Master Thesis

PLANNING IN A HEARTBEAT

Improving the planning system of the Heart Catheterisation Rooms at the Catharina hospital Eindhoven

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catharina ziekenhuis

UNIVERSITY OF TWENTE.

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I hope you enjoy reading this report!

Stef van Dijk
Eindhoven, March 2012

Management Summary

The cardiology department of the Catharina Hospital Eindhoven is the largest intervention- and electrophysiological centre of the Netherlands and primarily serves as a tertiary centre. Five Heart Catheterization Rooms (HCR) are at their disposal for intervention procedures, for instance angioplasties, or electrophysiological procedures as pacemaker implementations.

The planning of the HCRs is currently done using two different systems: an Excel spread sheet and the hospitals' information system EZIS. The hospital suspects that the planning system is not making optimal use of the HCRs. Therefore the aim of this research is to improve the planning system of the HCR through a better alignment of the information systems to the needs and requirements of all planning stakeholders and the primary care process.

In This research the current planning system was evaluated using the Delone and McLean [2] model for information system success. The main findings from this research show the planning system is underperforming in the root dimensions of the model, system quality and information quality. The first dimension underperformed due to a lack of integration between the two systems, where the second dimension underperformed due to incomplete and inaccurate information entry in the planning system. The low information quality also prevents management from effectively steering the HCRs.

A small task group was formed to investigate possible improvement alternatives for the planning system. Creating the planning completely in EZIS was selected out of four as the best alternative. This decision was based on four criteria set by the task group. The criteria are integration in information and work processes, complete and accurate information, ease of use and costs of the planning system.

For the implementation of the selected alternative a sense of urgency must be created among the users. This is an essential step as interests can greatly differ in a hospital setting. After the sense of urgency is created three steps have to be executed for the implementation. First EZIS has to be tailored to the needs of the HCR. The information needs of all the phases in the planning process must be mapped. Subsequently the input and output screens of EZIS can be tailored to comply to these information needs. In the second step the work processes concerning the planning must be rearranged. This includes both the primary (care) as the secondary (administrative) processes. The first and second step should be done simultaneously to ensure that the EZIS fits the processes and vice versa. Using pilot runs and feedback of all users these two steps must be repeated until it satisfies the needs of all stakeholders. The last step is then using the system in which constant feedback must be given to and by the users so that the system can remain optimal.

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List of abbreviations

CCU	Coronary Care Unit
CTS	CardioThoracic Surgery
CZE	Catharina Ziekenhuis Eindhoven (Catharina Hospital Eindhoven)
EHR	Electronic Health Record
EP	Electro Physiology (EFO)
EZIS	Electronisch Ziekenhuis Informatie Systeem (Electronic Hospital Information System)
D&M model	Delone and McLean model [2]
GP	General Practitioner
HCR	Heart Catheterization Room
HTM	Heart Team Meeting
IS	Information System

SECTION 1

INTRODUCTION

1 Introduction

Managerial aspects become increasingly important in health care as hospitals seek to improve their financial position and to reduce their costs [3], and simultaneously improve the quality of health. However, more than once these two interests conflict [4]. This has led to numerous articles concerning health care management in the last decade. Especially the operating theatre planning received great attention, as this is one of the largest profit and cost drivers within a hospital [5] and improving their efficiency is essential in the financial viability of the hospital [6]. For the Catharina Hospital Eindhoven (hereafter called the CZE) the Heart Catheterization Rooms (hereafter called the HCRs) are an equal cost and profit driver. Management of the HCR however is not an easy task due to the different priorities of the stakeholders [4]. The continuously pressure on resources increases the awareness among specialists on the need for methods to increase efficiency. Literature on operations- and information management already widely address these issues, and nowadays a trend is visible in the acceptance of these techniques by hospitals and specialists [3]. Operations management can significantly improve planning [7] whereas information management is needed to develop strategic information systems [8] to access and analyse data of complex processes for controlling and monitoring [9].

