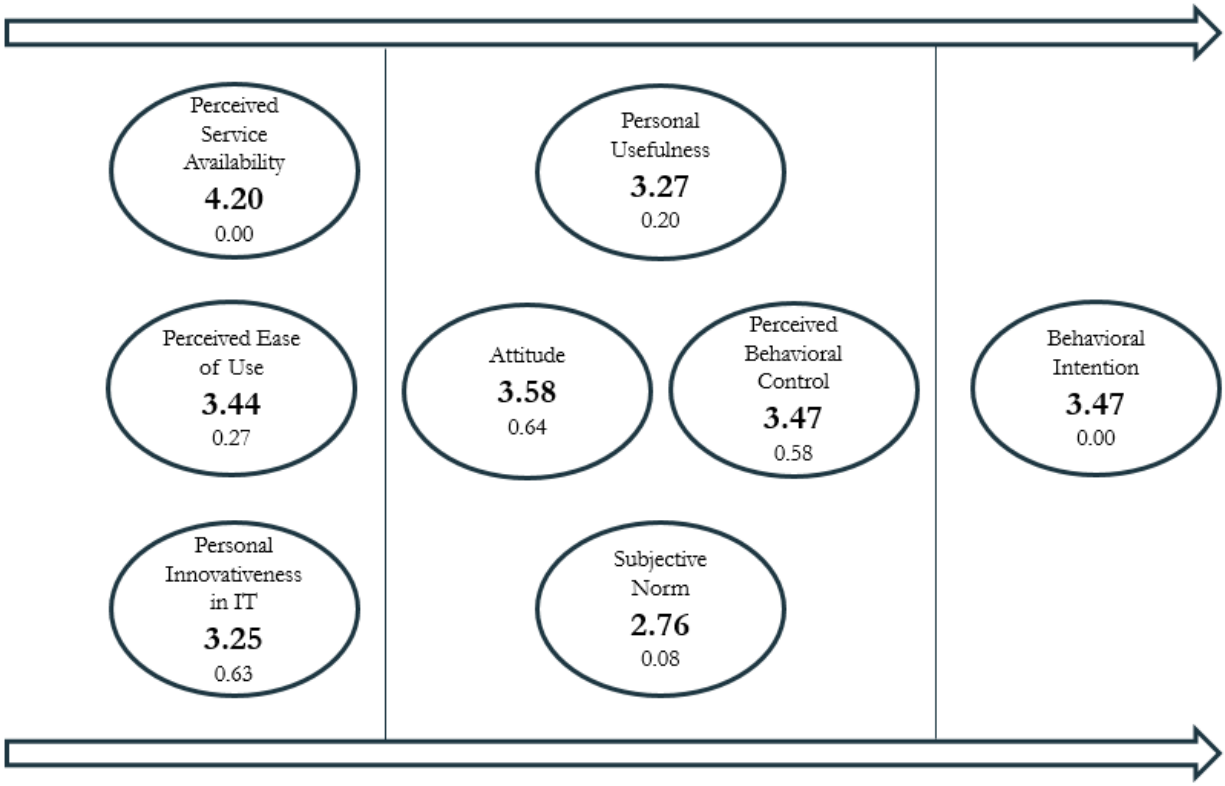

FIGURE 61: MEAN TAM RESULTS PRETEST - DEPARTMENT OF OPHTHALMOLOGY (N=15)

Interviews

The stated results of the survey are supported by the statements the healthcare professionals made in the interviews. 10 out of 15 healthcare professionals indicate that Check-It increased at least part of the work effectivity over the last ten months. Three participants stated that the system did not increased work productivity (even worsened a bit), while two others found the situation too complex to answer. The three healthcare professionals that answered the question with a negative formulated answer are in the 'nurses and paramedics' and '(medical) support personnel' groups.

In these interviews each participant is asked whether they experienced any positive or negative effects concerning Check-It. The results are summarized in Table 21.

TABLE 21: INTERVIEW RESULTS CHECK-IT EFFECTS – DEPARTMENT OF OPHTHALMOLOGY

Number of mentions	Positive/ negative?	Statement
6/15	+	Better overview
5/15	+	Less forgotten tasks
4/15	-	Inadequate clinical pathway
4/15	+	Improved protocol-based working
3/15	+	Increased protocol insight
3/15	-	More work
3/15	-	Difficult when not according to protocol
2/15	+	Prefilled orders and letters
2/15	-	Lots of clicks
1/15	-	Lack of flexibility

As can be seen in this table is Check-It's ability to create a better overview of completed tasks, task to be done, and the clinical pathway as a whole, is the most named statement in this department. This statement can be linked directly to the three separate mentions (of which two come from the (medical) support personnel group) of an increased protocol insight, which is illustrated in the following quote.

> ***"Now I do not only know which steps to take in the care process, I also know how they cohere with the steps of my collogues and why we do it"***
>
> (Medical) support personnel

The second most named statement is that Check-It ensures less tasks are forgotten. A noteworthy remark comes from one of the healthcare professionals in the 'physicians and medical specialists' group, who mentioned that upon initiating Check-It, it became clear that for one patient a particular test was never conducted. Therefore the test was carried out in retrospect. Based on the outcomes of that test, the patient was diagnosis differently.

Both mentioned four times are Check-It's positive influence on protocol-based working and the inadequacy of the clinical pathway in use. This inadequacy is only mentioned in the 'nurses and paramedics group' and is due to the fact that since the department started using Check-It, the 'nurses and paramedics group' took over some of the responsibilities of the 'physicians and medical specialists'. Especially the explanation of the clinical pathway to patients, -which leads in this department to more checks and tests, and should therefore be often explained- is something some of the healthcare professionals in the 'nurses and paramedics group' find cumbersome to do, which is illustrated with the following quote.

> ***"(…) I don't think it's my job to explain that. I think it seems absurd when I tell them (the patients) they should give another blood sample because it is written on a list"*** Nurses and paramedics

Even though the clinical pathway was formally in use before the department started using Check-It, it was easy to deviate from the paper-based version. This resulted in less frequent checks and tests. Since the clinical pathway is digitalized, and the healthcare professionals are reminded of the steps in the clinical pathway, the checks and test for the patients are more frequent. This consequently results in more work for the healthcare professionals, something that is mentioned three times by the participants in the 'nurses and paramedics' and '(medical) support personnel' groups.

Three out of six healthcare professionals in the '(medical) support personnel' group mentioned that it is difficult for them if the physicians or the patient diverges from the clinical pathway. Since it is the job responsibility of these employees to schedule appointments with the patients, they ought to know when the patient has to come back. This knowledge falls short when a patient unexpectedly differs from the clinical pathway.

The remaining three statements are all mentioned twice or less, which indicates that fewer healthcare professionals notice these Check-It aspects. However, the statements about the appreciation for the prefilled orders and letters and the lack of flexibility of the system are also mentioned by participants of other departments. That it also costs a lot of clicks to effectively work with the system, is something only two healthcare professionals of this department notice.

In addition to the questions about the effectiveness and effects of Check-It, the healthcare professionals are also asked what they think of the transition phase and whether they have any recommendations for Check-It. Two healthcare professionals were not employed by the department of ophthalmology at the time the transition phase started. Of the remaining 13 participants, one participant indicated that she would like to have had more personal contact in the transition phase, however, the rest of the participants stated that they thought the assistance and written documentation was just right. This indicates that changing the transition phase for this department would probably not affect the understanding of the system and thus the perceived effectiveness of it.

Based on the effects of Check-It discussed in this section, several improvement points are suggested by the healthcare participants. These improvement points are summarized in Table 22. Two of these improvement points are mentioned more than once; healthcare professionals in the 'physicians and medical specialists' group indicated that they would like to extent the use of the system to other syndromes and diseases in their department. In addition, two other participants mentioned that they would like to see the usability of the system improved. The remaining three improvement points are just mentioned once. Interesting to deduce is that nine healthcare professionals indicated that they don't see any improvement points for Check-It, even though most of them did name at least one negative statement about the system, as discussed in the previous two pages.

TABLE 22: INTERVIEW RESULTS IMPROVEMENT POINTS – DEPARTMENT OF OPTHALMOLOGY

Number of mentions	Improvement
2/15	Extent use to other patients in the department of ophthalmology
2/15	Improve the usability
1/15	Show a reminder when a patient has a Check-It file
1/15	Incorporate other programs with Check-It
1/15	Make it easier to change appointments

11.3 CONCLUSION FOR OPHTHALMOLOGY

To conclude this chapter a merged summarization of the covered results will be given. These results are presented in list-form to keep it organized. The points are all linked together and can't be seen as completely disjoint conclusions.

- The healthcare professionals at the department of ophthalmology have a lot of experience with Check-It.
- While the overall score of the objectives of Check-It for the department as a whole leaves much to be desired, Check-It did positively influence these objectives over the last ten months for the healthcare professionals in their work with Check-It patients. Therefore Check-It is perceived effective for this department.
- Two-thirds of the participants indicated in the interviews that Check-It has increased work productivity for them.
- Even though two-thirds indicated Check-It is effective for them, based on the data from the surveys it can be concluded that 'physicians and medical specialists' think Check-It is more effective for them than for the healthcare professionals in the other two groups (i.e. 'nurses and paramedics' and '(medical) support personnel'), and the healthcare professionals in the two other groups indicate that 'others' (i.e. the 'physicians and medical specialists') profit more from Check-It than them. Together this leads to roughly the same effectiveness-score for the department as a whole and for the healthcare professional's personal work environment.
- Among others, this insight ensures that the healthcare professionals at the department of ophthalmology accept Check-It.
- Check-It mainly ensures a better overview of completed tasks, task to be done, and the clinical pathway as a whole. Consequently it makes sure less tasks are forgotten, and it improves protocol-based working.
- When critically re-evaluate the clinical pathway of Uveitis with all involved stakeholders and improving the usability of the system, a more positive attitude towards Check-It will probably be realized.
- Changing the transition phase in the department would probably not change the outcomes of the results.

12. CASE STUDY RESULTS: FOUR DEPARTMENTS COMPARED

12.1 INTRODUCTION

The previous four chapters discussed the results per department, without a comprehensive analysis of the similarities and differences between them. In this chapter the four departments will be compared to each other, while keeping in mind that the goal of the case study is to answer the seventh subquestion: 'Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?'.

In total 95.45% of the healthcare professionals in the four departments participated in this study. This means that the opinions of in total 42 healthcare professionals form the basis of the perceived effectiveness results. The functions of these participants can be found in Figure 62. Vascular surgery not taken into account for a moment, these healthcare professionals' experiences range from four to ten months of system use and from ten to more than fifty Check-It patients.

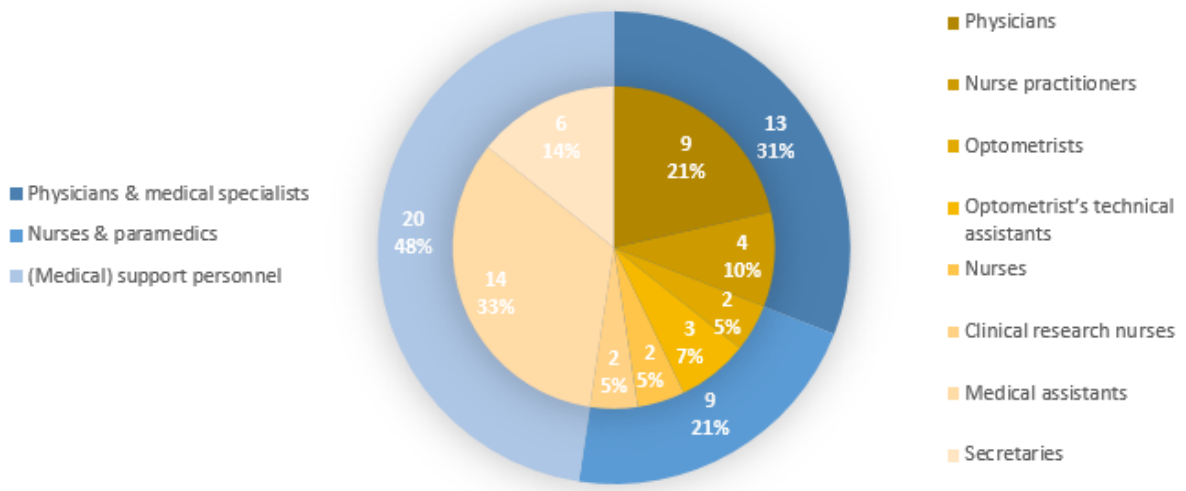

FIGURE 62: PARTICIPANT'S FUNCTIONS

12.2 VASCULAR SURGERY VS. PEDIATRIC PULMONOLOGY

Since no system use was realized at the department of vascular surgery, no conclusion about the perceived effectiveness for this department could be drawn. The underlying reasons of this lack of use are explained in Chapter 9, however the question remains: could it be predicted beforehand? In order to answer this question a comparison between the results of the pretests of vascular surgery and pediatric pulmonology will be made in this subsection.

When looking at the department grades in Table 23, it can be stated that the need for change is somewhat higher for pediatric pulmonology than vascular surgery. However, the differences are small for three of the four objectives.

TABLE 23: MEAN OBJECTIVE GRADES – DEPARTMENT OF PEDIATRIC PULMONOLOGY AND VASCULAR SURGERY

Department grade. Scale: 1-10				
	Protocol-based working	Monitoring of protocol-based working	Ease of administrative workload	Efficiency
Pediatric pulmonology	$\mu = 7.43$ $\sigma = 0.53$	$\mu = 5.86$ $\sigma = 1.21$	$\mu = 7.00$ $\sigma = 0.82$	$\mu = 7.14$ $\sigma = 0.38$
Vascular surgery	$\mu = 7.70$ $\sigma = 0.95$	$\mu = 7.20$ $\sigma = 1.32$	$\mu = 7.10$ $\sigma = 1.85$	$\mu = 7.20$ $\sigma = 1.03$

Since the differences are small, it is important to look to the expected change Check-It brings. No large differences would be expected, since the differences in need are also not particularly large. However, the results are further apart than the numbers in the previous discussed table, as can be seen in Figure 64 on the next page. As can be derived from this figure, the expected increase of efficiency differs the most between the two departments, while they are almost on the same page about the change Check-It brings to the monitoring of protocol-based working.

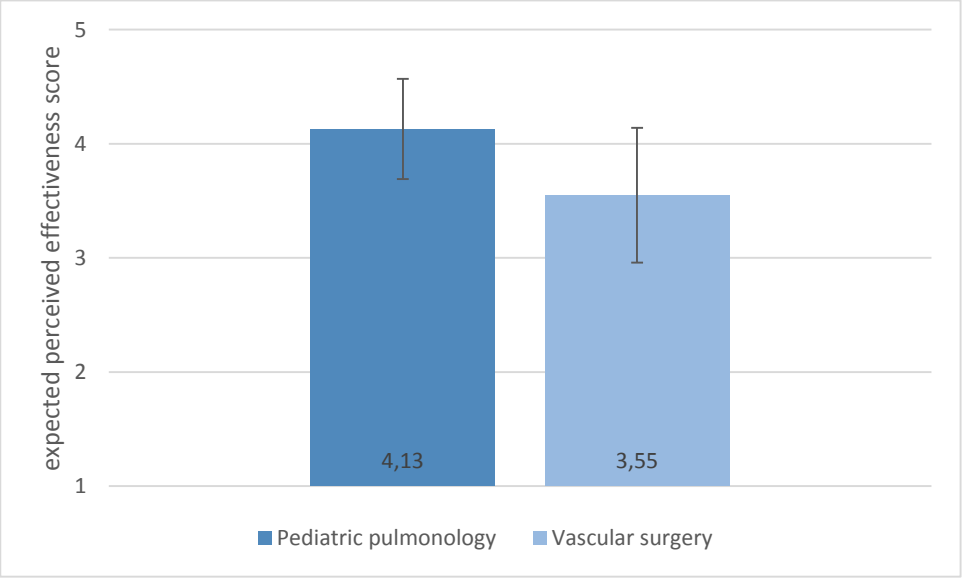

FIGURE 63: MEAN CHECK-IT EFFECTIVENESS SCORES – DEPARTMENT OF PEDIATRIC PULMONOLOGY AND VASCULAR SURGERY

Not only Check-It expected influence on the separate objective can be compared, but also the expected perceived effectiveness score, as is shown in Figure 63. Which is 4.13 ($\sigma = 0.44$) for pediatric pulmonology and 3.55 ($\sigma = 0.59$) for vascular surgery. This means that the expected perceived effectiveness score of pediatric pulmonary ($M = 4.13$, $SE = 0.16$) is significantly higher than the expected perceived effectiveness score of vascular surgery ($M = 3.55$, $SE = 0.19$), $t(16) = 2.29$, $p = 0.036$. The SPSS output of this independent t-test can be found in Table 38 in Appendix K. It should be kept in mind that even though the participants of vascular surgery expected Check-It to contribute significantly less, a score of 3.55 on a scale of 1 to 5, still meant that they were positive about the possible contribution.

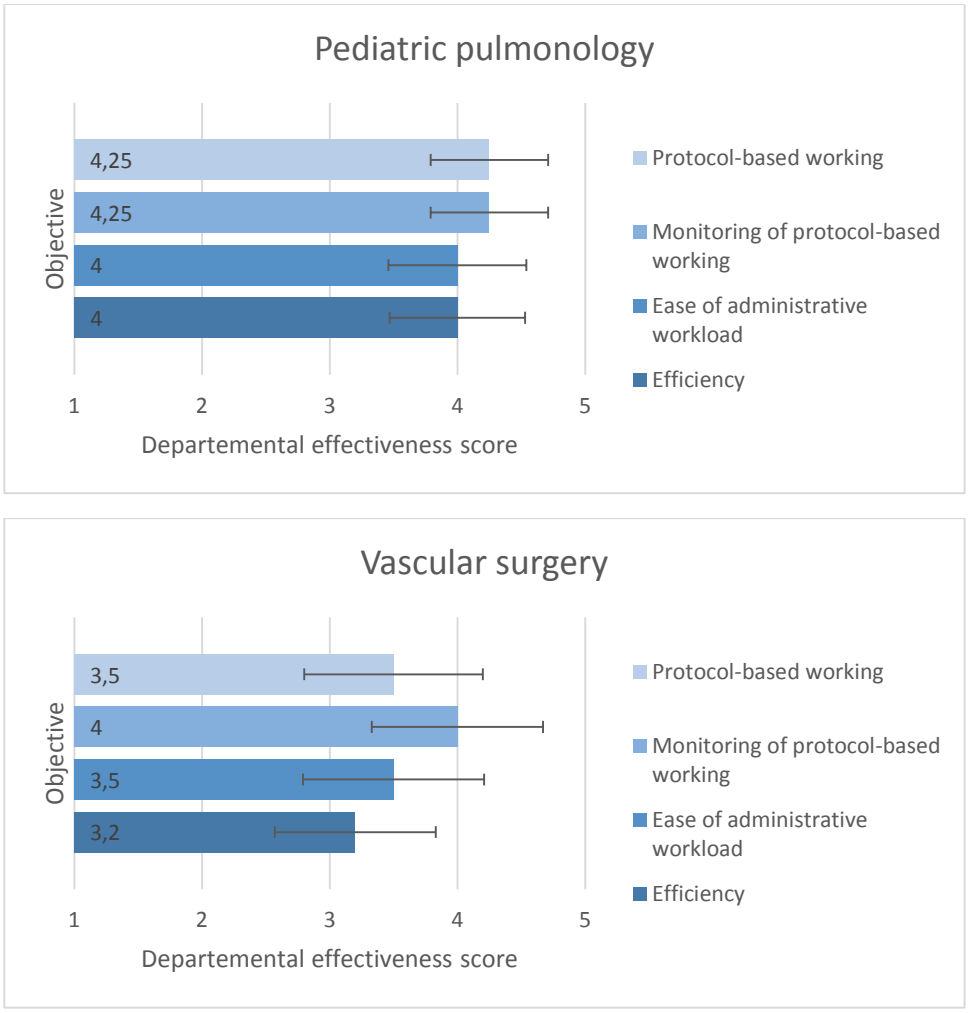

FIGURE 64: MEAN CHECK-IT EXPECTED CONTRIBUTION GRADES – DEPARTMENT OF PEDIATRIC PULMONOLOGY AND VASCULAR SURGERY

A measure which is designed in order to predict if a group of people accept a piece of technology, is the TAM. The TAM scores of both departments are shown in Figure 65, in which the score after the 'V' is the mean score for a particular construct assigned by the healthcare professionals of vascular surgery, and the score after the 'P' represents the same score however assigned by healthcare professionals of pediatric pulmonology.