1.1 Problem Description

The HCR uses two information systems for the planning. The first system is an Excel spread sheet, the second system is the hospitals' information system EZIS. The former one is the leading system until the scheduled day. The later system is leading from the scheduled day on. The reason for this is twofold. Firstly the schedule can change during the day because of emergency patients or procedures exceeding their scheduled time. EZIS can display the current status of the program, and is accessible throughout the hospital. Secondly, EZIS is the administrative system of the hospital which implies that all patient information has to be entered in EZIS for medical reasons, for financial reasons, logistic reasons (e.g. supply management), and management reasons (e.g. performance management).
Working with two systems has several disadvantages. Firstly the information systems cannot communicate with each other which causes the HCR planning secretariat to manually transfer information between the two systems. This creates an inefficient process, but also creates more room for error. Secondly not all relevant information can be found in both systems. For instance, which doctor and personnel are scheduled can only be found in the Excel spread sheet, and the waiting list can only be found in EZIS. Furthermore, there are several conditions which have to be met before a patient is allowed to be scheduled. These

conditions cannot be checked automatically as the planning of patients takes place in the Excel spread sheet. This also applies for the requirements of the HCR, doctor and personnel.

The current planning system of the HCRs results in a 75% utilization rate (which is low considering that the operating theatre achieves 94% utilization) [10]. Several factors influence the execution of the planned schedule. The two most important factors are the procedure times and emergency patients. At the moment a standard time is used for each procedure. In practice, the time needed for a procedure depends on several factors. For instance, who executes the procedure (an experienced cardiologist or a resident) or how many veins are included in the procedure. A recent internal investigation found that, during a 5 month period, 43% cases of one specific procedure exceeded the standard time [10]. Emergency patients are the second factor. In the current planning system no room is left for emergency patients, although they are one of the main reasons for uncertainty in the planning [3].

The current way of planning sometimes leads to undesirable outcomes as: patients who are sent home (e.g. the patient does not meet the requirements for the procedure), patients who have to (unplanned) stay overnight (e.g. too many procedures exceeded their scheduled time), or patients who are rescheduled before they are admitted (e.g. it was not clear that the patient needs to be treated by a specific doctor).

Changing the current planning and process does bring certain challenges. As Glouberman and Mintzberg [4] illustrate, professional health care organisations often show four faces. These are the *community (*the trustees of the hospital), *control* (managers), *cure* (doctors) and *care* (nurses). These four faces all have their own set of activities, own ways of organising and own priorities. For any change to succeed, all four worlds will need to face the same direction.

1.2 Research Objective

The aim of this research is to improve the planning system of the HCR through a better alignment of the information systems to the needs and requirements of all planning stakeholders and the primary care process.

1.3 Research Questions

The main research question guiding this research is:

> *What improvements can be made in the HCR planning method to better align the information systems with the needs and requirements of the planning stakeholders and the primary care process?*

In order to answer this main research question four sub-questions will be answered.

1) What determines a successful planning system for the HCR, based on the literature?
2) How is the current planning system performing at the HCR, based on the answers found in the previous question?
3) What are the needs and requirements of the different stakeholders for a planning system?
4) What improvements can be made to the planning systems at the HCR?

1.4 Research Focus

At the HCR a clear distinction can be made between intervention and electro physiology (EP). Both intervention and EP have two dedicated HCRs, and 1 common HCR. Both have their own cardiologists and personnel, which all have a unique set of procedures they are allowed to execute. The research will focus on the intervention department of the HCR, although the methods in this research will be applicable at the EP department of the HCR as well.

1.5 Research Method

For this research the model of Delone and McLean [2] on information system success will be used (hereafter called the D&M model). This model, as shown in Figure 1, identifies six dimensions to measure IS success. For the optimal use of information systems in a hospital, a meticulous cooperation is needed between the health care professional and the Information Systems (IS). In a hospital setting the IS should be interwoven within the organization and it should not be seen apart as a 'social' and a 'technical' system [9]. How the information systems are organized must be well considered as "having too much, poorly organized information can cause as many errors in decisions as having too little information" [11]. Van der Meijden et al. [12] found that there is no explicit definition of IS success and that it fluctuates over time. DeLone and McLean state that IS success is a "multidimensional and interdependent construct" [13]. Furthermore they state that their model is based on process and causal relations between the six dimensions [2]. This implies that dimension B follows dimension A (process), but also that dimension B is caused by dimension A (causal). Since its introduction the model is widely used and validated [13]. In a ten year update, DeLone and McLean [13] found 16 articles that empirically tested one or more causal relation. They conclude that the causality proposed in the original paper is validated, as 36 of the 38 causal relations studied are significant.

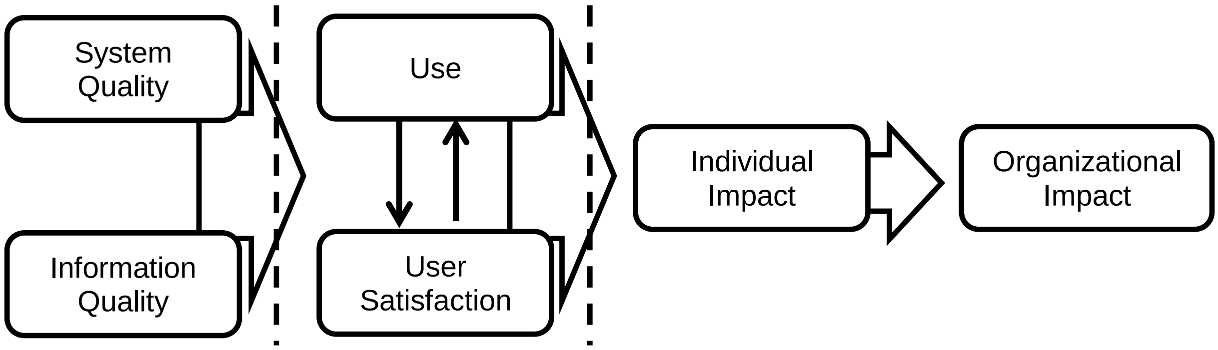


Figure 1 Delone & McLean IS success model [2]

The six dimension are 1) *system quality,* the characteristics of the information system, 2), *Information quality,* the characteristics of the information output, 3) *use*, the manner of and utilization of the systems' capacities , 4) *user satisfaction*, users' satisfaction on all aspects of the system, 5) i*ndividual impact,* the extent to which IS affects individuals in their daily practices and 6) *organizational impact,* the effects of IS on the organizations' performance [12, 14]. Measurements on each dimension must be done carefully and always in context of the research [13-15]. Van Der Meijden et al. [12] confirmed that the D&M model is applicable in a hospital setting if all six dimensions are included. The weight of each dimension should be determined by the context, purpose, unit of analysis and importance of the system [14]. Berg [9] enhances this by stating that "we need to know what the specific network that constitutes a health care practice looks like before we can think of (…) meaningful evaluation criteria". Gable et al. [16] conducted a validation study on the known measures of the D&M model. They validated a total of 27 measures for System Quality, Information Quality, Individual Impact and Organizational Impact. The complete set of measures can be found in appendix 9.2.

This research follows a qualitative approach. Van Aken et al. [17] argue the use of qualitative methods for problem solving in organisations. They state that qualitative approaches are "particularly important if one intends to study people, groups, organizations and societies" [17]. Within a hospital there is a deep intertwinement of social and technical aspects. Decisions are made in a large political arena [1] and a thorough understanding of the work practices is needed [18]. Berg [19] states that "qualitative research methods are (…)

essential to any thorough evaluation of an IT implementation" and both interviews and observations should be included in the research. Babbie [20] further stresses the use of on-site qualitative methods due to the many social factors present in a hospital setting which cannot always be captured in quantitative methods.

In the following chapter the current planning system and its context are elaborated after which chapter 3 will review the literature and generate an interview model. Chapter 4 subsequently reports on the results of the interviews and the observations. These results are analysed in chapter 0 after which four alternatives to improve the planning system are proposed in chapter 6. This chapter will further select one of these alternatives and give a preliminary insight on the implementation of it. Finally chapter 7 will give the conclusions of this research.

2 Context Analysis

The following chapter elaborates the processes in and around the HCRs. Starting in section 2.1 the hospital and the HCRs are further introduced. Subsequently section 2.2 and 2.3 will describe, respectively, the patient process and planning process. Finally section 2.4. presents the two information systems currently used in the planning process.

2.1 General information

The CZE is a general hospital located in the South-East of the Netherlands. It has approximately 3.300 employees and 700 beds, about 60.000 admissions a year and over 150.000 first time outpatients. The cardiology department is the largest intervention- and electrophysiological centre of the Netherlands and primarily serves as a tertiary centre (70% of the patients are referred by other hospitals) [21]. The cardiology department has 14 intervention cardiologists and 9 electro physiologists.