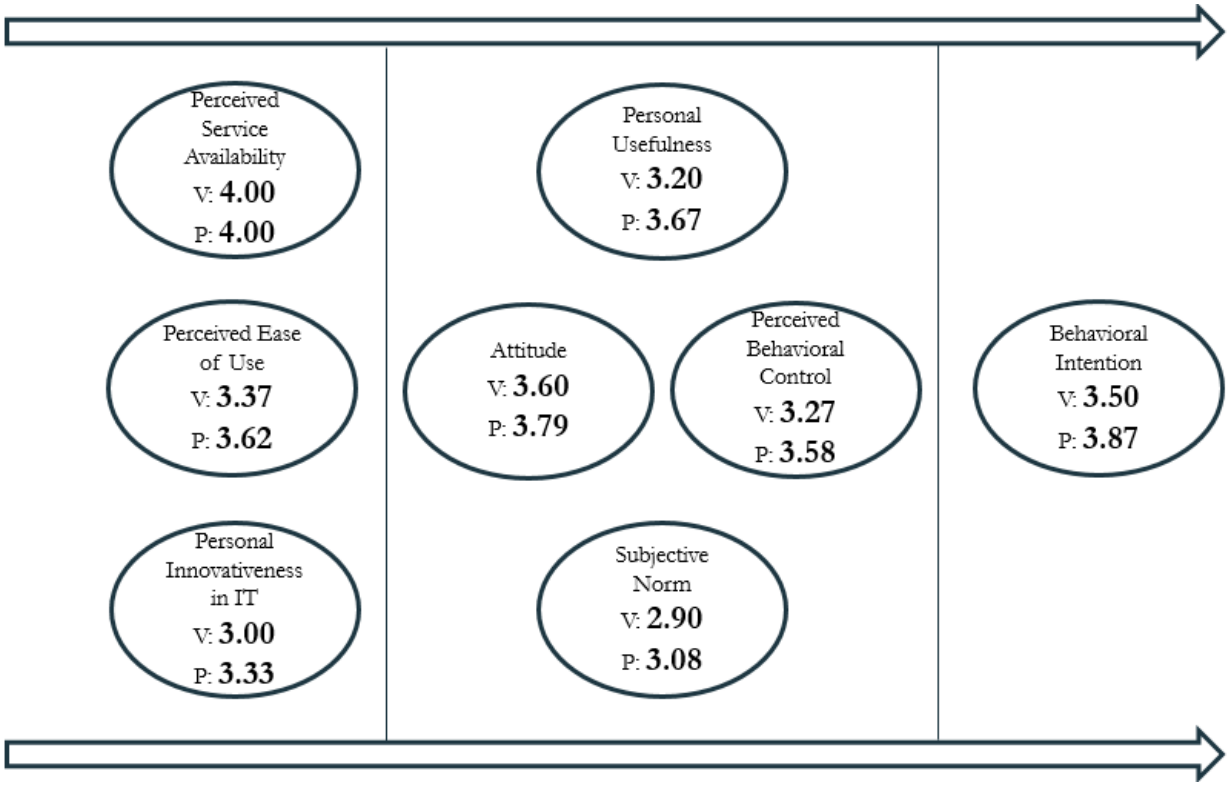

FIGURE 65: TAM QUESTIONS COMBINED – DEPARTMENT OF VASCULAR SURGERY AND PEDIATRIC PULMONOLOGY

While vascular surgery scores above a 3.0 on every construct except for Subjective Norm, pediatric pulmonology scores (somewhat) higher on every construct of the TAM model. However, none of these scores differ significantly from each other. The SPSS output of the calculations of these independent t-tests can be found in Table 39 in Appendix K. These insignificant results in combination with vascular surgery scoring above 3.0 on almost all objectives, indicates that also the TAM results are not a strong indicator that Check-It would not going to be used at the department of vascular surgery.

In addition, the results of the interviews as discussed in Sections 8.2 and 9.2 shows no noteworthy differences between the two departments as regards to the expectations. Both mention most that they expect Check-It to contribute to protocol-based working, and state several other positive and negative expectations. However, there is a small difference in number of negative statements. While the participants of pediatric pulmonology mention negative statements in 38.10% of the cases, 43.75% of the expectations of the participants of vascular surgery are negatively formulated. A difference of 5.65%.

To summarize, the healthcare professionals at pediatric pulmonology are in a little bit more need of improvement, have significant higher expectations of Check-It beforehand, are a little bit more inclined to accept the system, and tent to express themselves a little more often positive about the system. Together this leads to a higher chance of success for the system. However, when looking separately at the scores of vascular surgery, no indication of the initial failure can be detected. Vascular surgery did score positively on all measures, expect just not as positive as pediatric pulmonology. In other words; the lack of use could not have been predicted based on the available data.

12.3 Pediatric pulmonology vs. dermatology and allergology vs. ophthalmology

As explained in Section 8.5, Check-It's perceived influence on the objectives for the healthcare professionals themselves as well as how they regard Check-It to influence the department, are the two most important numeric measures in order to answer the seventh subquestion. The objective scores together are hypothesized to indicate a perceived effectiveness score. Together with the in-depth insight which is obtained in the interviews, the scores will give a comprehensive answer to the questions whether Check-It is perceived effective.

12.3.1 Perceived effectiveness scores – departmental differences

As already explained at the pediatric pulmonology chapter, the perceived effectiveness score is defined as the mean score for a test over the four objectives. The results of these effectiveness scores per department can be found in Table 24.

Table 24: Effectiveness scores per department

Effectiveness scores		
	Department grade	Personal grade
Dermatology and allergology	$\mu = 2.25$ $\sigma = 1.05$	$\mu = 2.31$ $\sigma = 0.99$
Ophthalmology	$\mu = 3.33$ $\sigma = 0.86$	$\mu = 3.19$ $\sigma = 0.78$
Pediatric pulmonology	$\mu = 3.67$ $\sigma = 0.63$	$\mu = 4.04$ $\sigma = 0.80$

A visualization of this result, in which the departmental effectiveness score is shown on the y-as and the personal effectiveness score on the x-as, is shown in Figure 66. As can be seen pediatric pulmonology and ophthalmology are in the top-right corner of the matrix, while dermatology and allergology is in the bottom-left corner. This means that while Check-It is perceived effective for the department as well as the healthcare professional themselves for pediatric pulmonology and ophthalmology, this is not the case for dermatology and allergology, which scores low on personal and departmental effectiveness. This is in accordance with the results discussed in the case study chapters.

In order to assess whether the three department also differ significantly from each other, ANOVA tests are performed for the departmental effectiveness score as well as the personal effectiveness score. Because Levine's test of homogeneity of variance is in both cases not significant (respectively 0.38 and 0.72) the homogeneity of variance assumption of ANOVA is not broken, and thus is allowed to be performed.

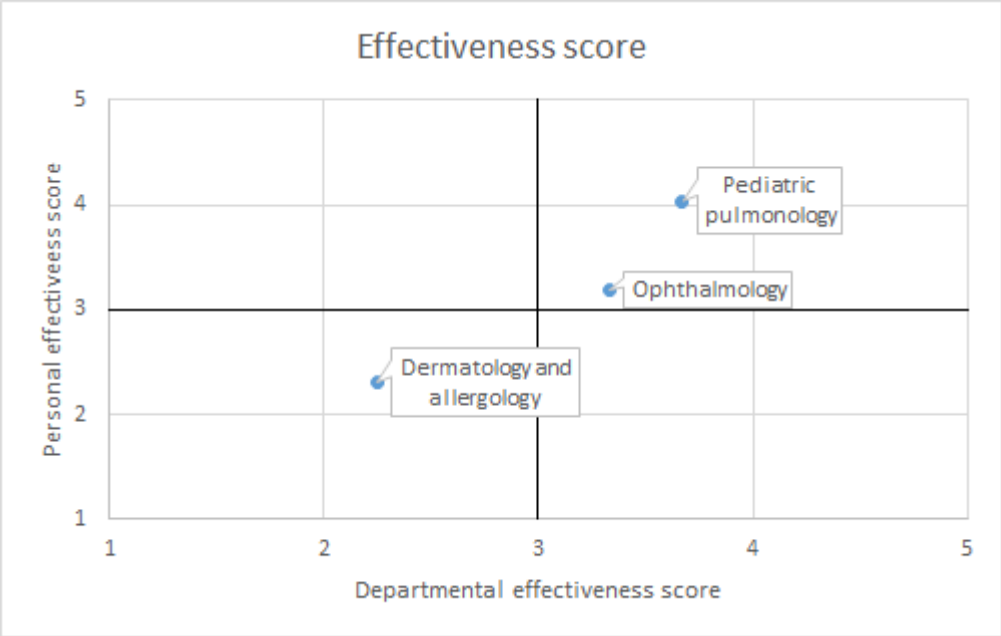

FIGURE 66: DEPARTMENT EFFECTIVENESS MATRIX

When looking at the departmental effectiveness score it can be stated that there is a significant difference between the scores of the departments $F(2,27) = 5.89$, $\rho = .008 < .05$. The Hochberg's GT2 is chosen as the ANOVA's post hoc tests to reveal which specific departments differ significantly from each other. This test is used because the sample sizes differ. The outcomes of this test shows that the differences between the departmental effectiveness scores of dermatology and allergology and ophthalmology differs significantly (Hochberg: $\rho = .021$), this is also the case between dermatology and pediatric pulmonology (Hochberg: $\rho = .016$). The differences between departmental effectiveness score of ophthalmology and pediatric pulmonology however, are not significant (Hochberg: $\rho = .820$). The SPSS output of these tests can be found in Table 40 and Table 42 in Appendix K.

Also starting with an ANOVA calculation for the personal effectiveness scores, it can be concluded that there is a significant difference between the departments $F(2,27) = 7.67$, $\rho = .002 < .05$. Again Hochberg's GT2 is used in order to calculate which departments differ significantly from each other. These test reveal that the only significant difference is between dermatology and allergology and pediatric pulmonology (Hochberg: $\rho = .002$). The difference between dermatology and allergology and ophthalmology is too small in order to speak of significance (Hochberg: $\rho = .060$), something which is also the case for the difference between pediatric pulmonology and ophthalmology (Hochberg: $\rho = .132$). The SPSS output for these calculations can be found in Table 41 and Table 43 in Appendix K.

Summarizing, it can be seen that the departmental effectiveness scores are significantly lower for the department of dermatology and allergology as for the other two departments. In addition, the personal effectiveness score only differs significantly between dermatology and allergology and pediatric pulmonology.

12.3.2 Perceived effectiveness scores – causes departmental differences

There are several ways to explain the differences between the tests, which are discussed in the previous subsection. It could be the case that the composition of the healthcare professional roles have an influence on these results, but also external influences, like an unfit clinical pathway or negative employee attitude, can have influence of the outcome. In order to assess this, this subsection makes a comparison between the influence of healthcare professionals groups on the effectiveness scores, the differences between TAM model results, and the differences between interview results.

Differences between healthcare professional groups

As mentioned several times in the previous chapters, sometimes a difference can be seen between the healthcare professional roles. Figure 67 shows the total division of healthcare professionals who participated in the posttests.

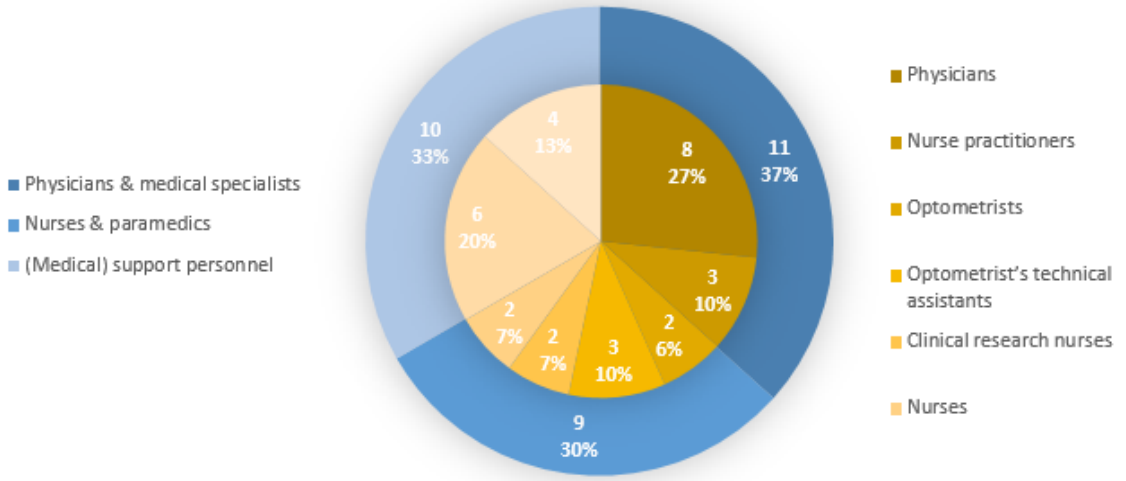

Figure 67: Total healthcare professional role overview

For these healthcare professional groups over the different departments the perceived effectiveness score are calculated. The results per healthcare professional group can be found in Table 25.

Table 25: Effectiveness scores per healthcare professional group

Effectiveness scores		
	Department grade	Personal grade
Physicians & medical specialists	$\mu = 3.30$ $\sigma = 0.74$	$\mu = 3.67$ $\sigma = 0.75$
Nurses & paramedics	$\mu = 2.92$ $\sigma = 1.16$	$\mu = 2.64$ $\sigma = 0.70$
(Medical) support personnel	$\mu = 2.98$ $\sigma = 1.22$	$\mu = 2.87$ $\sigma = 1.30$

A visualization of this result, in which the departmental effectiveness score is shown on the y-as and the personal effectiveness score on the x-as, is shown in Figure 68. As can be seen only the 'physicians and medical specialists' group is in the top-right corner of the matrix. The 'nurses and paramedics' group and '(medical) support personnel' group are in the bottom-left corner, however, it should be noted that they are very close to the middle and are almost in the positive numbers.

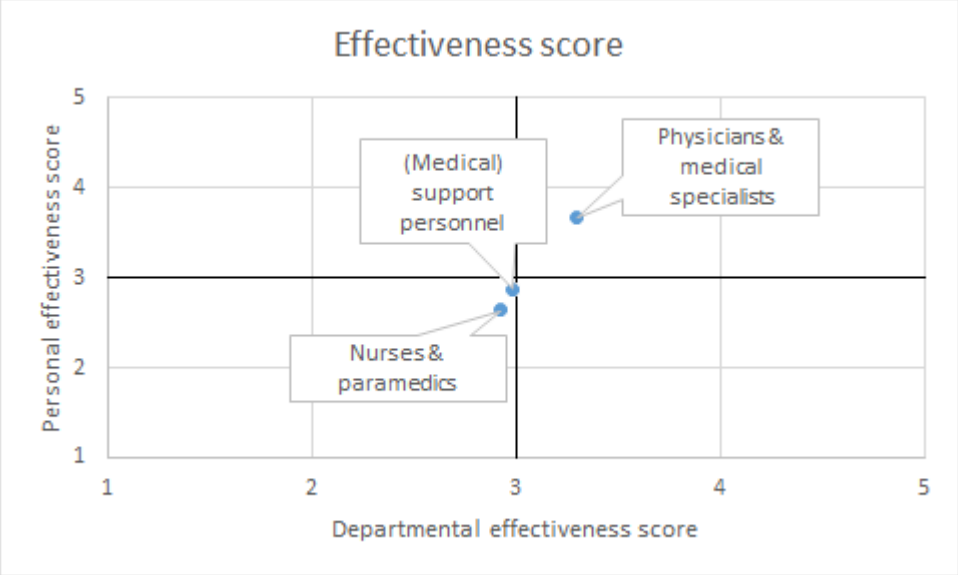

FIGURE 68: HEATHCARE PROFESSIONAL GROUP EFFECTIEVENESS MATRIX

In order to assess whether the three healthcare professional groups also differ significantly from each other, ANOVA tests are performed for the departmental effectiveness score as well as the personal effectiveness score. Because Levine's test of homogeneity of variance is in both cases not significant (respectively 0.71 and 0.07) the homogeneity of variance assumption of ANOVA is not broken, and thus is allowed to be performed.

When looking at the departmental effectiveness score it can be stated that there isn't a significant difference between the departmental effectiveness scores of the healthcare professionals groups $F(2,27) = 0.39$, $\rho = .679 > .05$. The same is the case for the personal effectiveness score $F(2,27) = 3.31$, $\rho = .052 > .05$. The SPSS output for these calculation can be found in Table 44 and Table 45 in Appendix K. Even though there isn't a significant difference, based on the placement of the healthcare professional groups in the effectiveness score matrix, it can be stated that there are strong indications that Check-It is more effective for 'physicians and medical specialists' than for 'nurses and paramedics' and '(medical) support personnel'. The latter two groups don't differ much from each other. Table 26 gives additional insight in the healthcare professional group scores per department. The 1-2-3 rank has to be read left to right, and indicate on which position the mean score of a particular healthcare professional group is in a department. The table shows that the personal effectiveness for 'physicians and medical specialists' is indeed higher in the departments of dermatology and allergology as well as ophthalmology. The department of pediatric pulmonology however, doesn't comply with this. Since there are no nurses and paramedics in this group, and only

one person in the (medical) support personnel group, the value of these results when looking at the different healthcare professional groups, is limited.

TABLE 26: PERSONAL EFFECTIVENESS SCORE PER HEALTHCARE PROFESSIONAL GROUP PER DEPARTMENT

	Physicians & medical specialists		Nurses & paramedics		(Medical) support personnel	
Pediatric pulmonology	2	$\mu = 3.85$ $\sigma = 0.72$ $n = 5$		-	1	$\mu = 5.00$ $\sigma = 0.00$ $n = 1$
Ophthalmology	1	$\mu = 3.71$ $\sigma = 1.05$ $n = 3$	3	$\mu = 2.83$ $\sigma = 0.75$ $n = 6$	2	$\mu = 3.28$ $\sigma = 0.62$ $n = 6$
Dermatology & allergology	1	$\mu = 3.33$ $\sigma = 0.63$ $n = 3$	2	$\mu = 2.25$ $\sigma = 0.43$ $n = 3$	3	$\mu = 1.33$ $\sigma = 0.58$ $n = 3$

Even though there are strong indications that 'physicians and medical specialists' get out more out of Check-It than the other two healthcare professional groups, this difference cannot solemnly explain the departmental differences discussed in the previous subsection. The percentage of participants in the 'physicians and medical specialists' group per department are:

- Pediatric pulmonology 83.33%
- Ophthalmology 20.00%
- Dermatology and allergology 33.33%

This shows that the high number of healthcare professionals in the 'physicians and medical specialists' group of pediatric pulmonology could have an influence on their department scoring the highest on perceived effectivity, however it does not explain the differences of the low scores of dermatology and allergology nor why ophthalmology does score more close to pediatric pulmonology. Therefore the differences in the TAM results and interviews are discussed next.

DIFFERENCES BETWEEN DEPARTMENTS BASED ON TAM SCORES

The order of perceived effectiveness according to healthcare professionals in the different departments, in which pediatric pulmonology comes first, followed by ophthalmology and dermatology and allergology, is reflected in the scores of the TAM model. Table 27 shows an overview of all construct scores per department. Just like Table 26, the order of the mean scores per construct per department are shown.

It can be derived from the table that, except for the Perceived Service Availability, pediatric pulmonology scores highest on every objective. In addition, the department in which Check-It is perceived effective second-best scores also on almost every TAM construct second-best.

Dermatology and allergology, the only department in which Check-It is not perceived effective, scores lowest on all constructs except for Personal Innovativeness in IT. This is the only construct that does not ask questions about the system but about the personal IT skills of the healthcare professionals. The means over the three clusters do follow the same pattern: pediatric pulmonology scores the highest, followed by ophthalmology, and the lowest score is of dermatology and allergology.

TABLE 27: TAM SCORE PER CLUSTER/CONSTRUCT PER DEPARTMENT

		Pediatric pulmonology		Ophthalmology		Dermatology & allergology	
Cluster one	PSA	2	$\mu = 4.17$ $\sigma = 0.00$	1	$\mu = 4.20$ $\sigma = 0.00$	3	$\mu = 4.00$ $\sigma = 0.00$
	PEOU	1	$\mu = 3.56$ $\sigma = 0.24$	2	$\mu = 3.44$ $\sigma = 0.27$	3	$\mu = 3.19$ $\sigma = 0.74$
	PITT	1	$\mu = 3.47$ $\sigma = 0.30$	3	$\mu = 3.25$ $\sigma = 0.63$	2	$\mu = 3.31$ $\sigma = 0.29$
	MEAN	*1*	*$\mu = 3.73$* $\sigma = 0.38$	*2*	*$\mu = 3.63$* $\sigma = 0.50$	*3*	*$\mu = 3.5$* $\sigma = 0.44$
Cluster two	PU	1	$\mu = 3.90$ $\sigma = 0.21$	2	$\mu = 3.27$ $\sigma = 0.20$	3	$\mu = 2.19$ $\sigma = 0.32$
	ATT	1	$\mu = 3.94$ $\sigma = 3.94$	2	$\mu = 3.58$ $\sigma = 0.64$	3	$\mu = 3.08$ $\sigma = 0.62$
	PBC	1	$\mu = 3.67$ $\sigma = 0.73$	2	$\mu = 3.47$ $\sigma = 0.58$	3	$\mu = 3.04$ $\sigma = 1.01$
	SN	1	$\mu = 3.17$ $\sigma = 0.17$	2	$\mu = 2.76$ $\sigma = 0.08$	3	$\mu = 2.5$ $\sigma = 0.33$
	MEAN	*1*	*$\mu = 3.67$* $\sigma = 0.36$	*2*	*$\mu = 3.27$* $\sigma = 0.36$	*3*	*$\mu = 2.70$* $\sigma = 0.38$
Cluster three	BI	1	$\mu = 4.17$ $\sigma = 0.00$	2	$\mu = 3.47$ $\sigma = 0.00$	3	$\mu = 3.11$ $\sigma = 0.00$

PSA: Perceived Service Availability —PEOU: Perceived Ease Of Use — PIIT: Personal Innovativeness in IT — PU: Personal Usefulness — ATT: Attitude — PBC: Perceived behavioral control — SN: Subjective Norm — BI: Behavioral Intention

When calculating the significance for these cluster means, based on ANOVA's (Levine's test of homogeneity of variance respectively for cluster one, two, and three: 0.36, 0.48, 0.87) it can be seen that there is no significance between the departments in the first cluster $F(2,27) = 0.21$, $\rho = .812 > .05$, and in the third cluster (which only consists of Behavioral Intention) $F(2,27) = 1.63$, $\rho = .214 > .05$. However, the mean TAM scores in the second cluster do differ significantly from each other $F(2,27) = 4.32$, $\rho = .024 < .05$. Conducting the Hochberg's GT2 as the ANOVA's post hoc tests learns that the differences between pediatric pulmonology and dermatology and allergology are significant (Hochberg: $\rho = .025$), while the differences between ophthalmology and the other two departments aren't (Hochberg: $\rho = .138$ & $\rho = .484$). The SPSS output for these calculation can be found in Table 46 to Table 49 in Appendix K

Even though not all scores differ significantly, and the ones that do only differ significantly between pediatric pulmonology and dermatology and allergology, they are generally speaking in the same order as the perceived effectiveness scores of the departments. Therefore it can be stated that there are indications that the scores of the TAM model, which represent the healthcare professional's their willingness to accept a system, have an influence on the perceived effectiveness of Check-It.

Differences between departments based on interview results

When comparing the interview statements of the three departments with each other it can be seen that four out of six (66.67%) healthcare professionals of pediatric pulmonology indicated that Check-It improved effectivity. The two healthcare professionals who indicated that it didn't improve effectivity just yet, were the only two nurse practitioners who participated in the study for this department. Ten out of fifteen (66.67%) of the healthcare professionals of ophthalmology indicated that they thought Check-It improved their effectivity. Of the remaining five healthcare professionals, two indicated that the question was too hard to answer, and three healthcare professional stated that Check-It decreased effectivity. These three healthcare professionals all belong to the 'nurses and paramedics' group. Two out of nine (22.22%) healthcare professionals of dermatology and allergology state that Check-It increased their effectivity, these two healthcare professionals are the only two physicians who participated in the study for this department. It should be noted that dermatology and allergology is the only department which uses a more basic version of Check-It. Therefore it could be the case that this has an influence on the overall results. The numbers discussed in this paragraph further support the theory that healthcare professional role does have influence on the outcome of the results, even though this differs from department to department. It could be the case that for example due to the nature of the clinical pathway it increases effectiveness for nurse practitioners in a particular department, but doesn't do so in another.

Table 28 shows the combined result of the interview statements derived from the interviews in the three departments. In which the percentages in the columns labeled 'PP' (for pediatric pulmonology), 'D&A' (for dermatology and allergology), and 'O' (for ophthalmology) indicate how many healthcare professionals of the total amount of healthcare professionals for that department have mentioned a particular statement. The 'Total' column indicates the percentage of healthcare professionals who mentioned a statement of the total amount of healthcare professionals over the three groups. For example when looking at the statement 'less forgotten tasks'. It can be seen that 16.67% (one out six) of the healthcare professionals of pediatric pulmonology mentioned this, 33.33% (three out nine)

of dermatology and allergology, and 33.33% (four out fifteen) of ophthalmology. When looking at the total amount of healthcare professionals, this statement is mentioned by 30% (nine out thirty) of all participants.

TABLE 28: COMBINED INTERVIEW STATEMENTS

Positive/ negative?	Statement	PP	D&A	O	Total
+	Less forgotten tasks	16.67%	33.33%	33.33%	30%
+	Pre filled orders and letters	50%	33.33%	13.33%	26.67%
+	Better overview	-	-	40%	20%
+	Increased protocol insight	16.67%	11.11%	20%	16.67%
+	Increased efficiency	66.67%	-	-	13.33%
+	Improved protocol-based working	66.67%	-	-	13.33%
+	Decreased cognitive workload	33.33%	-	-	6.67%
+	Increased patient care	16.67%	-	-	3.33%
+	Decreased orientation time	16.67%	-	-	3.33%
+	More accurate administration	-	11.11%	-	3.33%
-	Not flexible enough	16.67%	44.44% *	6.67%	20%
-	Difficult when not according to protocol	16.67%	-	20%	13.33%
-	Lack of use	-	44.44%	-	13.33%
-	Inadequate clinical pathway	-	-	26.67%	13.33%
-	High learning curve	50%	-	-	10%
-	More work	-	-	20%	10%
-	Lots of clicks	-	-	13.33%	6.67%
-	Not aligned with other programs	16.67%	-	-	3.33%
-	Lack of usability	16.67%	-	-	3.33%
-	Unclear	-	11.11%	-	3.33%
-	Declined learning ability	-	11.11%	-	3.33%

PP = Pediatric pulmonology, D&A = Dermatology and allergology, O = Ophthalmology
*mentioned due to the inadequacy of the clinical pathway

As is shown in the table above, most of the statements are mentioned only by one department. This indicates that what healthcare professionals perceive about the system, is dependent on the environment they work in. So it can be seen that the declination of the learning ability is an issue for dermatology and allergology but not for the other departments, and the high learning curve is something that is only perceived at pediatric pulmonology. Something else that can be derived from the table is that for ophthalmology and pediatric pulmonology there are more positive statements than negative ones. For dermatology and allergology this is the other way around. Especially the

inflexibility of the program and lack of use have a high impact. Even though this inflexibility is also mentioned in the other departments, it is mentioned less often. The lack of use is unique for dermatology and allergology, and can therefore be identified as a determining factor for perceived effectiveness.

Looking at the total amount of most mentioned statements it can be stated that Check-It leads to less forgotten tasks, makes it easier to work due to pre filled orders and letters, leads to an better overview, but is also perceived as not flexible enough. In order for Check-It to be perceived more effective, healthcare professionals got the opportunity to indicate which improvement points they envision for Check-It. An overview of these improvement points can be found in Table 29.

TABLE 29: COMBINED IMPROVEMENT POINTS

Improvement point	PP	D&A	O	Total
Make it easier to change appointments	-	33.33%	6.67%	13.33%
Incorporate other programs with Check-It	50%	-	6.67%	13.33%
Show a reminder when a patient has a Check-It file	-	22.22%	6.67%	10%
Highlight the current tab	16.67%	11.11%	-	6.67%
Improve the usability	-	-	13.33%	6.67%
Extent use to other patients in the department of ophthalmology	-	-	13.33%	6.67%
Make it possible to add, remove, and postpone tasks for a particular patient	16.67%	-	-	3.33%
Make it possible to do changes to an activity afterwards	-	11.11%	-	3.33%
Make an telephone-consult also an activity	-	11.11%	-	3.33%
Add free text to all activities	-	11.11%	-	3.33%
Include clinical pathway parts 6-12 and 12-18 for pediatric pulmonology	16.67%	-	-	3.33%
Improve the communication between EZIS and Check-It	-	-	6.67%	3.33%
PP = Pediatric pulmonology, D&A = Dermatology and allergology, O = Ophthalmology				

The combined improvement point table has the same column distribution as the combined interview statement table. The percentages in the columns labeled 'PP' (for pediatric pulmonology), 'D&A' (for dermatology and allergology), and 'O' (for ophthalmology) indicate how many healthcare professionals of the total amount of healthcare professionals for that department have mentioned a particular improvement point. The 'Total' column indicates the percentage of healthcare professionals who mentioned an improvement points of the total amount of healthcare professionals over the three groups.

When analyzing this table it can be seen that the same holds true as for the statement table; most of the improvement points are mentioned by only one of the departments. Therefore it can be derived that also the improvement points a healthcare professional experiences, are dependent on the

environment they work in. In order for Check-It to reach a higher perceived effectiveness it is most important that they make it easier to change appointments, incorporate Check-It with other programs of the UMCU, and show a reminder when a patient has a Check-It file.

12.4 CASE STUDY CONCLUSION

To conclude these last five chapters an answer has to be given to the subquestion: 'Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?'.

Check-It is perceived effective in two of the four departments which served as objects of study. These two departments are the department of pediatric pulmonology who used Check-It for four months, and the department of ophthalmology, who used the system for ten months. Even though Check-It is perceived effective at pediatric pulmonology, it did entail a learning curve which the healthcare professionals had to go through.

The department in which Check-It is not perceived effective, is the department of dermatology and allergology, which has used Check-It for nine months. For this department the change Check-It brings to the four objectives is too small in order to for it to label it as perceived effective. The lack of use, in addition to lack of flexibility, are the two key causes of Check-It not being perceived effective. This lack of flexibility is due to the strictness of the clinical pathway, which does not comply with the reality. This is also supported by the effectiveness scores of this department. The departmental effectiveness scores are significantly lower for the department of dermatology and allergology as compared to the two departments who do perceive Check-It as effective. In addition, the personal effectiveness score differs significantly between dermatology and allergology and pediatric pulmonology.

For the department of vascular surgery no perceived effectiveness could be determined, since no system use was realized. The reason why no system use was realized is due to healthcare professionals not being on the same page, postponing system use after training, having the responsibility of initiating the start of Check-It use for a patient at a single person, not having leaders express a strong believe in Check-It, and not having a strong guiding coalition to fall back on.

In order to conclude where the differences between perceived effectiveness in the departments come from several analyses are made, which can be read in the previous chapters. The most important and mutual exclusive ones are summarized in Table 30 on the next page. This table provides input for the case study conclusion, elaborated on thereafter. The question marks indicate that a particular element is not measured in a particular department, which causes no data to be available about the subject.

TABLE 30: OVERVIEW DEPARTMENTAL OUTCOMES

	Vascular surgery	Dermatology & allergology	Ophthalmology	Pediatric pulmonology
Time in use at measurement	0 months	9 months	10 months	4 months
Experience number of patients	0 patients	30-40 patients	>50 patients	10-20 patients
Perceived effectiveness	?	-	+	+
Lack of use	✓	✓	✖	✖
Behavioral Intention score	?	3.11	3.47	4.17
Positive/negative statement ratio	?	8/10	16/13	17/7
Percentage of mentions of unfit pathway	?	44.44%	0.00%	26.67%
Percentage of 'physicians and medical specialists'	20.00%	33.33%	20%	83.33%
Healthcare professionals not on the same page	✓	?	?	?
System not directly used after training	✓	?	?	✖
Understanding of the system	✓	?	?	?
Understanding of the need	✓	?	?	?

Summarizing this table and the information in the previous chapters, it can be seen that Check-It is still in a piloting phase. A lot can be learned from the feedback of the participating healthcare professionals. It should be kept in mind that the results have shown that what healthcare professionals perceive about the system, is dependent on the environment (i.e. department) they work in. Especially healthcare professionals in departments with a positive attitude towards a (new) system -which is expressed in a positive ratio of the number of positive/negative statements and the willingness to accept a system measured by TAM scores- and who collectively use the system, are more inclined to profit from Check-It. In addition, there are some more frail indications that departments which consist of healthcare professionals who understand how to work with the system, the need to use it, don't postpone system use after training, and have a clinical pathway that doesn't need much flexibility, have a higher chance to successfully work with Check-It. However these four indications are all measures in only one or two of the departments, without the opportunity to cross reference them with the others.

When looking at the overall perceived effectiveness, there are strong indications that Check-It is more effective according to 'physicians and medical specialists' than according to 'nurses and paramedics' and '(medical) support personnel'. For these healthcare professionals, Check-It leads among others to less forgotten tasks, makes it easier to work due to pre filled orders and letters, leads to a better overview, but is also perceived as not flexible enough.

In order for Check-It to reach a higher perceived effectiveness the DIT make it easier to change appointments, incorporate Check-It with other programs of the UMCU, and show a reminder when a patient has a Check-It file.

13. CONCLUSION

In order to conclude this research an answer has to be given to the main research question. To put this answer in perspective, a short overview of the answers of the first seven subquestions will be given. After this overview, the main research question and eighth subquestion are answered.

***SQ1:* Which IT systems are generally used in hospital environments and what is known about their added value?**

The delivery of safe and effective healthcare remains an ongoing challenge to healthcare professionals (Jamal et al., 2009). IT is seen as a key enabler to improve these healthcare processes and can lead to several benefits including the reduction of medical errors and costs, and improving efficiency, quality, practitioner performance, and patient outcome. Whether or not a system is effective in a particular hospital depends on the hospital environment. A hospital environment is the circumstance in which a specific system is used in terms of users, tasks, equipment, and environment. Needless to say a hospital environment can differ a lot from hospital to hospital.

There is a wide variety of systems that are generally used in hospital environments, these can be for example grouped based on their based on the processes they support or how many systems they entail. The most common systems found in hospitals are: patient administration systems, medical documentation systems, nursing management and documentation systems, outpatient management systems, computerized provider/physician order entry systems, patient data management systems, operation management systems, radiology management systems, picture archiving and communication systems, laboratory information systems, enterprise resource planning systems, data warehouse systems, and document archiving systems.

When linking several of these systems together it can be called a Hospital Information System. A HIS is a comprehensive, integrated information system designed to manage different aspects of a hospital. They are aimed to achieve the best possible support of patient care and administration by electronic data processing.

***SQ2:* What are clinical pathways and how do they contribute to the performance of hospital environments?**

Over the past years a lot has been written about clinical pathways. Even though there is a lot of uncertainty surrounding the concept and definition of clinical pathways, a leading definition has come forward. This definition comes from the European Pathway Association and states that clinical pathways are a methodology for mutual decision making and organization of care for a well-defined group of patients, during a well-defined period. The aim of these clinical pathways is to enhance the quality of care across the continuum by improving risk-adjusted patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources.

Clinical pathways are seen as a critical organizational factor for high performing hospitals. Different studies provide evidence that they improve patient outcome, ensure less adverse events, increase participation of patients in treatment procedures, reduce length of stay, and increase patient satisfaction. Also, a reduction of the costs of patient care, a more efficient use of resources, an improvement of the quality of documentation, a reduced clinical variance, and better clinical outcomes, are proven to be true by multiple studies. For healthcare professionals clinical pathways are proven to enhance junior and staff education and training, and improve communication and collaboration between healthcare professionals. However, some articles report clinical pathways to lead to "cookbook" medicine, an increased level of documentation, increased cost, fragmentation of care, a less personal relationship between professionals and patients, and a restriction of creativity, intuition and clinical judgement of healthcare professionals. Therefore it can be concluded that different studies provide evidence to a multitude of positive as well as negative effects of clinical pathways. It will depend on the circumstances whether positive or negative effects dominate.

SQ3: What is known about clinical pathway management and related success factors?

Several authors proposed models for Clinical Pathway Management. The 7-phased model based on PDCA cycles of Vanhaecht et al. is the most used and elaborate one. It consists of a screening phase, project management phase, diagnoses and objectification phase, development phase, implementation phase, evaluation phase, and continuous follow-up phase. These phased can be incorporated in the CPM definition that is in use in this study: definition, implementation, and execution. In which screening, project management, and diagnosis and objectification falls in the definition phase, the development and implementation in the implementation phase, and evaluation and continuous follow-up in the execution phase. For the execution phase to have success there are several factors to consider when managing clinical pathways. These factors include the (financial) support of the executive board and involved healthcare professionals, the necessary of the clinical pathway to meet multiple agenda's, include goals and outcomes, to manage staff expectations and variances, having a single well-defined clinical problem, producing simple and clear documents, being a part of an organizational quality program, and being up-to-dare and relevant.

SQ4: What is known about clinical pathway management software?

IT is known to be important for hospitals and also thought to be of importance for clinical pathways. Even though the majority of clinical pathways are at least for a part paper-based, there are some clear advantages for using clinical pathway management software. These advantages include the opportunity to deliver faster and better information, economic benefits, and a higher patient satisfaction. This can be reached if the CPM software program supports the complete treatment process. In order for a CPM software program to do this is should at least support displaying, recording, ordering, editing, variance, and statistics.