The CZE has five HCRs located at the seventh floor of the hospital. HCRs 1 and 2 are located in the east wing, and HCRs 3, 4 and 5 are located in the west wing. HCRs 1, 2 and 3 can be used for intervention procedures and HCRs 3, 4 and 5 can be used for electro physiologic procedures. The HCRs are open for elective patients during weekdays from 08.00 hours to 17.00 hours. For emergency patients the HCRs are open 24/7.

A total of 8 cardiologists and 6 residents perform intervention procedures. For elective patients 12 beds are reserved at the short stay ward on the eighth floor, next to that 8 beds are dedicated for PCI patients (one of the intervention procedures) at the cardiology ward on the seventh floor. Besides these dedicated beds the total general cardiology ward consists of 37 beds. Finally a Coronary Care Unit (CCU) has 11 beds, which are for patients in need of constant monitoring (e.g. emergency patients).

2.2 Patient process

Figure 2 describes the main patient process at the HCR. Patients arrive in three different ways: 1) as elective inpatient, 2) as elective referral or 3) as emergency patient. The latter two types of patients can be transferred from another hospital, from home (in case of an elective referral) or any other place (in case of an emergency patient). Emergency patients and already administered elective referrals are transported directly to the HCR complex upon arrival. If the HCR is not yet available the patient remains in the hallway in front of the HCRs. Elective inpatients and non-administered elective referrals are first administered to the ward. After the admission the ward prepares the patients for the procedure. To time the arrival of patients who need to be transported from another hospital, a HCR personnel member calls the referring hospital. The caller indicates a time at which the patient must be present, based on his judgement on the progress of the schedule. The referring hospital is responsible for the transport of the patient.

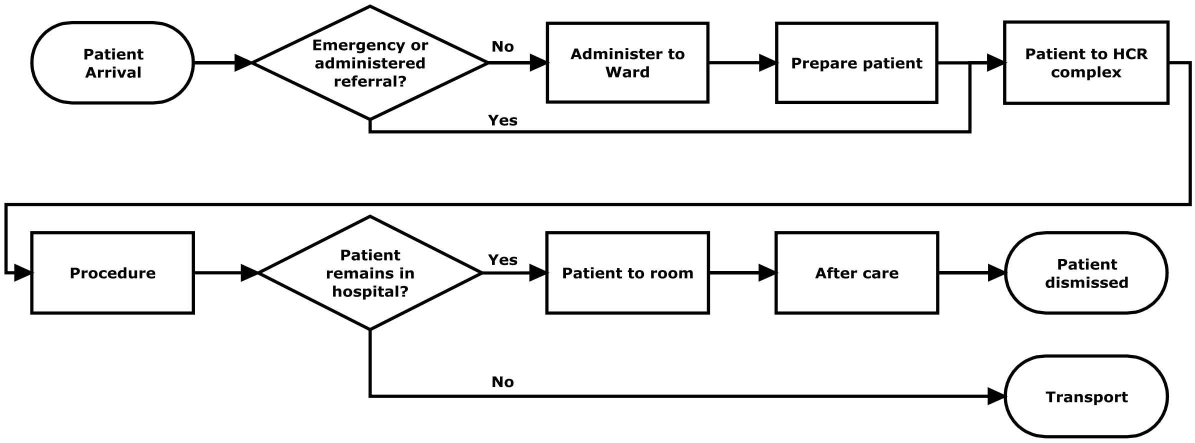


Figure 2 Patient process

After the procedure the patient either returns to his originating hospital, or the ward. For emergency patients who did not get transported from another hospital, a bed is held available at the ward, or if necessary, at the CCU. The ambulance service will however always try to find out what the patients ‘own’ hospital is, and if the patient can be administered there after the procedure. This is advantageous for both the patient and the CZE. The patient will be at his ‘own’ hospital, where he is known and close to home. And the CZE has no unplanned admission, which prevents the usage of an extra bed.

2.3 Planning process

The planning process can be divided in three steps as can be seen in Figure 3. These steps are described in detail in the upcoming section. The construction of the week schedule provides a blue print for a certain week, where the heart team meeting provides most of the patients. The procedure planning is where these two are brought together for the actual planning of the patient.