***SQ5:* What is the hospital environment of the UMCU and which IT systems do they use?**

The hospital environment of the UMCU is complex. It consists of many different elements and actors. The hospital itself consists of a fusion between the AZU, WKZ, and MFU. It employs around 11.000 people over eleven medical divisions, six support departments, three representative councils, two advisory boards, a supervisory board, an executive board, UNOVATE and UMC Utrecht participations. It focuses on providing excellent care at 21 selected syndromes/diseases or patient groups. In order for all these people to effectively carry out their work, many different IT systems are in use. There are four overarching systems: MyUMC which is a patient and employee portal, SAP which is the ERP system in use, EZIS which serves as the UMCU's HIS and EPD, and Ultimo which is a facility management system. In addition to this there are 26 systems that are more important and more used than the others. These systems are: BI, METC, Research Online, LMS, Pure, RDP, Allgeier, Helix, Triasus, Diamant, PDMS MV, 4KP, Cato, Edumanager, Blackboard, TestVision, Evasys, Osiris, KVO Digitaal inschrijven, Cerberus, Syllabus+, AVMS, Monaco, ARTA, Nordined, and TOPdesk.

***SQ6:* What are the indented goals of Check-It, a CPM software program, and how does it work?**

Check-It has four intended goals:

1. To improve protocol-based working
2. To improve the monitoring of protocol-based working
3. To ease administrative workload
4. To reach a more efficient work floor, among other by reducing consultation preparation time.

In order to reach these goals Check-It has different functionalities:

1. Users can document whether they completed a clinical pathway activity or not. When it is chosen not to conduct an activity, an explanation has to be filled in.
2. For every activity it can be seen whether or not that activity is completed and by whom.
3. Measurements can be filled in in Check-It, where after it is automatically communicated with EZIS.
4. (Standardized) Lab requests, radiology requests, and patient letters can be sent.
5. A new appointment can be made, which ensures that all activities for that particular appointment will appear automatically on the task lists of the healthcare professionals.
6. A 'moment of contact' can be linked to an (already made) outpatient clinic appointment.
7. An OR date or inpatient admission can be linked to a 'moment of contact'.
8. Questionnaires can be documented.
9. Free text can be added.
10. Extra activities can be added for a particular patient.

11. Based on the active tab it can be seen where a patient is in a particular clinical pathway.
12. The clinical pathway can be printed for the patient.
13. Data about individual activities, as well as the clinical pathway as a whole can be aggregated.

As can be derived, all elements of a potential successful CPM software program (i.e. displaying, recording, ordering, editing, variance, and statistics) are present in Check-It.

7: Is Check-It, a CPM software program, perceived effective according to healthcare professionals at the UMCU?

Check-It is perceived effective by healthcare professionals in two of the four department which were object of study.

The results have shown that what healthcare professionals perceive about the system, is dependent on the environment (i.e. department) they work in. Healthcare professionals in departments with a positive attitude towards a (new) system -which is expressed in a positive ratio of the number of positive/negative statements and the willingness to accept a system measured by TAM scores- and who collectively use the system, are more inclined to profit from Check-It. Next to this, there are some frail indications that departments which consist of healthcare professionals who understand how to work with the system, the need to use it, don't postpone system use after training, and have a clinical pathway that doesn't need much flexibility, have a higher chance to successfully work with Check-It.

When looking at the overall perceived effectiveness, there are strong indications that Check-It is more effective for 'physicians and medical specialists' than for 'nurses and paramedics' and '(medical) support personnel'. Check-It leads among others to less forgotten tasks, makes it easier to work due to pre filled orders and letters, leads to a better overview, but is also perceived as not flexible enough.

In order for Check-It to reach a higher perceived effectiveness the DIT should make it easier to change appointments, incorporate Check-It with other programs of the UMCU, and show a reminder when a patient has a Check-It file.

MRQ: Can CPM software be effective for healthcare professionals in hospital environments?

It is possible for CPM software to be effective for healthcare professionals in hospital environments. It should be noted that effectivity is defined based on the specific objectives and goals of a particular CPM software program, which results in different effectivity measures for different CPM software programs. In general, CPM software is known to be able to lead to a delivery of faster and better information, several economic benefits, and a higher patient satisfaction. This study adds that it can also be effective for healthcare professionals themselves by reducing the amount of forgotten tasks, contribute to a more efficient workflow due to pre filled orders and letters, and creating a better overview of tasks for the entire department which increases the understanding between healthcare professional functions. Even though these effects influence the department as a whole, CPM

software seems to be more effective for 'physicians and medical specialists' than for 'nurses and paramedics' and '(medical) support personnel'. In order to reach effectiveness with a CPM software program, there are several departmental environment specifics that influence the extent of this effectivity. The departmental environment factors that influence (perceived) effectiveness that are found in this study are:

1. The attitude of healthcare professionals towards a (new) system, and
2. The collective use of the system by the healthcare professionals.

The following departmental environment factors possibly play a role in the perceived effectiveness:

1. The understanding the healthcare professionals have of the system,
2. The understanding the healthcare professionals have of need to use the system,
3. Healthcare professionals who don't postpone system use after training, and
4. Having a clinical pathway that doesn't need much flexibility.

However more research is needed to be able to conclusively state these four factors.

SQ8: Evaluating the effectiveness of CPM software in general and the perceived effectiveness of Check-It according to healthcare professionals ate the UMCU in particular, what recommendations for further research and hospital policy can be formulated?

Hospitals which are considering the possibility to develop or just buy and implement CPM software programs should take several factors into account. First of all the attitude of the healthcare professionals who are going to use the system should be positive, i.e. they should be willing to work with the system. In addition, if such a software program is implemented, everyone who is involved with the patients whose data is in the CPM software program should work with the system. When some healthcare professional decline system use, the system becomes less effective for all other healthcare professionals who work with it. Next to the two most important factors, it is advised to asses the fitness of the clinical pathway for a CPM software program. The clinical pathway should be applicable to most patients in the targeted patient group without having to deviate from it. Furthermore, it should be realized that training and demos are an important part of implementing CPM software. This phase is advised to be directly followed by the deployment of the system, otherwise the know-how about how to use the system fades away. It is of importance that all involved healthcare professionals know how to work with the system and see the need of it. This need could be proclaimed by a strong guiding coalition.

In order to increase the prohibitive value of these results and knowledge in this domain, additional research has to be done to clinical pathway management software. The same case study method could be performed in other hospitals with other CPM systems. For example factors like national culture, whether it is an academic or local hospital, the composition of CPM system components, and the length of use can have an influence on the perceived effectiveness of it. These different conditions should therefore be studied. Finally, an interesting research topic would be to find out which factors can be measures beforehand that could predict whether a clinical pathway management

system will succeed in a particular department. A few critical success factors are already identified in this study, however, more research into this will refine and complement this.

14. Discussion

Any research can be affected by different kinds of factors which can invalidate the findings (Seliger & Shohamy, 1989). This research is no different. There is a difference between the validity of research, which is whether an instrument actually measures what it sets out to measure, and reliability, which is whether an instrument ca be interpreted consistently across different situations (Field, 2009). The limitations of this research will be grouped as threats to construct validity, internal validity, external validity and reliability.

Construct validity

Construct validity refers to whether a scale or test measures the construct adequately. The most important construct in this study is 'effectivity'. There are many different definitions for this concept, the one chosen in this study is not per definition the right one. Defining (perceived) effectivity differently could mean that the research method and thus outcomes are changed. In addition, also in this study two types of effectivity are seen. First of all the effectivity of CPM software, which is measured based on the objectives of a specific system. In addition to this, in the interview part of the case study healthcare professionals are asked to indicate if Check-It increased their effectivity. The healthcare professional are not asked to keep the objectives of Check-It in mind at that point, and can thus make a free interpretation of the concept. A positive answer in the interview does not necessarily mean that the system is also perceived effective according to the leading definition in this study.

Internal validity

Internal validity is a measure which ensures that a researcher's experiment design closely follows the principle of cause and effect. There are different hypothetical influences that could influence the results as presented in this study. These influences are also named in the answer on subquestion eighth, since future research would be able to exclude or include these influences. In addition to this, there are three other treads to the internal validity, all influencing the case study part of the research. First of all, none of the departments use the system more than ten months. It could well be the case that more 'mature' users perceive the effectiveness of a system differently. Closely related to this is the fact that also Check-It, the object of study in the case study, was not mature. The system was still in a piloting phase, which resulted in different versions at different departments. The third and last identified thread of internal validity is about the two medical assistants at pediatric pulmonology who participated in the pretest and first posttest, but were not available for the second posttest.

External validity

External validity asks the question of generalizability: To what populations, settings, treatment variables and measurement variables can this effect be generalized? The external validity for this study is limited since different external influences could be present as discussed at the internal validity paragraph. However, because four different departments over three divisions were object of study, the results can at least be generalized to the UMCU and probably other academic hospitals in the Netherlands. The high participation rate (i.e. of the 44 people who use Check-It in the departments, 42 people participated in this research) has a positive influence on the external validity.

Reliability

The reliability of a study refers to the consistency and repeatability of it and is concerned with to what extent the data and analysis are dependent on the specific researchers. Three factors have an influence on the reliability of the study. Two of these factors have to do with reporting the interview results. The coding, as explained in Section 7.2, is dependent on the choices of abstraction of the researcher. Another researcher could choose to group the statements differently, with more or less abstractions. In addition, all quotes included in this research are freely translated from Dutch to English. Even though this translation is done as good as it gets, information in the original language could be lost while translating. The third and last factor which has an influence on the reliability of the results is the nature of systematic literature reviews. Because the body of articles is limited to the search keys defined by the researcher, the selection of articles could differ per study. This limitation is tried to overcome by validating the search keys beforehand by experts, and including also 'snowball' and 'extra search' articles.

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APPENDIX A: CLINICAL PATHWAY CHEST PAIN

This appendix shows a visual example of clinical pathway for people with chest pain used in the medical center in Alkmaar. Not all clinical pathways are shown in figures, also written text is used a lot to capture clinical pathways.

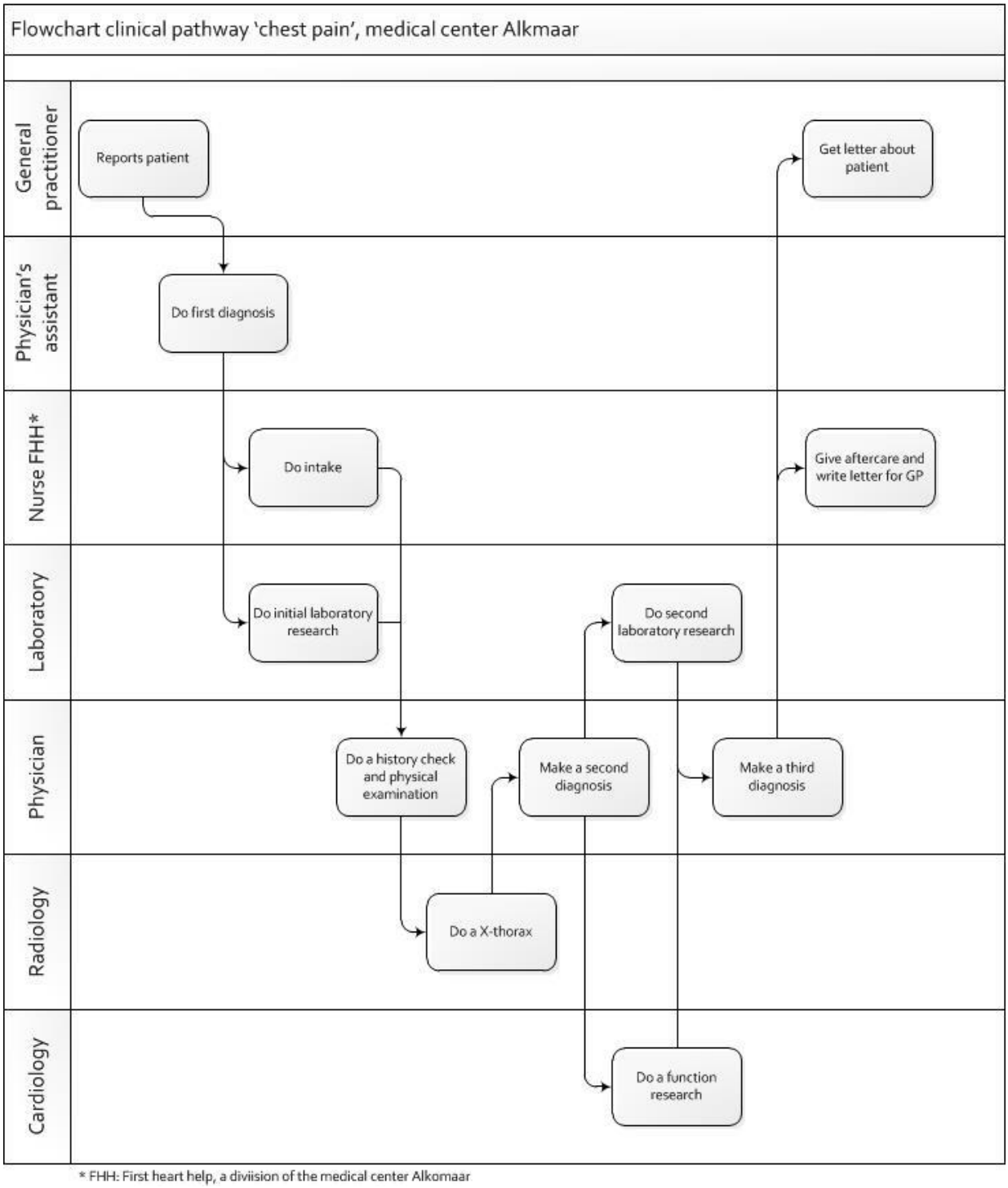

FIGURE 69: FLOWCHART CP CHEST PAIN. ADOPTED FROM HUISKES AND SCHRIJVERS (2010)

APPENDIX B: ORIGINAL PRISMA FLOW DIAGRAM

This appendix shows the original PRISMA flow diagram, which serves as a basis for the SLR method used in this study.

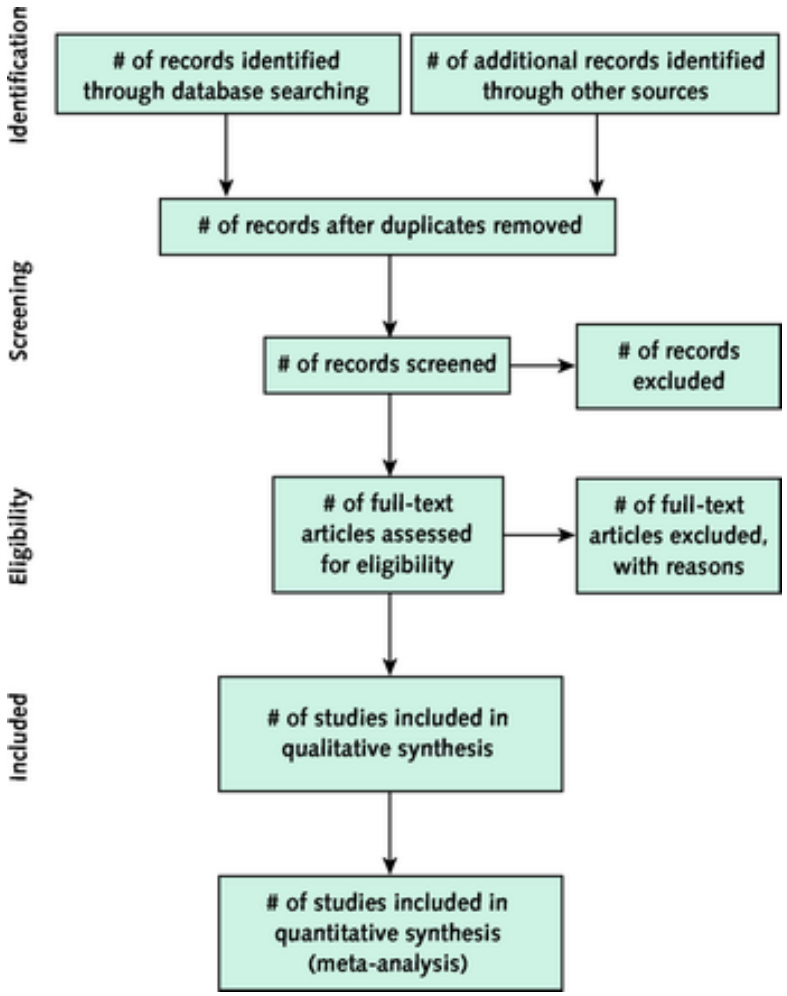

FIGURE 70: ORIGINAL PRISMA STATEMENT. REPRINTED FROM PRISMA STATEMENT (N.D.)

APPENDIX C: ORIGINAL TAM QUESTIONS

This appendix shows the original TAM questions from Wu, Fu, and li (2011). A translated and adjusted version of these questions are used for the surveys in this study.

Part I
Basic information Type of hospital: □Medical center □Regional hospital □Local hospital
Bed size: □<500 □500–1000 □1000–1500 □>1500
Position: □Physician □Nurse
Gender: □Female □Male
Work experience: □<5 years □5–15 years □15–25 years □>25 years
Education level: □High school □College □Graduate □M.D.
Age: □<30 years old □30–40 years old □40–50 years old □>50 years old

Part II
Perceived usefulness
PU1 Using mobile devices for wireless healthcare would improve my work performance.
PU2 Using mobile devices for wireless healthcare would improve my work productivity.
PU3 Using mobile devices for wireless healthcare would enhance my work effectiveness.
PU4 I find mobile devices for wireless healthcare to be useful in my job.

Perceived ease of use
PEOU1 My interaction with mobile devices for wireless healthcare is clear and understandable.
PEOU2 My interaction with mobile devices for wireless healthcare does not require a lot of mental effort.
PEOU3 It is easy to get mobile devices for wireless healthcare to do what I want it to do.
PEOU4 It is easy to use mobile devices for wireless healthcare.

Attitude
ATT1 Using mobile devices for wireless healthcare would be a good idea.
ATT2 Using mobile devices for wireless healthcare would be a wise idea.
ATT3 I like the idea of using mobile devices for wireless healthcare.
ATT4 Using mobile devices for wireless healthcare would be a pleasant experience.

Perceived behavior control
PBC1 I would be able to use mobile devices for wireless healthcare well for my job.
PBC2 Using mobile devices for wireless healthcare are entirely within my control.
PBC3 I had the resources, knowledge and ability to use mobile devices for wireless healthcare.

Subjective norm
SN1 People who are important to me would think that I should use mobile devices for wireless healthcare.
SN2 People who influence me would think that I should use mobile devices for wireless healthcare.
SN3 People whose opinions are valued to me would prefer that I should use mobile devices for wireless healthcare.

Behavioral intention
BI1 Assuming I have access to mobile devices for wireless healthcare, I intend to use it.
BI2 Given that I have access to mobile devices for wireless healthcare, I predict that I would use it.
BI3 If I have access to mobile devices for wireless healthcare, I want to use it as much as possible.

Personal innovativeness in IT
PIIT1 If I heard about a new information technology, I would look for ways to experiment with it.
PIIT2 Among my peers, I am usually the first to try out new information technologies.
PIIT3 In general, I am not hesitant to try out new information technologies.
PIIT4 I like to experiment with new information technologies.