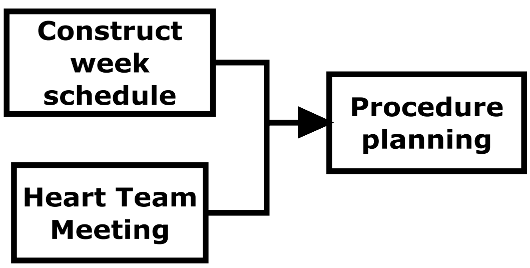


Figure 3 Planning process

2.3.1 Construct week schedule

Six weeks in advance the week schedule is constructed. As can be seen in Figure 4 the construction starts with the master schedule of the HCR. This is a blue print for the week planning of the 5 HCRs. An example of (a part of) the master schedule can be found in Table 3 in appendix 9.1. The HCR planning secretariat and the cardiologist secretary meet weekly to fine-tune this master schedule (e.g. which cardiologist is working). Subsequently a similar meeting with the HCR personnel planner is held. After this fine-tuning a week schedule is constructed identifying the doctor and personnel working at a specific HCR, and the procedures they will execute. The indicated procedures are only guidelines; the actual procedures are based on the actual demand. Furthermore the doctor and personnel planning often change after the meetings due to, for instance, conferences, training days or illness. Due to this the week schedule often changes during the upcoming six weeks.

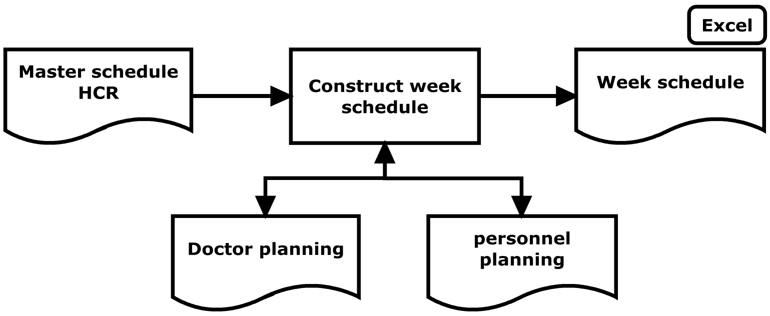


Figure 4 Week schedule construction process

2.3.2 Heart Team Meeting

Almost all patients (internal and external) enter the HCR planning via the Heart Team Meeting (HTM), whose process is displayed in Figure 5. The HTM is a cross-specialist meeting with one cardiologist and one cardiothoracic surgeon. The HTM determines whether a patient needs an intervention at the HCR or Cardiothoracic Surgery (CTS).

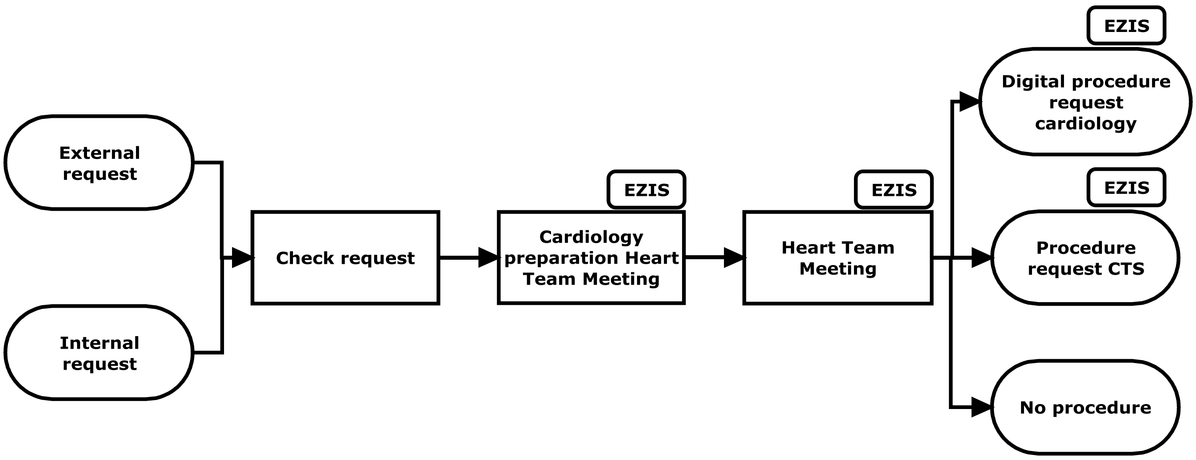


Figure 5 Heart Team Meeting process

The majority of the requests arriving at the heart team secretary are external request. The heart team secretary first checks if all information needed for the HTM is present in the request. If this is not the case, the heart team secretary will inform the applicant about the missing information. The heart team secretary prepares the HTM once all information is present by entering all relevant information in EZIS. The HTM next assess the patient based on the information in EZIS and the paper patient records. The conclusion of the HTM can be that the patient receives an intervention, CTS, or no procedure. Once this decision is entered in EZIS the request is automatically send to the HCR planning secretariat.