Perceived service availability
PSA1 I would be able to use mobile devices for wireless healthcare at anytime, from anywhere.
PSA2 I would find mobile devices for wireless healthcare easily accessible and portable.
PSA3 Mobile devices for wireless healthcare would be available to use whenever I need it.

APPENDIX D: SLR SEARCH KEYS

In this appendix the SLR search keys are shown. First the search keys as inserted in Google Scholar, then the search keys as inserted in PubMed.

SCHOLAR

For the search keys 1-34 the custom year range is set at '2000 to recent'.

1. "Telemedicine"
2. "Clinical information system" OR "Clinical information systems"
3. "Hospital information system" OR "Hospital information systems"
4. "E-health"

5. "Hospital environment" + "ICT"
6. "Hospital environment" + "Information Technology"
7. "Hospital environment" + "Information system" OR "Information Systems"
8. "Hospital environment" + "System" OR "Systems"
9. "Hospital environment" + "Tool" OR "Tools"

10. "Hospital" + "ICT"
11. "Hospital" + "Information Technology"
12. "Hospital" + "Information system" OR "Information Systems"
13. "Hospital" + "System" OR "Systems"
14. "Hospital" + "Tool" OR "Tools"

15. "Hospital environment" + "Effectiveness" + "ICT"
16. "Hospital environment" + "Effectiveness" + "Information Technology"
17. "Hospital environment" + "Effectiveness" + "Information system" OR "Information Systems"
18. "Hospital environment" + "Effectiveness" + "System" OR "Systems"
19. "Hospital environment" + "Effectiveness" + "Tool" OR "Tools"

20. "Hospital" + "Effectiveness" + "ICT"
21. "Hospital" + "Effectiveness" + "Information Technology"
22. "Hospital" + "Effectiveness" + "Information system" OR "Information Systems"
23. "Hospital" + "Effectiveness" + "System" OR "Systems"
24. "Hospital" + "Effectiveness" + "Tool" OR "Tools"

25. "Hospital environment" + "Added Value" + "ICT"
26. "Hospital environment" + "Added Value" + "Information Technology"
27. "Hospital environment" + "Added Value" + "Information system" OR "Information Systems"
28. "Hospital environment" + "Added Value" + "System" OR "Systems")
29. "Hospital environment" + "Added Value" + "Tool" OR "Tools"

30. "Hospital" + "Added Value" + "ICT"
31. "Hospital" + "Added Value" + "Information Technology"
32. "Hospital" + "Added Value" + "Information system" OR "Information Systems"
33. "Hospital" + "Added Value" + "System" OR "Systems"
34. "Hospital" + "Added Value" + "Tool" OR "Tools"

35. “Clinical pathway” OR “Clinical pathways”
36. “Clinical pathway” OR “Clinical pathways” + “ICT”
37. “Clinical pathway” OR “Clinical pathways” + “Information Technology”
38. “Clinical pathway” OR “Clinical pathways” + “Information system” OR “Information Systems”
39. “Clinical pathway” OR “Clinical pathways” + “System” OR “Systems”
40. “Clinical pathway” OR “Clinical pathways” + “Tool” OR “Tools”
41. “Clinical pathway” OR “Clinical pathways” + “Performance”
42. “Clinical pathway” OR “Clinical pathways” + “Success factors”
43. “Clinical pathway” OR “Clinical pathways” + “Management”

44. “Integrated care pathway” OR “Integrated care pathways”
45. “Integrated care pathway” OR “Integrated care pathways” + “ICT”
46. “Integrated care pathway” OR “Integrated care pathways” + “Information Technology”
47. “Integrated care pathway” OR “Integrated care pathways” + “Information system” OR “Information Systems”
48. “Integrated care pathway” OR “Integrated care pathways” + “System” OR “Systems”
49. “Integrated care pathway” OR “Integrated care pathways” + “Tool” OR “Tools”
50. “Integrated care pathway” OR “Integrated care pathways” + “Performance”
51. “Integrated care pathway” OR “Integrated care pathways” + “Success factors”
52. “Integrated care pathway” OR “Integrated care pathways” + “Management”

53. “Critical pathway” OR “Critical pathways”
54. “Critical pathway” OR “Critical pathways” + “ICT”
55. “Critical pathway” OR “Critical pathways” + “Information Technology”
56. “Critical pathway” OR “Critical pathways” + “Information system” OR “Information Systems”
57. “Critical pathway” OR “Critical pathways” + “System” OR “Systems”
58. “Critical pathway” OR “Critical pathways” + “Tool” OR “Tools”
59. “Critical pathway” OR “Critical pathways” + “Performance”
60. “Critical pathway” OR “Critical pathways” + “Success factors”
61. “Critical pathway” OR “Critical pathways” + “Management”

62. “Care pathway” OR “Care pathways”
63. “Care pathway” OR “Care pathways” + “ICT”
64. “Care pathway” OR “Care pathways” + “Information Technology”
65. “Care pathway” OR “Care pathways” + “Information system” OR “Information Systems”
66. “Care pathway” OR “Care pathways” + “System” OR “Systems”
67. “Care pathway” OR “Care pathways” + “Tool” OR “Tools”
68. “Care pathway” OR “Care pathways” + “Performance”
69. “Care pathway” OR “Care pathways” + “Success factors”
70. “Care pathway” OR “Care pathways” + “Management”

71. “Care map” OR “Care maps”
72. “Care map” OR “Care maps” + “ICT”
73. “Care map” OR “Care maps” + “Information Technology”
74. “Care map” OR “Care maps” + “Information system” OR “Information Systems”
75. “Care map” OR “Care maps” + “System” OR “Systems”
76. “Care map” OR “Care maps” + “Tool” OR “Tools”
77. “Care map” OR “Care maps” + “Performance”
78. “Care map” OR “Care maps” + “Success factors”

79. “Care map” OR “Care maps” + “Management”

PUBMED

1. "Telemedicine" AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])
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3. "Hospital information system"[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31"[PDAT]) OR "Hospital information systems"[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])
4. "E-Health" AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])

5. "Hospital environment"[All Fields] AND "ICT"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31" [PDAT])
6. "Hospital environment"[All Fields] AND "Information Technology" [All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])
7. "Hospital environment"[All Fields] AND "Information system"[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31"[PDAT]) OR “Hospital environment"[All Fields] AND “Information systems”[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])
8. "Hospital environment"[All Fields] AND "system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital environment"[All Fields] AND "systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31" [PDAT])
9. "Hospital environment"[All Fields] AND "tool"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital environment"[All Fields] AND "tools"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])

10. "Hospital"[All Fields] AND "ICT"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
11. "Hospital"[All Fields] AND "Information Technology"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
12. "Hospital"[All Fields] AND "Information system"[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31"[PDAT]) OR “Hospital"[All Fields] AND “Information systems”[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])
13. "Hospital"[All Fields] AND "system"[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31"[PDAT]) OR “Hospital"[All Fields] AND “systems”[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])
14. "Hospital"[All Fields] AND "Tool"[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31"[PDAT]) OR “Hospital"[All Fields] AND “Tools”[All Fields] AND ("2000/01/01" [PDAT] : "3000/12/31" [PDAT])

15. "Hospital environment"[All Fields] AND "Effectiveness"[All Fields] AND "ICT"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
16. "Hospital environment"[All Fields] AND "Effectiveness"[All Fields] AND "Information technology"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
17. "Hospital environment"[All Fields] AND "Effectiveness"[All Fields] AND "Information system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital environment"[All Fields] AND "Effectiveness"[All Fields] AND "Information systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])

18. "Hospital environment"[All Fields] AND "Effectiveness"[All Fields] AND "system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital environment"[All Fields] AND "Effectiveness"[All Fields] AND "systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
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20. "Hospital"[All Fields] AND "Effectiveness"[All Fields] AND "ICT"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
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22. "Hospital"[All Fields] AND "Effectiveness"[All Fields] AND "Information system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital"[All Fields] AND "Effectiveness"[All Fields] AND "Information systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
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28. "Hospital environment"[All Fields] AND "Added value"[All Fields] AND "system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital environment"[All Fields] AND "Added value"[All Fields] AND "systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
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32. "Hospital"[All Fields] AND "Added value"[All Fields] AND "Information system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital"[All Fields] AND "Added value"[All Fields] AND "Information systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])

33. "Hospital"[All Fields] AND "Added value"[All Fields] AND "system"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT]) OR "Hospital"[All Fields] AND "Added value"[All Fields] AND "systems"[All Fields] AND ("2000/01/01"[PDAT] : "3000/12/31"[PDAT])
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37. "Clinical pathway" [All Fields] AND "Information technology" [All Fields] OR "Clinical pathways" [All Fields] AND "Information technology" [All Fields]
38. "Clinical pathway" [All Fields] AND "Information system" [All Fields] OR "Clinical pathway" [All Fields] AND "Information systems" [All Fields] OR "Clinical pathways" [All Fields] AND "Information system" [All Fields] OR "Clinical pathways" [All Fields] AND "Information systems" [All Fields]
39. "Clinical pathway" [All Fields] AND "System" [All Fields] OR "Clinical pathway" [All Fields] AND "Systems" [All Fields] OR "Clinical pathways" [All Fields] AND "System" [All Fields] OR "Clinical pathways" [All Fields] AND "Systems" [All Fields]
40. "Clinical pathway" [All Fields] AND "Tool" [All Fields] OR "Clinical pathway" [All Fields] AND "Tool" [All Fields] OR "Clinical pathways" [All Fields] AND "Tool" [All Fields] OR "Clinical pathways" [All Fields] AND "Tools" [All Fields]
41. "Clinical pathway" [All Fields] AND "Performance" [All Fields] OR "Clinical pathways" [All Fields] AND "Performance" [All Fields]
42. "Clinical pathway" [All Fields] AND "Success factors" [All Fields] OR "Clinical pathways" [All Fields] AND "Success factors" [All Fields]
43. "Clinical pathway" [All Fields] AND "Management" [All Fields] OR "Clinical pathways" [All Fields] AND "Management" [All Fields]

44. "Integrated care pathway" [All Fields] OR "Integrated care pathways" [All Fields]
45. "Integrated care pathway" [All Fields] AND "ICT" [All Fields] OR "Integrated care pathways" [All Fields] AND "ICT" [All Fields]
46. "Integrated care pathway"[All Fields] AND "Information Technology" [All Fields] OR "Integrated care pathways"[All Fields] AND "Information Technology" [All Fields]
47. "Integrated care pathway"[All Fields] AND "Information system"[All Fields] OR "Integrated care pathway"[All Fields] AND "Information systems"[All Fields] OR "Integrated care pathways"[All Fields] AND "Information system"[All Fields] OR "Integrated care pathways"[All Fields] AND "Information systems"[All Fields]
48. "Integrated care pathway"[All Fields] AND "System"[All Fields] OR "Integrated care pathway"[All Fields] AND "Systems"[All Fields] OR "Integrated care pathways"[All Fields] AND "System"[All Fields] OR "Integrated care pathways"[All Fields] AND "Systems"[All Fields]
49. "Integrated care pathway"[All Fields] AND "Tool"[All Fields] OR "Integrated care pathway"[All Fields] AND "Tools"[All Fields] OR "Integrated care pathways"[All Fields] AND "Tool"[All Fields] OR "Integrated care pathways"[All Fields] AND "Tools"[All Fields]
50. "Integrated care pathway"[All Fields] AND "Performance"[All Fields] OR "Integrated care pathways"[All Fields] AND "Performance"[All Fields]

51. "Integrated care pathway"[All Fields] AND "Success factors"[All Fields] OR "Integrated care pathways"[All Fields] AND "Success factors"[All Fields]
52. "Integrated care pathway"[All Fields] AND "Management"[All Fields] OR "Integrated care pathways"[All Fields] AND "Management"[All Fields]

53. "Critical pathway"[All Fields] OR "Critical pathways"[All Fields]
54. "Critical pathway"[All Fields] AND "ICT" [All Fields] OR "Critical pathways"[All Fields] AND "ICT" [All Fields]
55. "Critical pathway"[All Fields] AND "Information technology"[All Fields] OR "Critical pathways"[All Fields] AND "Information technology"[All Fields]
56. "Critical pathway"[All Fields] AND "Information system"[All Fields] OR "Critical pathway"[All Fields] AND "Information systems"[All Fields] OR "Critical pathways"[All Fields] AND "Information system"[All Fields] OR "Critical pathways"[All Fields] AND "Information systems"[All Fields]
57. "Critical pathway"[All Fields] AND "System"[All Fields] OR "Critical pathway"[All Fields] AND "Systems"[All Fields] OR "Critical pathways"[All Fields] AND "System"[All Fields] OR "Critical pathways"[All Fields] AND "Systems"[All Fields]
58. "Critical pathway"[All Fields] AND "Tool"[All Fields] OR "Critical pathway"[All Fields] AND "Tools"[All Fields] OR "Critical pathways"[All Fields] AND "Tool"[All Fields] OR "Critical pathways"[All Fields] AND "Tools"[All Fields]
59. "Critical pathway"[All Fields] AND "Performance"[All Fields] OR "Critical pathways"[All Fields] AND "Performance"[All Fields]
60. "Critical pathway"[All Fields] AND "Success factors"[All Fields] OR "Critical pathways"[All Fields] AND "Success factors" [All Fields]
61. "Critical pathway"[All Fields] AND "Management"[All Fields] OR "Critical pathways"[All Fields] AND "Management" [All Fields]

62. "Care pathway"[All Fields] OR "Care pathways"[All Fields]
63. "Care pathway"[All Fields] AND "ICT"[All Fields] OR "Care pathways"[All Fields] AND "ICT"[All Fields]
64. "Care pathway"[All Fields] AND "Information technology"[All Fields] OR "Care pathways"[All Fields] AND "Information technology"[All Fields]
65. "Care pathway"[All Fields] AND "Information system"[All Fields] OR "Care pathway"[All Fields] AND "Information systems"[All Fields] OR "Care pathways"[All Fields] AND "Information system"[All Fields] OR "Care pathways"[All Fields] AND "Information systems"[All Fields]
66. "Care pathway"[All Fields] AND "System"[All Fields] OR "Care pathway"[All Fields] AND "Systems"[All Fields] OR "Care pathways"[All Fields] AND "System"[All Fields] OR "Care pathways"[All Fields] AND "Systems"[All Fields]
67. "Care pathway"[All Fields] AND "Tool"[All Fields] OR "Care pathway"[All Fields] AND "Tools"[All Fields] OR "Care pathways"[All Fields] AND "Tool"[All Fields] OR "Care pathways"[All Fields] AND "Tools"[All Fields]
68. "Care pathway"[All Fields] AND "Performance"[All Fields] OR "Care pathways"[All Fields] AND "Performance"[All Fields]
69. "Care pathway"[All Fields] AND "Success factors"[All Fields] OR "Care pathways"[All Fields] AND "Success factors"[All Fields]
70. "Care pathway"[All Fields] AND "Management"[All Fields] OR "Care pathways"[All Fields] AND "Management"[All Fields]

71. "Care map"[All Fields] OR "Care maps"[All Fields]

72. "Care map"[All Fields] AND "ICT" [All Fields] OR "Care maps"[All Fields] AND "ICT" [All Fields]
73. "Care map"[All Fields] AND "Information technology"[All Fields] OR "Care maps"[All Fields] AND "Information technology"[All Fields]
74. "Care map"[All Fields] AND "Information System"[All Fields] OR "Care map"[All Fields] AND "Information Systems"[All Fields] OR "Care maps"[All Fields] AND "Information System"[All Fields] OR "Care maps"[All Fields] AND "Information Systems"[All Fields]
75. "Care map"[All Fields] AND "System"[All Fields] OR "Care map"[All Fields] AND "Systems"[All Fields] OR "Care maps"[All Fields] AND "System"[All Fields] OR "Care maps"[All Fields] AND "Systems"[All Fields]
76. "Care map"[All Fields] AND "Tool"[All Fields] OR "Care map"[All Fields] AND "Tools"[All Fields] OR "Care maps"[All Fields] AND "Tool"[All Fields] OR "Care maps"[All Fields] AND "Tools"[All Fields]
77. "Care map"[All Fields] AND "Performance"[All Fields] OR "Care maps"[All Fields] AND "Performance"[All Fields]
78. "Care map"[All Fields] AND "Success factors"[All Fields] OR "Care maps"[All Fields] AND "Success factors"[All Fields]
79. "Care map"[All Fields] AND "Management"[All Fields] OR "Care maps"[All Fields] AND "Management"[All Fields]

APPENDIX E: NUMBERS PER SEARCH KEY

The table in this appendix is divided over two sides, the Google Scholar results, and the PubMed results. The first column shown the number of results (i.e. hits) these search engines found for a particular search key. For every search key the first x-number of results are scanned. The second column shows the exact number of those scanned articles. The third and last column shows how many of those scanned articles are marked as potentially relevant. On the last row of the table the total numbers the number of hits, scanned articles, and potentially relevant articles per search engine can be found.