Occasionally (approximately 1 out of 10) a patient the enters the HTM via the intervention secretary but the HTM decides the patient needs CTS, or vice versa. This sometimes leads to problems, as the CTS secretariat does not enter all the data which is needed to plan an intervention patient. The intervention secretary tries to prevent this, but does not always succeed as the requests are automatically send to the HCR planning secretary.

2.3.3 Procedure planning

The actual planning of the patients is done at the HCR planning secretariat which is located on the same floor as the HCRs. There are three ways to enter the procedure planning process: 1) as an emergency patient, 2) through an internal request or 3) through the above-mentioned HTM.

Emergency patients are obviously not planned, and, as can be seen in Figure 6, are immediately added to the day schedule. The HCR planning secretariat contacts the patients' own hospital, if known, for additional information on the patient.

Elective patients can enter the planning process through the above mentioned HTM or via a direct request. The latter one is the case when a cardiologist of the CZE decides for an intervention after seeing a patient at the ward or inpatient clinic. The cardiologist enters the request digitally via EZIS or uses a paper request which is delivered to the HCR planning secretariat.

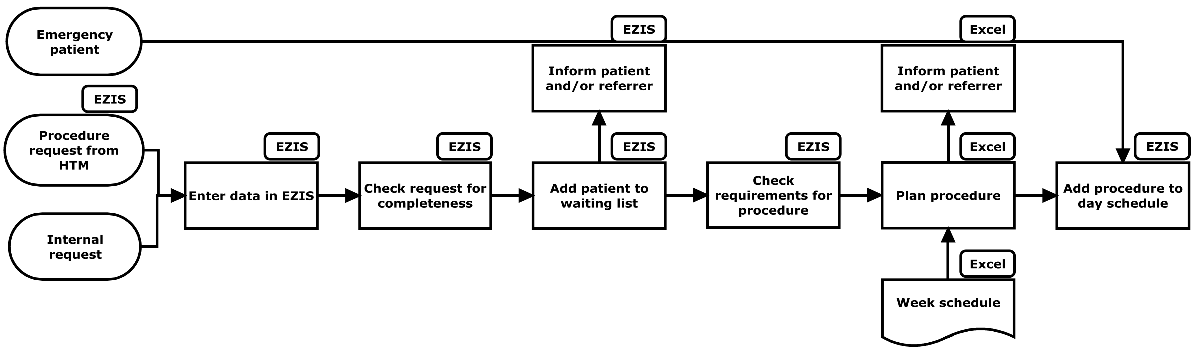


Figure 6 Procedure planning process

The HCR planning secretariat checks all requests for completeness, and, if anything is missing the request is send back to either the heart team secretary or the inpatient clinic. Patients with a complete request are registered on the intervention waiting list in EZIS. The patient, and if applicable the referrer, are informed about the current length of the waiting list. The waiting list is checked daily against the available slots in the Excel week schedule. Before a patient is added to the week schedule, the HCR planning secretariat checks whether the patient is allowed to be planned as there are certain (medical) conditions which have to be met before the procedure. An example of a week schedule can be found in Table 4 in appendix 9.1.