TABLE 31: NUMBERS PER SEARCH KEY

	Scholar			**PubMed**		
	Hits	Scanned	Potentially Relevant	Hits	Scanned	Potentially Relevant
Telemedicine	57,300	200	12	12,321	100	1
Clinical information system(s)	1,630,000	100	3	974	100	0
Hospital information system(s)	16,000	100	4	5,706	100	0
E-health	71,700	100	3	1,624	100	0
Hospital environment + ICT	1,210	100	11	3	3	0
Hospital environment + Information technology	4,350	100	2	10	10	0
Hospital environment + Information system(s)	5,770	100	1	35	35	2
Hospital environment + System(s)	23,100	100	2	147	100	1
Hospital environment + Tool(s)	15,700	50	-	27	27	0
Hospital + ICT	64,000	100	2	502	100	1
Hospital + Information technology	152,000	100	6	2,130	100	1
Hospital + Information system(s)	18,500	100	4	9,188	100	0
Hospital + System(s)	1,560,000	100	1	64,595	100	0
Hospital + Tool(s)	1,740,000	50	-	17,389	100	0
Hospital environment + Effectiveness + ICT	589	100	4	1	1	0
Hospital environment + Effectiveness + Information technology	2,180	100	4	0	0	0
Hospital environment + Effectiveness + Information system(s)	2,660	100	3	3	3	1
Hospital environment + Effectiveness + System(s)	14,800	100	2	9	9	1
Hospital environment + Effectiveness + Tool(s)	11,200	50	0	3	3	0

	Scholar			PubMed		
	Hits	Scanned	Potentially Relevant	Hits	Scanned	Potentially Relevant
Hospital + Effectiveness + ICT	17,800	100	1	23	23	0
Hospital + Effectiveness + Information technology	38,000	100	5	132	100	2
Hospital + Effectiveness + Information system(s)	18,100	100	0	306	100	1
Hospital + Effectiveness + System(s)	1,460,000	100	0	2,445	100	0
Hospital + Effectiveness + Tool(s)	1,180,000	50	0	737	100	0
Hospital environment + Added value + ICT	107	107	1	0	0	0
Hospital environment + Added value + Information technology	215	100	2	0	0	0
Hospital environment + Added value + Information system(s)	243	100	2	0	0	0
Hospital environment + Added value + System(s)	678	100	2	0	0	0
Hospital environment + Added value + Tool(s)	565	100	2	0	0	0
Hospital + Added value + ICT	3,560	100	1	0	0	0
Hospital + Added value + Information technology	6,700	100	2	5	5	1
Hospital + Added value + Information system(s)	7,870	100	1	14	14	1
Hospital + Added value + System(s)	20,200	100	0	72	72	1
Hospital + Added value + Tool(s)	19,300	100	0	26	26	0
Clinical pathway	17,900	200	27	2,148	100	4
Clinical pathway + ICT	745	100	9	4	4	0
Clinical pathway + Information technology	3,530	100	20	18	18	4
Clinical pathway + Information system(s)	5,800	100	12	45	45	9
Clinical pathway + System(s)	17,000	100	26	224	100	7
Clinical pathway + Tool(s)	17,200	100	23	117	100	7
Clinical pathway + Performance	15,500	100	13	118	100	6
Clinical pathway + Success factors	603	100	10	2	2	0
Clinical pathway + Management	17,500	100	10	828	100	3
Integrated care pathway	6,420	100	25	234	100	3
Integrated care pathway + ICT	269	100	4	1	1	0
Integrated care pathway + Information technology	758	100	8	2	2	0

	Scholar			PubMed		
	Hits	Scanned	Potentially Relevant	Hits	Scanned	Potentially Relevant
Integrated care pathway + Information system(s)	945	100	8	2	2	1
Integrated care pathway + System(s)	4,890	100	6	18	18	3
Integrated care pathway + Tool(s)	4,110	100	14	11	11	3
Integrated care pathway + Performance	2,830	100	4	11	11	0
Integrated care pathway + Success factors	169	100	8	1	1	0
Integrated care pathway + Management	5,440	100	9	100	100	7
Critical pathway	17,800	100	4	5,686	100	2
Critical pathway + ICT	293	100	6	1	1	0
Critical pathway + Information technology	1,330	100	6	21	21	0
Critical pathway + Information system(s)	2,680	100	4	135	100	8
Critical pathway + System(s)	17,100	100	3	537	100	2
Critical pathway + Tool(s)	14,500	100	8	231	100	4
Critical pathway + Performance	9,650	100	2	195	100	4
Critical pathway + Success factors	222	100	10	2	2	2
Critical pathway + Management	15,800	100	12	1,968	100	2
Care pathway	17,400	100	17	1,908	100	0
Care pathway + ICT	1,140	100	8	7	7	1
Care pathway + Information technology	3,610	100	12	9	9	0
Care pathway + Information system(s)	4,840	100	4	18	18	1
Care pathway + System(s)	17,300	100	12	141	100	4
Care pathway + Tool(s)	17,000	100	25	66	66	6
Care pathway + Performance	15,700	100	11	82	82	1
Care pathway + Success factors	621	100	10	2	2	0
Care pathway + Management	17,300	100	14	663	100	0
Care Maps	3,560	100	2	100	100	3
Care Maps + ICT	66	66	6	0	0	0
Care Maps + Information technology	350	100	6	2	2	0
Care Maps + Information system(s)	620	100	1	3	3	0
Care Maps + System(s)	2,930	100	1	11	11	0
Care Maps + Tool(s)	2,230	100	5	7	7	0

	Scholar			PubMed		
	Hits	Scanned	Potentially Relevant	Hits	Scanned	Potentially Relevant
Care Maps + Performance	1,580	100	1	4	4	0
Care Maps + Success factors	51	51	5	0	0	0
Care Maps + Management	2,270	100	4	38	38	2
Total	**8,473,949**	**7,824**	**517**	**134,148**	**3,719**	**113**

APPENDIX F: SLR RESULTS

In this appendix the SLR results are shown. Figure 11 in Chapter 3 already shows the total number of articles included in this research. The figures included in this appendix show how these results are divided over the subquestions they answer. Figure 71 shows the results for subquestion 1 and Figure 72 shows the result for subquestions 2, 3, and 4. These last three subquestions are shown in the same figure since the search keys and articles used to answer these questions overlap.

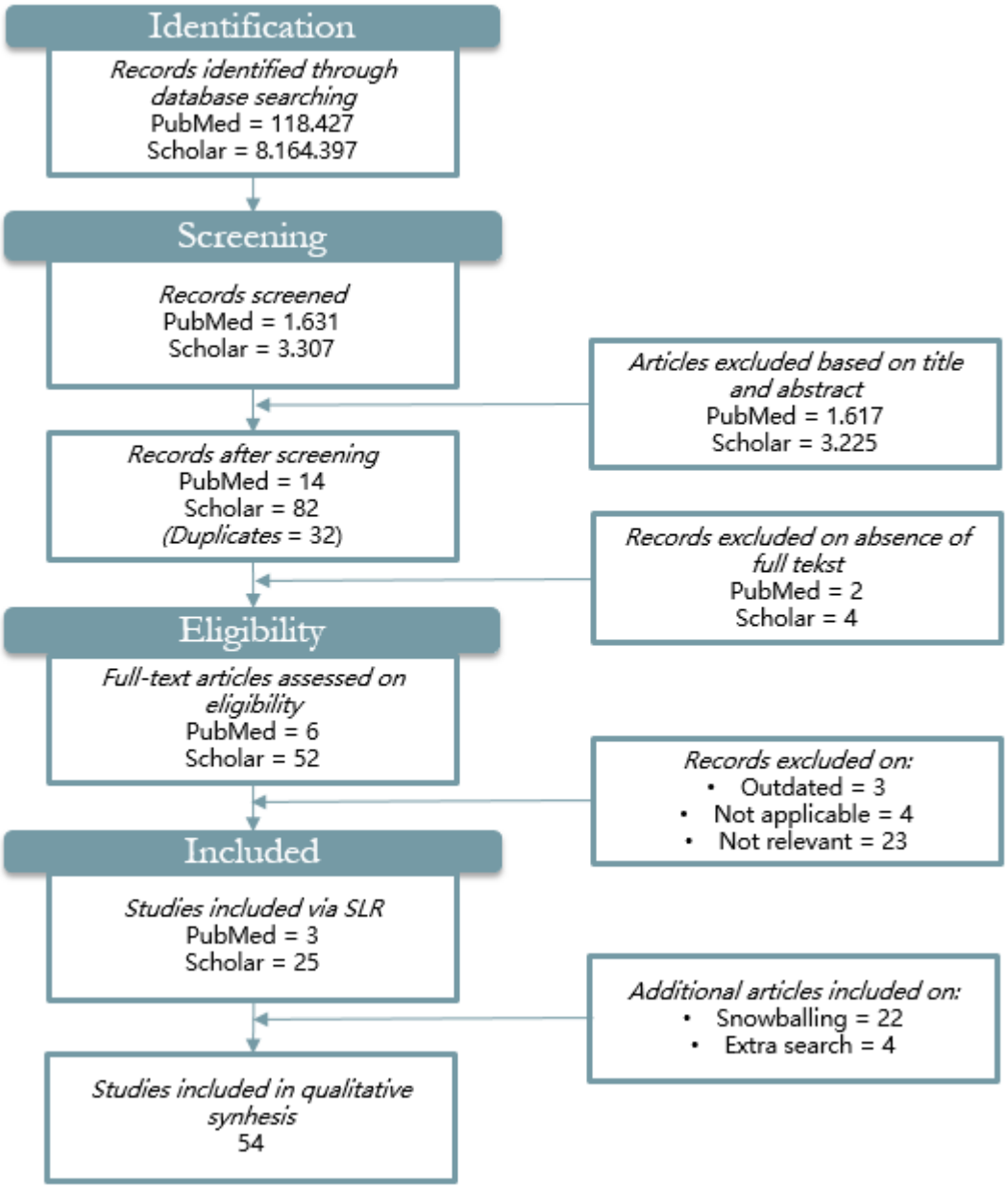

FIGURE 71: SLR RESULTS 1

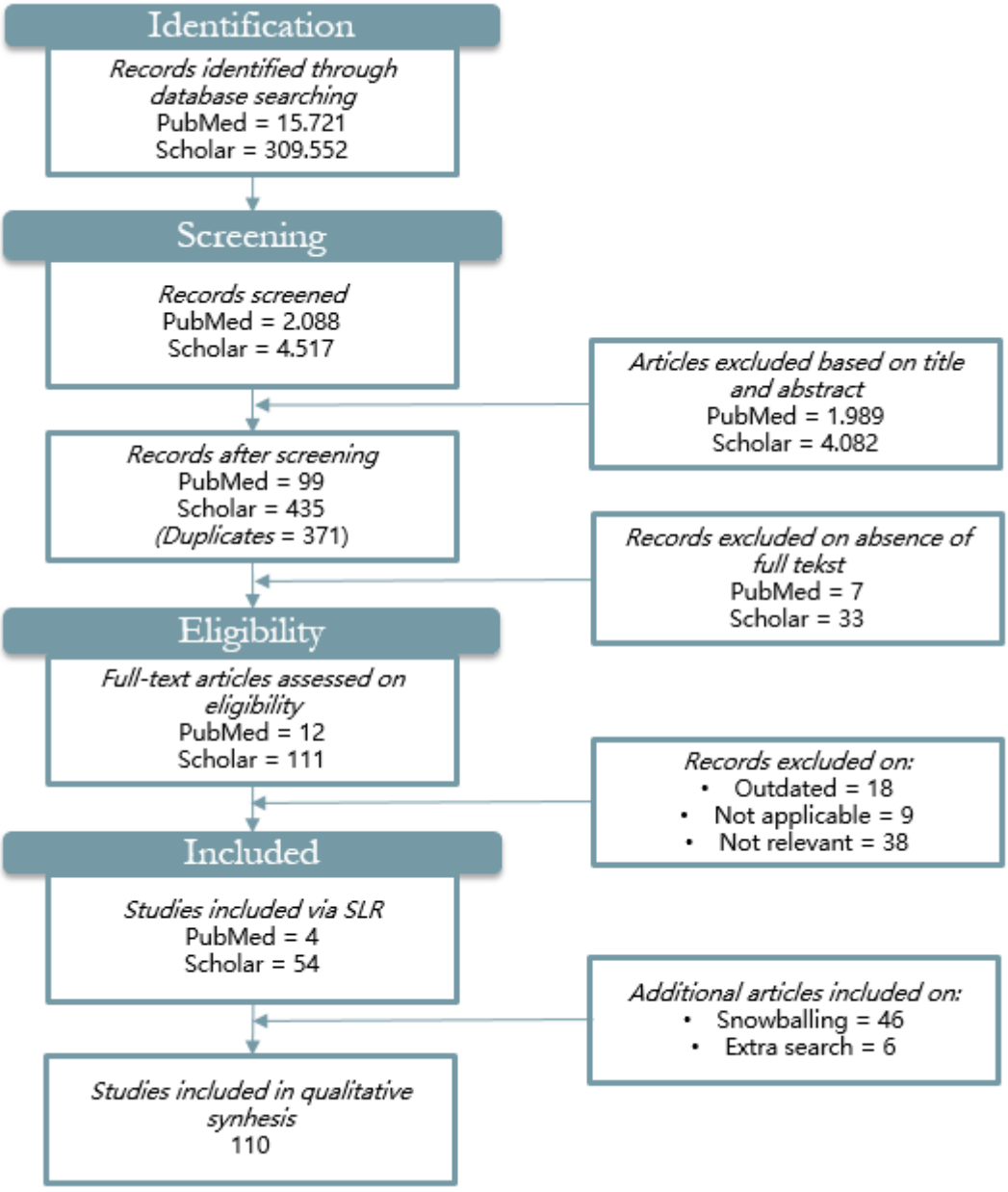

FIGURE 72: SLR RESULTS 2, 3, 4

APPENDIX G: DOMAIN REFERENCE MODEL HOSPITALS OF I-ZIEKENHUIS

This appendix shows the domain reference model hospital of i-Ziekenhuis which is used by the UMCU to map their own systems.

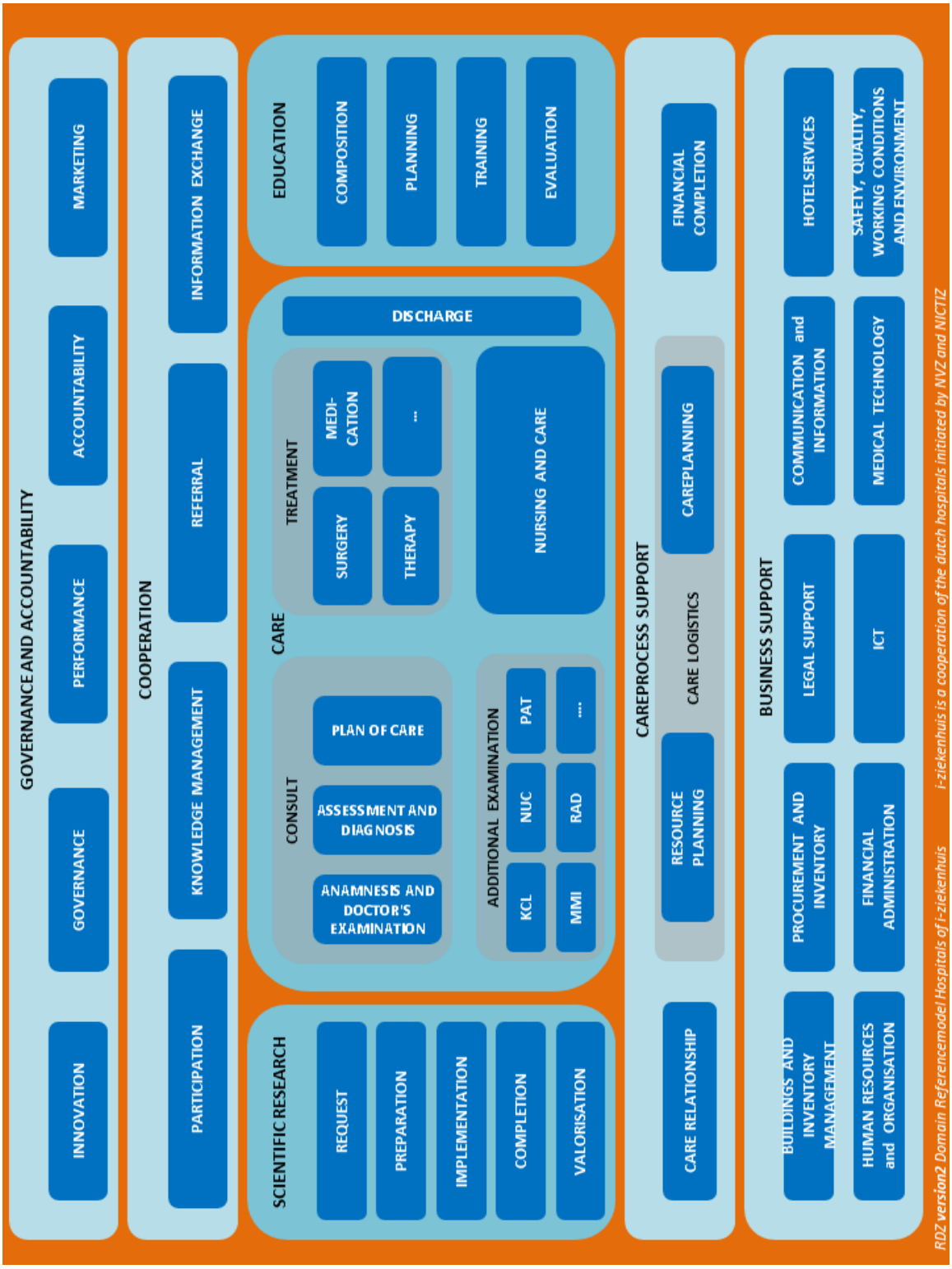

FIGURE 73: DOMAIN REFERENCE MODEL HOSPITALS OF I-ZIEKENHUIS

APPENDIX H: SYSTEMS AT THE UMCU

This appendix shows the most used systems at the UMCU, excluding the four overarching systems in use (i.e. MyUMC, SAP, EZIS, and Ultimo) which are discussed in Section 6.1. Where these systems can be placed in the domain reference model of i-Ziekenhuis can be found in Figure 22.

- **BI**: This element consists of several Business Intelligence (BI) components, which together serve as the BI platform of the UMCU. It support the performance of the hospital, by giving the organization the data which leads to the information and ultimately knowledge that gives them insight about their performance. Due to this insight, (clinical) improvements can be made.
- **METC**: The METC, which stands for Medische Etische Toetsingscommissie (translates to Medical Ethics Review Committee) is an independent committee which has the authority to judge research proposals, based on the law for scientific medical research. They have a software system, also named METC, which supports the members in their task.
- **Research online**: This web based electronic data capture system is used and developed by the Julius Center for Health Sciences & Primary Care. It offers researchers secure websites, which can be tailored to the study specific workflow which enables easier questionnaire management for research staff and participants.
- **LMS**: For certain types of medical research patient tissue is required. The Laboratory Management System (LMS) of the UMCU serves as the electronic database for the physical biobank. The LMS enables medical researchers to find the appropriate tissue samples for their study.
- **Pure**: Pure serves as the UMCU's Research Information System. It facilitates their evidence-based approach to research, among others by providing insight in the amount of publications per medical researcher and the impact of the journals they are published in.
- **RDP**: The Research Data Platform (RDP) is developed by the UMCU to collect and integrate research data from many different sources. Due to this software program researchers can more easily find their required data in the RDP data warehouse.
- **Allgeier**: Allgeier is a digital medical archive. After the UMC switched from paper filling to electronic filling, all old files had to be scanned and digitalized. All digital versions of these paper files can be found in Allgeier.
- **Helix**: This systems supports the healthcare professionals who work with biomedical genetics, to conduct genetic research and counseling. In addition also patient files can be found in this system. Summaries and conclusions constructed by Helix are made available in EZIS.
- **Triasus**: Triasus is a web based information management system which focusses on stem cell transplantation. Hematology and pathology results for these stem cell transplantations are saved in this system. It enables searching for the right donor across multiple hospitals due to Triasus' link with Europdonor; the Dutch foundation that ensues that patients with leukemia and other types of blood disorders receive a transplantation of stem cell from healthy donors.
- **Diamant**: This software package supports healthcare professionals who work with patients who need dialyses. Things like dialysis prescriptions, planning, medication, nursing plans,

reports, data export, and machine confections are supported by Diamant. Diamant is shown twice in Figure 23, since it helps in the areas of care planning, pathology, surgery, therapy, as well as medication.

- **PDMS MV**: The UMCU's Patient Data Management System (PDMS) of MetaVision serves as an addition to the EPD functions in EZIS. In PDMS MV all patient data can be integrated. The system is often used by complex intensive care, high care, or medium care patients. As opposed to the EPD, the PDMS can handle data from all kinds of monitors, like ventilators or infusion pumps.
- **4KP**: 4KP supports the anesthesia program, by electronically processing the data from a patient monitor and anesthesia reports. During surgery all relevant data (e.g. ECG waveforms, pressure waveforms, and capnography waveforms) are stored and showed in this system.
- **Cato**: Cato is comprehensive software product that support all phases of chemotherapy, except for the processes where therapy relevant decisions have to be made. It helps healthcare professionals with therapy planning, online ordering, preparation, and administration. By for example providing software to work with the electronic scales which are used to measure the amount of chemo.
- **Edumanager**: Healthcare professionals at the UMCU have the opportunity to follow electronic learning modules. Edumanager handles the subscriptions and access to these electronic learning modules. After completing a specific learning module, UMCU employees get an accreditation for that particular subject.
- **Blackboard**: This is the electronic learning environment of the UU, which is therefore also used by the students at the UMCU. Blackboard is used for an array of processes (e.g. contact between the professors and students, student specific course lists, alerts, and to do lists) and it contains electronic learning modules and electronic lectures.
- **TestVision**: TestVision is an electronic test/exam system, and supports the UMCU with their e-assessments.
- **Evasys**: This is an online evaluation system. It is used to send electronic forms to teachers or other involved people.
- **Osiris**: Osiris is the student administration system where all study results (including certificates and diplomas) are kept. Students can register for (non-electronic) courses and retrieve individual schedules and results.
- **KVO Digitaal Inschrijven**: Klinisch Vaardigheids Onderwijs (KVO) Digitaal inschrijven is the digital registration for clinical skill education. As a part of some courses, students have to practice their clinical skills in real life. They have to register in a separate system for this, since Osiris only handles the course registrations and is not linked to the schedules of healthcare professional or patient data.
- **Cerberus**: This is the planning program for clinical internships the UMCU uses for her students. It provides the schedulers with detailed information about available spots and students who want to start their internships.
- **Syllabus+**: Syllabus+ is a planning systems which supports the whole UU with timetabling their classrooms and other teaching facilities.

- **AVMS**: When a student becomes a 'Specialist Registrar' (i.e. a doctor to be) he/she has to do specific procedures (e.g. cecum operation, Alzheimer diagnosis, applying an orthopedic cast) a number of times, before he/she can become a 'full doctor'. AVMS keeps track of the number of procedures a Specialist Registrar has performed, to which department/procedure the Specialist Registrar has to go next, and which departments have a spot for Specialist Registrars.
- **Monaco**: Monaco is a software program which supports the UMCU with their employee planning.
- **ARTA**: This software program specializes in transportation orders within and between hospitals. Transportation orders can relate to patients as well as resources.
- **Nordined**: Nordined helps the UMCU with its computer-aided design (CAD) tasks in 2D as well as 3D graphics. These technical drawings are used for the building plans of the UMCU in order to show for example where the power lines are.
- **TOPdesk**: TOPdesk's systems supports the UMCU in its change and incident management. Wherever something brakes down, all incidents are registered in a single location, which makes it easier for the DIT to handle all incidents and changes.

APPENDIX I: SURVEYS

This appendix consist of the three different versions of the survey used in this study.

PRETEST - VASCULAR SURGERY AND PEDIATRIC PULMONARY

This pretest is for the department of pediatric pulmonology and the department of vascular surgery.

Enquête Check-It

Beste toekomstige Check-It gebruiker,

Deze enquête is onderdeel van een onderzoek naar Check-It, het systeem voor zorgpad ondersteuning die jullie binnenkort gaan gebruiken.

De onderstaande vragenlijst zal bestaan uit vier verschillende delen. De eerste sectie zal vragen naar persoonlijke informatie. De tweede sectie zal gaan over de huidige situatie, terwijl sectie drie gaat over de toekomstige situatie. Deze enquête sluit met enkele vragen over uw affiniteit met ICT. Het is van belang voor het onderzoek **alle vragen** te beantwoorden.

De gegevens zullen anoniem en vertrouwelijk worden behandeld.

Vragen en/of opmerkingen met betrekking tot deze enquête of in het algemeen over het onderzoek naar Check-It kunt u onderaan dit formulier kwijt of mailen naar M.F.Aarnoutse@umcutrecht.nl .

Hartelijk dank voor uw medewerking,
Floor Aarnoutse

Opmerkingen

.....

.....

.....

.....

Persoonlijke informatie

Naam .....

Geslacht:	☐ Man	☐ Vrouw			
Divisie:	☐ Kinder CF	☐ Vaat			
Werkervaring:	☐ < 5 jaar	☐ 5 – 15 jaar	☐ 15 – 25 jaar	☐ > 25 jaar	
Leeftijd:	☐ < 20	☐ 20 – 30	☐ 30 – 40	☐ 40 – 50	☐ >50
Opleidingsniveau:	☐ MBO	☐HBO	☐WO	☐ Anders namelijk, ...	

Functie:.....

Huidige situatie

De onderstaande vragen zijn geformuleerd aan de hand van de doelstellingen van Check-It en zullen ingaan op de huidige situatie waarin u vindt dat uw afdeling zich bevindt. Bij elke vraag staat de schaal waarop de vragen beantwoord kunnen worden. Graag één vakje per vraag aankruisen.

Hoe lang doet u ongeveer aan spreekuur voorbereiding?
Hiermee wordt bedoeld het opzoeken welke patiënten die dag komen, wat er voor die patiënten moet gebeuren, wat er al gedaan is etc.

☐ n.v.t ☐ 0-30 min. ☐ 30-60 min ☐ 1-1,5 uur ☐ 1,5-2 uur ☐ >2 uur

Wat voor cijfer zou u uw afdeling (= vaatchirugie) geven voor:

	1	2	3	4	5	6	7	8	9	10
Het werken volgens protocol?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Voor het monitoren van protocollair werken?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Voor efficiënt werken?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Het gemak van dossiervoering?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

De volgende vragen zijn op basis van een vijfpunts-schaal. Hierbij gelden de volgende waarden:

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

Deze schaal zal als geheugensteuntje op elke bladzijde herhaald worden.

In hoeverre bent u het (on)eens met de volgende stellingen?

	1	2	3	4	5
Ik spreek collega's er wel eens op aan dat zij niet volgens het protocol werken	☐	☐	☐	☐	☐
Ik word er wel eens op aangesproken dat ik niet volgens protocol werk	☐	☐	☐	☐	☐
Ik vind protocollair werken van belang	☐	☐	☐	☐	☐
Ik vind het gemakkelijk te monitoren dat anderen volgens het protocol werken	☐	☐	☐	☐	☐
Ik vind het gemakkelijk te monitoren dat ik zelf volgens het protocol werk	☐	☐	☐	☐	☐
Ik verwacht dat Check-It zorgt dat ik beter volgens protocol werk	☐	☐	☐	☐	☐
Ik verwacht dat Check-It zorgt dat het monitoren van protocollair werken makkelijker wordt	☐	☐	☐	☐	☐

In hoeverre bent u het (on)eens met de volgende stellingen?

	1	2	3	4	5
Ik vind dat ik nu efficiënt werk	☐	☐	☐	☐	☐
Ik vind dossiervoering nu gemakkelijk	☐	☐	☐	☐	☐
Ik verwacht dat Check-It zorgt dat ik efficiënter ga werken/tijd bespaar	☐	☐	☐	☐	☐
Ik verwacht dat Check-It dossiervoering vergemakkelijkt	☐	☐	☐	☐	☐

Verwachtingen

De onderstaande vragen zijn geformuleerd aan de hand van het technology acceptance model en zullen ingaan op de verwachte situatie waarin u denkt dat uw afdeling zich bevindt **ná invoering van Check-It**. Achter elke vraag staat de schaal waarop de vragen beantwoord kunnen worden. Graag één vakje per vraag aankruisen.

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

Ik verwacht dat…

	1	2	3	4	5
Het gebruik van Check-It de uitvoering van mijn werk zal verbeteren	☐	☐	☐	☐	☐
Het gebruik van Check-It mijn productiviteit op werk zal verbeteren	☐	☐	☐	☐	☐
Het gebruik van Check-It mijn effectiviteit op werk zal verbeteren	☐	☐	☐	☐	☐
Check-It nuttig/bruikbaar zal zijn voor mijn werkzaamheden	☐	☐	☐	☐	☐
Mijn interactie met Check-It duidelijk en begrijpelijk zal zijn	☐	☐	☐	☐	☐
Mijn interactie met Check-It niet veel mentale inspanning zal vergen	☐	☐	☐	☐	☐
Het makkelijk is om Check-It te laten doen wat ik wil	☐	☐	☐	☐	☐

In hoeverre ben je het (on)eens met de volgende stellingen:

	1	2	3	4	5
Ik denk dat het gebruiken van Check-It een goed idee is	☐	☐	☐	☐	☐
Ik denk dat het gebruiken van Check-It een verstandig idee is	☐	☐	☐	☐	☐
Ik denk dat het gebruik van Checkt-It prettig zal zijn	☐	☐	☐	☐	☐
Mensen die belangrijk voor mij zijn vinden dat ik Check-It zou moeten gebruiken	☐	☐	☐	☐	☐
Mensen die mij beïnvloeden vinden dat ik Check-It zou moeten gebruiken	☐	☐	☐	☐	☐
Mensen wiens meningen ik waardeer vinden dat ik Check-It zou moeten gebruiken	☐	☐	☐	☐	☐
Wanneer ik toegang heb tot Check-It, wil ik de tool zo veel mogelijk gebruiken	☐	☐	☐	☐	☐

Ik denk dat ik…

	1	2	3	4	5
Check-It goed kan gebruiken voor mijn werkzaamheden	☐	☐	☐	☐	☐
Over het gebruik van Check-It totale controle heb	☐	☐	☐	☐	☐
De kennis, mogelijkheid, en bronnen heb om Check-It te gebruiken	☐	☐	☐	☐	☐
Ongeacht op welke computer ik inlog, overal toegang heb tot Check-It	☐	☐	☐	☐	☐

Computer vaardigheden

De onderstaande vragen zijn geformuleerd aan de hand van het technology acceptance model en zullen ingaan op uw affiniteit met IT. Achter elke vraag staat de schaal waarop de vragen beantwoord kunnen worden. Graag één vakje per vraag aankruisen.

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

	1	2	3	4	5
Als ik hoor over nieuwe technologieën, kijk ik of ik er mee kan experimenteren	☐	☐	☐	☐	☐
In mijn vriendengroep ben ik meestal degene die nieuwe technologieën als eerste probeert	☐	☐	☐	☐	☐
Over het algemeen aarzel ik niet om nieuwe technologieën te proberen	☐	☐	☐	☐	☐
Ik vind het leuk om te experimenteren met nieuwe technologieën	☐	☐	☐	☐	☐
Ik kan goed overweg met een computer	☐	☐	☐	☐	☐

Hartelijk dank voor uw medewerking. Graag benader ik u nogmaals over een maand, voor een nieuwe enquête, na uw eerste gebruik van Check-It in de praktijk.

Als u interesse hebt in de uitkomsten van dit onderzoek vult u dan hieronder uw e-mailadres in. Naar verwachting loopt dit onderzoek in juli 2015 af.

Email adres: .....

POSTTEST 1 & 2 - VASCULAR SURGERY AND PEDIATRIC PULMONOLOGY

This posttest is for the department of pediatric pulmonology and the department of vascular surgery

Enquête Check-It

Beste Check-It gebruiker,

Deze enquête is onderdeel van een onderzoek naar Check-It, het systeem voor zorgpad ondersteuning die jullie inmiddels twee maanden gebruiken.

De onderstaande vragenlijst zal bestaan uit twee delen. De eerste sectie zal gaan over de algemene huidige situatie, terwijl sectie twee gaat over de huidige situatie m.b.t. Check-It patiënten. Het is van belang voor het onderzoek alle vragen te beantwoorden.

De gegevens zullen anoniem en vertrouwelijk worden behandeld.

Vragen en/of opmerkingen met betrekking tot deze enquête of in het algemeen over het onderzoek naar Check-It kunt u onderaan dit formulier kwijt of mailen naar M.F.Aarnoutse@umcutrecht.nl .

Hartelijk dank voor uw medewerking,
Floor Aarnoutse

Opmerkingen

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Persoonlijke informatie

Naam .....

Functie: .....

Huidige situatie (na invoering van Check-It)

De onderstaande vragen zijn geformuleerd aan de hand van de doelstellingen van Check-It en zullen ingaan op de huidige situatie waarin u vind dat uw afdeling zich bevindt. Bij elke vraag staat de schaal waarop de vragen beantwoord kunnen worden. Graag één vakje per vraag aankruisen.

Voor hoeveel patiënten heeft u ongeveer met Check-It gewerkt?

☐ 0 ☐ 1-5 ☐ 5-10 ☐ 10-20 ☐ 20-30 ☐ >30

Hoe lang doet u ongeveer aan spreekuur voorbereiding?
Hiermee wordt bedoeld het opzoeken welke patiënten die dag komen, wat er voor die patiënten moet *gebeuren, wat er al gedaan is etc.*

☐ n.v.t ☐ 0-30 min. ☐ 30-60 min ☐ 1-1,5 uur ☐ 1,5-2 uur ☐ >2 uur

Heeft Check-It volgens u invloed gehad op de duur van de spreekuur voorbereiding?

☐ n.v.t ☐ Ja ☐Nee

Wat voor cijfer zou u uw afdeling (= kinderlongziekten) geven voor:

	1	2	3	4	5	6	7	8	9	10
Het werken volgens protocol?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Voor het monitoren van protocollair werken?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Voor efficiënt werken?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Het gemak van dossiervoering?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Wat is de mate van verandering binnen jullie afdelingen door invoering van Check-It voor:

Helemaal niet veranderd	1	2	3	4	5	*Heel erg veranderd*
Het werken volgens protocol?	☐	☐	☐	☐	☐	
Voor het monitoren van protocollair werken?	☐	☐	☐	☐	☐	
Voor efficiënt werken?	☐	☐	☐	☐	☐	
Het gemak van dossiervoering?	☐	☐	☐	☐	☐	

Z.O.Z. ⟶

De volgende vragen zijn op basis van een vijfpunts-schaal. Hierbij gelden de volgende waarden:

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

Deze schaal zal als geheugensteuntje op elke bladzijde herhaald worden.

In hoeverre bent u het (on)eens met de volgende stellingen?

	1	2	3	4	5
Ik spreek sinds de invoering van Check-It collega's er vaker op aan dat zij niet volgens het protocol werken	☐	☐	☐	☐	☐
Ik word sinds de invoering van Check-It er wel eens op aangesproken dat ik niet volgens protocol werk	☐	☐	☐	☐	☐
Ik vind het sinds de invoering van Check-It gemakkelijk te monitoren dat anderen volgens het protocol werken	☐	☐	☐	☐	☐
Ik vind het sinds de invoering van Check-It gemakkelijk te monitoren dat ik zelf volgens het protocol werk	☐	☐	☐	☐	☐

In hoeverre bent u het (on)eens met de volgende stellingen:

	1	2	3	4	5
Ik vind dat het gebruiken van Check-It een goed idee is	☐	☐	☐	☐	☐
Ik vind dat het gebruiken van Check-It een verstandig idee is	☐	☐	☐	☐	☐
Ik vind dat het gebruik van Checkt-It prettig is	☐	☐	☐	☐	☐
Mensen die belangrijk voor mij zijn vinden dat ik Check-It moet gebruiken	☐	☐	☐	☐	☐
Mensen die mij beïnvloeden vinden dat ik Check-It moet gebruiken	☐	☐	☐	☐	☐
Mensen wiens meningen ik waardeer vinden dat ik Check-It moet gebruiken	☐	☐	☐	☐	☐
Als het mogelijk is, wil ik de Check-It zo veel mogelijk gebruiken	☐	☐	☐	☐	☐

	1	2	3	4	5
Ik kan Check-It goed gebruiken voor mijn werkzaamheden	☐	☐	☐	☐	☐
Ik heb over over het gebruik van Check-It totale controle	☐	☐	☐	☐	☐
Ik heb de kennis, mogelijkheid, en bronnen heb om Check-It goed te gebruiken	☐	☐	☐	☐	☐
Ongeacht op welke computer ik inlog, ik heb overal toegang tot Check-It	☐	☐	☐	☐	☐

Z.O.Z. ⟶

Huidige situatie m.b.t. Check-It patiënten

De onderstaande vragen gaan over uw werkzaamheden m.b.t. Check-It patiënten.

De volgende vragen zijn op basis van een vijfpunts-schaal. Hierbij gelden de volgende waarden:

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

In hoeverre bent u het (on)eens met de volgende stellingen?

	1	2	3	4	5
Ik vind dat ik efficiënter werk na invoering van Check-It	☐	☐	☐	☐	☐
Ik vind dossiervoering gemakkelijker na invoering van Check-It	☐	☐	☐	☐	☐
Ik vind het werken volgens protocol makkelijker na invoering van Check-It	☐	☐	☐	☐	☐
Ik vind het makkelijker to monitoren of anderen werken volgens protocol na invoering van Check-It	☐	☐	☐	☐	☐

In hoeverre bent u het (on)eens met de volgende stellingen:

	1	2	3	4	5
Het gebruik van Check-It heeft de uitvoering van mijn werk verbeterd	☐	☐	☐	☐	☐
Het gebruik van Check-It heeft mijn productiviteit op werk verbeterd	☐	☐	☐	☐	☐
Het gebruik van Check-It heeft mijn effectiviteit op werk verbeterd	☐	☐	☐	☐	☐
Check-It is nuttig/bruikbaar voor mijn werkzaamheden	☐	☐	☐	☐	☐
Het gebruik van Check-It is voor mij duidelijk en begrijpelijk	☐	☐	☐	☐	☐
Het gebruik van Check-It vergt voor mij weinig mentale inspanning	☐	☐	☐	☐	☐
Het makkelijk is om Check-It te laten doen wat ik wil	☐	☐	☐	☐	☐

Hartelijk dank voor uw medewerking. Graag benader ik u nogmaals over anderhalve maand, voor een nieuwe enquête, na uw herhaaldelijke gebruik van Check-It in de praktijk.

POSTTEST – DERMATOLOGY AND ALLERGOLOGY AND OPHTHALMOLOGY

This posttest is for the department of dermatology and allergology, and the department of ophthalmology.

Enquête Check-It

Beste Check-It gebruiker,

Deze enquête is onderdeel van een onderzoek naar Check-It, het systeem voor zorgpad ondersteuning die jullie inmiddels een maand gebruiken.

De onderstaande vragenlijst zal bestaan uit drie delen. De eerste sectie zal gaan over de algemene huidige situatie, terwijl sectie twee gaat over de huidige situatie m.b.t. Check-It patiënten. Deze vragenlijst sluit af met enkele vragen over uw affiniteit met IT. Het is van belang voor het onderzoek alle vragen te beantwoorden.

De gegevens zullen anoniem en vertrouwelijk worden behandeld.

Vragen en/of opmerkingen met betrekking tot deze enquête of in het algemeen over het onderzoek naar Check-It kunt u onderaan dit formulier kwijt of mailen naar M.F.Aarnoutse@umcutrecht.nl .

Hartelijk dank voor uw medewerking,
Floor Aarnoutse

Opmerkingen

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Persoonlijke informatie

Naam .....

Geslacht:	☐ Man	☐ Vrouw			
Divisie:	☐ Derma	☐ Oog			
Werkervaring:	☐ < 5 jaar	☐ 5 – 15 jaar	☐ 15 – 25 jaar	☐ > 25 jaar	
Leeftijd:	☐ < 20	☐ 20 – 30	☐ 30 – 40	☐ 40 – 50	☐ >50
Opleidingsniveau:	☐ MBO	☐HBO	☐WO	☐ Anders namelijk, ...	

Functie: .....

Huidige situatie

De onderstaande vragen zijn geformuleerd aan de hand van de doelstellingen van Check-It en zullen ingaan op de huidige situatie waarin u vind dat uw afdeling zich bevindt. Bij elke vraag staat de schaal waarop de vragen beantwoord kunnen worden. Graag één vakje per vraag aankruisen.

Voor hoeveel patiënten heeft u ongeveer met Check-It gewerkt?

☐ 0-10 ☐ 10-20 ☐ 20-30 ☐ 30-40 ☐ 40-50 ☐ >50

Wat voor cijfer zou u uw afdeling (=oogheelkunde) geven voor:

	1	2	3	4	5	6	7	8	9	10
Het werken volgens protocol?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Voor het monitoren van protocollair werken?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Voor efficiënt werken?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Het gemak van dossiervoering?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Wat is de mate van verandering binnen jullie afdeling door invoering van Check-It voor:

Helemaal niet veranderd	1	2	3	4	5	*Heel erg veranderd*
Het werken volgens protocol?	☐	☐	☐	☐	☐	
Voor het monitoren van protocollair werken?	☐	☐	☐	☐	☐	
Voor efficiënt werken?	☐	☐	☐	☐	☐	
Het gemak van dossiervoering?	☐	☐	☐	☐	☐	n.v.t.
De duur van spreekuur voorbereiding?	☐	☐	☐	☐	☐	☐

De volgende vragen zijn op basis van een vijfpunts-schaal. Hierbij gelden de volgende waarden:

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

Deze schaal zal als geheugensteuntje op elke bladzijde herhaald worden.

In hoeverre bent u het (on)eens met de volgende stellingen?

	1	2	3	4	5
Ik spreek sinds de invoering van Check-It collega's er vaker op aan dat zij niet volgens het protocol werken	☐	☐	☐	☐	☐
Ik word sinds de invoering van Check-It er wel eens op aangesproken dat ik niet volgens protocol werk	☐	☐	☐	☐	☐
Ik vind het sinds de invoering van Check-It gemakkelijk te monitoren dat anderen volgens het protocol werken	☐	☐	☐	☐	☐
Ik vind het sinds de invoering van Check-It gemakkelijk te monitoren dat ik zelf volgens het protocol werk	☐	☐	☐	☐	☐

In hoeverre bent u het (on)eens met de volgende stellingen:

	1	2	3	4	5
Ik vind dat het gebruiken van Check-It een goed idee is	☐	☐	☐	☐	☐
Ik vind dat het gebruiken van Check-It een verstandig idee is	☐	☐	☐	☐	☐
Ik vind dat het gebruik van Checkt-It prettig is	☐	☐	☐	☐	☐
Mensen die belangrijk voor mij zijn vinden dat ik Check-It moet gebruiken	☐	☐	☐	☐	☐
Mensen die mij beïnvloeden vinden dat ik Check-It moet gebruiken	☐	☐	☐	☐	☐
Mensen wiens meningen ik waardeer vinden dat ik Check-It moet gebruiken	☐	☐	☐	☐	☐
Als het mogelijk is, wil ik de Check-It zo veel mogelijk gebruiken	☐	☐	☐	☐	☐

	1	2	3	4	5
Ik kan Check-It goed gebruiken voor mijn werkzaamheden	☐	☐	☐	☐	☐
Ik heb over over het gebruik van Check-It totale controle	☐	☐	☐	☐	☐
Ik heb de kennis, mogelijkheid, en bronnen heb om Check-It goed te gebruiken	☐	☐	☐	☐	☐
Ongeacht op welke computer ik inlog, ik heb overal toegang tot Check-It	☐	☐	☐	☐	☐

Huidige situatie m.b.t. Check-It patiënten

De onderstaande vragen gaan over **uw werkzaamheden** m.b.t. **Check-It patiënten**.

De volgende vragen zijn op basis van een vijfpunts-schaal. Hierbij gelden de volgende waarden:

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

In hoeverre bent u het (on)eens met de volgende stellingen?

	1	2	3	4	5
Ik vind dat ik efficiënter werk na invoering van Check-It	☐	☐	☐	☐	☐
Ik vind dossiervoering gemakkelijker na invoering van Check-It	☐	☐	☐	☐	☐
Ik vind het werken volgens protocol makkelijker na invoering van Check-It	☐	☐	☐	☐	☐
Ik vind het makkelijker te monitoren of anderen werken volgens protocol na invoering van Check-It	☐	☐	☐	☐	☐

In hoeverre bent u het (on)eens met de volgende stellingen:

	1	2	3	4	5
Het gebruik van Check-It heeft de uitvoering van mijn werk verbeterd	☐	☐	☐	☐	☐
Het gebruik van Check-It heeft mijn productiviteit op werk verbeterd	☐	☐	☐	☐	☐
Het gebruik van Check-It heeft mijn effectiviteit op werk verbeterd	☐	☐	☐	☐	☐
Check-It is nuttig/bruikbaar voor mijn werkzaamheden	☐	☐	☐	☐	☐
Het gebruik van Check-It is voor mij duidelijk en begrijpelijk	☐	☐	☐	☐	☐
Het gebruik van Check-It vergt voor mij weinig mentale inspanning	☐	☐	☐	☐	☐
Het makkelijk is om Check-It te laten doen wat ik wil	☐	☐	☐	☐	☐

Computer vaardigheden

De onderstaande vragen zijn geformuleerd aan de hand van het technology acceptance model en zullen ingaan op uw affiniteit met IT. Achter elke vraag staat de schaal waarop de vragen beantwoord kunnen worden. Graag één vakje per vraag aankruisen.

1 = Helemaal mee oneens
2 = Mee oneens
3 = Niet mee oneens/niet mee eens
4 = Mee eens
5 = Helemaal mee eens

	1	2	3	4	5
Als ik hoor over nieuwe technologieën, kijk ik of ik er mee kan experimenteren	☐	☐	☐	☐	☐
In mijn vriendengroep ben ik meestal degene die nieuwe technologieën als eerste probeert	☐	☐	☐	☐	☐
Over het algemeen aarzel ik niet om nieuwe technologieën te proberen	☐	☐	☐	☐	☐
Ik vind het leuk om te experimenteren met nieuwe technologieën	☐	☐	☐	☐	☐
Ik kan goed overweg met een computer	☐	☐	☐	☐	☐

Hartelijk dank voor uw medewerking. Als u interesse hebt in de uitkomsten van dit onderzoek vult u dan hieronder uw e-mailadres in. Naar verwachting loopt dit onderzoek in november 2015 af.

Email adres: .....

APPENDIX J: COMBINED PEDIATRIC PULMONOLOGY RESULTS

This appendix shows the combined data for the department grades and TAM results over the pretest and two posttests of the department of pediatric pulmonology.

TABLE 32: MEAN OBJECTIVE GRADES - DEPARTMENT OF PEDIATRIC PULMONOLOGY

Department grade. Scale: 1-10				
	Protocol-based working	Monitoring of protocol-based working	Ease of administrative workload	Efficiency
Pre	7.43	5.86	7.00	7.14
Post 1	6.50	6.38	6.13	5.94
Post 2	7.83	7.83	7.67	7.83

TABLE 33: MEAN CHECK-IT DEPARTMENT CONTRIBUTION GRADE - DEPARTMENT OF PEDIATRIC PULMONOLOGY

Check-It department contribution grade. Scale: 1-5					
	Protocol-based working	Monitoring of protocol-based working	Ease of administrative workload	Efficiency	*Perceived effectiveness score*
Pre	4.25	4.25	4.00	4.00	*4.13*
Post 1	3.25	3.63	3.13	3.00	*3.25*
Post 2	3.83	3.67	3.50	3.67	*3.67*

TABLE 34: MEAN CHECK-IT PERSONAL CONTRIBUTION GRADE – DEPARTMENT OF PEDIATRIC PULMONOLOGY

Check-It personal contribution grade. Scale: 1-5				
	Protocol-based working	Monitoring of protocol-based working	Ease of administrative workload	Efficiency
Post 1	3.12	3.12	3.00	3.00
Post 2	4.17	4.00	4.00	4.00

TABLE 35: TAM RESULTS - DEPARTMENT OF PEDIATRIC PULMONOLOGY

TAM grades. Scale: 1-5								
	PU	PSA	PEOU	ATT	BI	PIIT	PBC	SN
Pre	3.67	4.00	3.62	3.79	3.87	3.33	3.58	3.08
Post 1	3.13	4.00	3.10	3.65	3.75	3.33	3.21	2.79
Post 2	3.90	4.17	3.56	3.94	4.17	3.33	3.67	3.17
PU: Personal Usefulness – PSA: Perceived Service Availability – PEOU: Perceived Ease Of Use ATT: Attitude – BI: Behavioral Intention – PIIT: Personal Innovativeness in IT PBC: Perceived behavioral control – SN: Subjective Norm								

APPENDIX K: SPSS RESULTS

This appendix shows all SPSS output, as discussed in Chapter 8 and 12.

TABLE 36: PAIRED SAMPLES T-TEST FOR THE DEPARTMENT EFFICIENCY SCORE – PEDIATRIC PULMONOLOGY

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Eff_Dept_Pre	4,1250	8	,44320	,15670
	Eff_Dept_Post1	3,2913	8	,96105	,33978
Pair 2	Eff_Dept_Post1	3,0967	6	1,05122	,42916
	Eff_Dept_Post2	3,6667	6	,62583	,25550
Pair 3	Eff_Dept_Pre	4,1667	6	,51640	,21082
	Eff_Dept_Post2	3,6667	6	,62583	,25550

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Eff_Dept_Pre - Eff_Dept_Post1	,83375	,98291	,34751	,01202	1,65548	2,399	7	,048
Pair 2	Eff_Dept_Post1 - Eff_Dept_Post2	-,57000	,79775	,32568	-1,40718	,26718	-1,750	5	,140
Pair 3	Eff_Dept_Pre - Eff_Dept_Post2	,50000	,57009	,23274	-,09827	1,09827	2,148	5	,084

TABLE 37: PAIRED SAMPLES T-TEST FOR THE PERSONAL EFFICIENCY SCORE – PEDIATRIC PULMONOLOGY

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Eff_Own_Post1	2,9167	6	,90370	,36893
	Eff_Own_Post2	4,0417	6	,79713	,32543

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Eff_Own_Post1 - Eff_Own_Post2	-1,12500	,60725	,24791	-1,76227	-,48773	-4,538	5	,006

TABLE 38: INDEPENDENT SAMPLES T-TEST FOR THE EXPECTED PERCEIVED EFFICIENCY SCORE – PEDIATRIC PULMONOLOGY VS. VASCULAR SURGERY

Group Statistics

	Division	N	Mean	Std. Deviation	Std. Error Mean
Effectivenss_score	Kinder	8	4,1250	,44320	,15670
	Vaat	10	3,5500	,58689	,18559

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Effectivenss_score	Equal variances assumed	,658	,429	2,292	16	,036	,57500	,25086	,04321	1,10679
	Equal variances not assumed			2,367	15,970	,031	,57500	,24290	,06001	1,08999

TABLE 39: INDEPENDENT SAMPLES T-TEST FOR THE TAM SCORES – PEDIATRIC PULMONOLOGY VS. VASCULAR SURGERY

Group Statistics

	Division	N	Mean	Std. Deviation	Std. Error Mean
PU_Mean	Kinder	8	3,6875	,45806	,16195
	Vaat	10	3,2000	,58689	,18559
PEOU_Mean	Kinder	8	3,6250	,57563	,20352
	Vaat	10	3,3667	,48305	,15275
ATT_Mean	Kinder	8	3,7917	,58926	,20833
	Vaat	10	3,6000	,56218	,17778
SN_Mean	Kinder	8	3,0833	,38832	,13729
	Vaat	10	2,9000	,98194	,31052
BI_Mean	Kinder	8	3,8750	,83452	,29505
	Vaat	10	3,5000	,52705	,16667
PBC_Mean	Kinder	8	3,5833	,70711	,25000
	Vaat	10	3,2667	,58373	,18459
PSA_Mean	Kinder	8	4,0000	1,06904	,37796
	Vaat	10	4,0000	,47140	,14907
PIIT_Mean	Kinder	8	3,3250	,73241	,25895
	Vaat	10	4,9800	6,35851	2,01074

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PU_Mean	Equal variances assumed	,123	,731	1,923	16	,072	,48750	,25347	-,04984	1,02484
	Equal variances not assumed			1,979	15,998	,065	,48750	,24632	-,03467	1,00967
PEOU_Mean	Equal variances assumed	,511	,485	1,036	16	,315	,25833	,24930	-,27015	,78682
	Equal variances not assumed			1,015	13,721	,328	,25833	,25446	-,28848	,80515
ATT_Mean	Equal variances assumed	,234	,635	,704	16	,492	,19167	,27236	-,38571	,76904
	Equal variances not assumed			,700	14,802	,495	,19167	,27388	-,39277	,77610
SN_Mean	Equal variances assumed	7,073	,017	,496	16	,627	,18333	,36997	-,60096	,96763
	Equal variances not assumed			,540	12,260	,599	,18333	,33951	-,55466	,92133
BI_Mean	Equal variances assumed	1,214	,287	1,164	16	,261	,37500	,32204	-,30770	1,05770
	Equal variances not assumed			1,107	11,286	,291	,37500	,33887	-,36854	1,11854
PBC_Mean	Equal variances assumed	,862	,367	1,042	16	,313	,31667	,30388	-,32753	,96087
	Equal variances not assumed			1,019	13,575	,326	,31667	,31076	-,35182	,98515
PSA_Mean	Equal variances assumed	4,218	,057	,000	16	1,000	,00000	,37500	-,79496	,79496
	Equal variances not assumed			,000	9,174	1,000	,00000	,40630	-,91646	,91646
PIIT_Mean	Equal variances assumed	2,617	,125	-,728	16	,477	-1,65500	2,27372	-6,47507	3,16507
	Equal variances not assumed			-,816	9,298	,435	-1,65500	2,02734	-6,21888	2,90888

TABLE 40: ANOVA DEPARTMENAL EFFECTIVENESS SCORES PER DEPARTMENT

Test of Homogeneity of Variances

Eff_Dept

Levene Statistic	df1	df2	Sig.
,995	2	27	,383

ANOVA

Eff_Dept

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9,227	2	4,614	5,885	,008
Within Groups	21,167	27	,784		
Total	30,394	29			

TABLE 41: ANOVA PERSONAL EFFECTIVENESS SCORE PER DEPARTMENT

Test of Homogeneity of Variances

Eff_Own

Levene Statistic	df1	df2	Sig.
,340	2	27	,715

ANOVA

Eff_Own

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11,110	2	5,555	7,670	,002
Within Groups	19,555	27	,724		
Total	30,666	29			

TABLE 42: ANOVA POST HOC TEST DEPARTMENTAL EFFECTIVENESS SCORE

Multiple Comparisons

Dependent Variable: Eff_Dept
Hochberg

(I) Division	(J) Division	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Derma	Oog	-1,08333*	,37332	,021	-2,0308	-,1358
	Kind	-1,41667*	,46665	,016	-2,6010	-,2323
Oog	Derma	1,08333*	,37332	,021	,1358	2,0308
	Kind	-,33333	,42769	,820	-1,4188	,7522
Kind	Derma	1,41667*	,46665	,016	,2323	2,6010
	Oog	,33333	,42769	,820	-,7522	1,4188

*. The mean difference is significant at the 0.05 level.

TABLE 43: ANOVA POST HOC TEST PERSONAL EFFECTIVENESS SCORE

Multiple Comparisons

Dependent Variable: Eff_Own
Hochberg

(I) Division	(J) Division	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Derma	Oog	-,88056	,35883	,060	-1,7913	,0302
	Kind	-1,73611*	,44854	,002	-2,8745	-,5977
Oog	Derma	,88056	,35883	,060	-,0302	1,7913
	Kind	-,85556	,41109	,132	-1,8989	,1878
Kind	Derma	1,73611*	,44854	,002	,5977	2,8745
	Oog	,85556	,41109	,132	-,1878	1,8989

*. The mean difference is significant at the 0.05 level.

TABLE 44: ANOVA DEPARTMENAL EFFECTIVENESS SCORES PER HEALTHCARE PROFESSIONAL GROUP

Test of Homogeneity of Variances

Eff_Dept

Levene Statistic	df1	df2	Sig.
,348	2	27	,709

ANOVA

Eff_Dept

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,860	2	,430	,393	,679
Within Groups	29,534	27	1,094		
Total	30,394	29			

TABLE 45: ANOVA PERSONAL EFFECTIVENESS SCORE PER HEALTHCARE PROFESSIONAL GROUP

Test of Homogeneity of Variances

Eff_Own

Levene Statistic	df1	df2	Sig.
2,900	2	27	,072

ANOVA

Eff_Own

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6,036	2	3,018	3,309	,052
Within Groups	24,629	27	,912		
Total	30,666	29			

TABLE 46: ANOVA TAM SCORES CLUSTER 1 PER HEALTHCARE PROFESSIONAL GROUP

Test of Homogeneity of Variances

Cluster1_Mean

Levene Statistic	df1	df2	Sig.
1,067	2	27	,358

ANOVA

Cluster1_Mean

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,195	2	,098	,210	,812
Within Groups	12,513	27	,463		
Total	12,708	29			

TABLE 47: ANOVA TAM SCORES CLUSTER 2 PER HEALTHCARE PROFESSIONAL GROUP

Test of Homogeneity of Variances

Cluster2_Mean

Levene Statistic	df1	df2	Sig.
,762	2	27	,477

ANOVA

Cluster2_Mean

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3,927	2	1,964	4,315	,024
Within Groups	12,288	27	,455		
Total	16,215	29			

TABLE 48: ANOVA TAM SCORES CLUSTER 3 PER HEALTHCARE PROFESSIONAL GROUP

Test of Homogeneity of Variances

BI_WhenAvailable

Levene Statistic	df1	df2	Sig.
,866	2	27	,432

ANOVA

BI_WhenAvailable

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4,044	2	2,022	1,632	,214
Within Groups	33,456	27	1,239		
Total	37,500	29			

TABLE 49: ANOVA POST HOC TEST TAM CLUSTER 2 SCORE

Multiple Comparisons

Dependent Variable: Cluster2_Mean
Hochberg

(I) Division	(J) Division	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Derma	Oog	-,58578	,28444	,138	-1,3077	,1361
	Kind	-1,01111*	,35555	,025	-1,9135	-,1087
Oog	Derma	,58578	,28444	,138	-,1361	1,3077
	Kind	-,42533	,32587	,484	-1,2524	,4017
Kind	Derma	1,01111*	,35555	,025	,1087	1,9135
	Oog	,42533	,32587	,484	-,4017	1,2524

*. The mean difference is significant at the 0.05 level.

APPENDIX L: INTERVIEW COMPARISON

This appendix shows the difference between the expectations and statements about Check-It for the department of pediatric pulmonology.

TABLE 50: INTERVIEW STATEMENT COMPARISON – PEDIATRIC PULMONOLOGY

Positive/ negative?	Expectation	Pre	Post 1	Post 2	Δ Pre – post 1	Δ Post 1 – Post 2	Δ Pre – Post 2
+	Improved protocol-based working	7/8	3/8	4/6	-4	+1	-3
+	Less forgotten tasks	3/8	3/8	-	-	-3	-3
+	Increased efficiency	3/8	-	4/6	-3	+4	+1
+	Improved monitoring of protocol-based working	2/8	-	-	-2	-	-2
+	Decreased cognitive workload	2/8	-	2/6	-2	+2	-
+	Better patient care	2/8	-	1/6	-2	+1	-1
+	Ease of administrative workload	1/8	-	-	-1	-	-1
+	Increased protocol insight	1/8	-	1/6	-1	+1	-
+	Decreased orientation time	-	-	1/6	-	+1	+1
-	Lack of clarity	-	3/8	-	+3	-3	-
-	More work	-	3/8	-	+3	-3	-
-	Pre filled orders and letters	-	2/8	3/6	+2	+1	+3
-	High learning curve	3/8	-	3/6	-3	+3	-
-	Difficult when not according to protocol	3/8	2/8	1/6	-1	-1	-2
-	Decreased cognitive workload	2/8	-	-	-2	-	-2
-	Lack of usability	-	-	1/6	-	+1	+1
-	Lack of flexibility	-	-	1/6	-	+1	+1
-	Not aligned with other programs	-	-	1/6	-	+1	+1