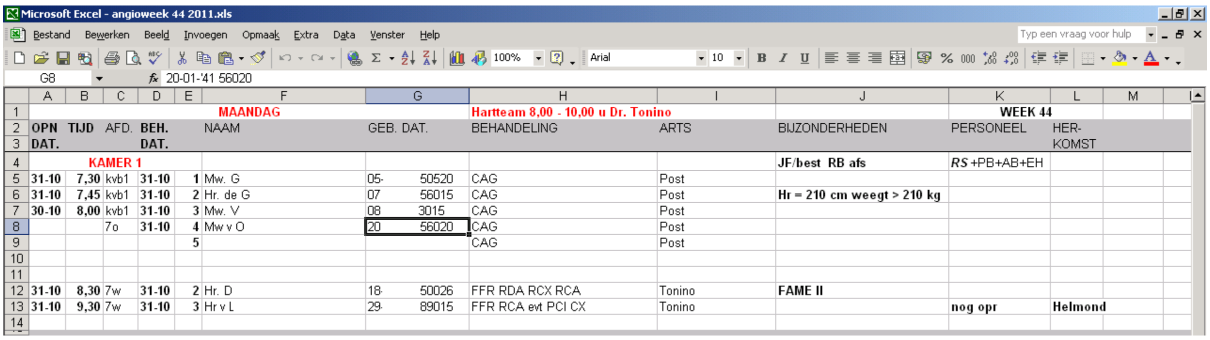
A week prior to the procedure the patient receives a call from the HCR planning secretariat about the exact procedure date. The patient is given a time to check in at the ward, and is informed whether the procedure is in the morning or afternoon. Additional information about medication, breakfast and driving limitations are also given. Already administered patients (in another hospital) are not directly informed. Instead, the HCR planning secretariat informs the other hospital one day prior to the procedure. Only after the patient (or hospital) is informed the patient is put on the day schedule in EZIS. Formally, from this moment on the patient cannot be rescheduled, however this is not always possible. Failing equipment, illness of personnel or too many emergent and urgent patients can be reasons for rescheduling.

2.4 Current systems

As mentioned before two systems are used for the planning of the HCRs. The first one is an Excel spread sheet, the second one is the hospitals' information system EZIS. Both systems will be explained shortly.

2.4.1 Excel

The Excel sheet is the leading program for the planning of the HCR until the actual day. As can be seen in Figure 7 the Excel sheet provides information on: admission date and time; procedure date; the ward; the number of patients registered to a ward; the patient name; date of birth; treatment; doctor; personnel; remarks and patient origin (if the patient is transferred from another hospital). The numbers in the fifth column represent the number of beds which are taken at a specific ward. The HCR planning secretariat uses this method to prevent the overbooking of beds.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1						MAANDAG		Hartteam 8,00 - 10,00 u Dr. Tonino			WEEK 44		
2	OPN	TIJD	AFD.	BEH.		NAAM	GEB. DAT.	BEHANDELING	ARTS	BIJZONDERHEDEN	PERSONEEL	HER-	
3	DAT.			DAT.								KOMST	
4			KAMER 1							JF/best RB afs	*RS* +PB+AB+EH		
5	31-10	7,30	kvb1	31-10	1	Mw. G	05- 50520	CAG	Post				
6	31-10	7,45	kvb1	31-10	2	Hr. de G	07 56015	CAG	Post	Hr = 210 cm weegt > 210 kg			
7	30-10	8,00	kvb1	31-10	3	Mw. V	08 3015	CAG	Post				
8			7o	31-10	4	Mw v O	20 56020	CAG	Post				
9					5			CAG	Post				
10													
11													
12	31-10	8,30	7w	31-10	2	Hr. D	18- 50026	FFR RDA RCX RCA	Tonino	FAME II			
13	31-10	9,30	7w	31-10	3	Hr v L	29- 89015	FFR RCA evt PCI CX	Tonino		nog opr	Helmond	
14													

Figure 7 Excel planning sheet

2.4.2 EZIS

The second system is the hospitals' information system EZIS. For the cardiology department EZIS is used for planning at the inpatient clinic, patient planning at the HCR, patient record keeping, financial administration, registration of the HTM, financial administration and materials administration.

Procedure requests through EZIS come either from the HTM, or as a direct internal request. The HCR planning secretariat receives this request in a work list within EZIS. Examples of the HTM request (Figure 26) and internal request (Figure 27) can be found in appendix 9.2. The HCR planning secretariat adds the patient to the day schedule in EZIS (Figure 28) after the patient is informed about his procedure date.

2.5 Conclusion

This chapter described the current state of the planning system. The planning system involves multiple locations, multiple people and multiple systems. The exact processes and responsibilities are not clearly documented which is why the planning secretariat of the HCR has a crucial role. They are the link between the HTM, the patients and the two information systems. The fact that the processes are nowhere clearly defined is a great risk in case the planning secretariat is unavailable. Another disadvantage of missing clear rules is that all users expect the planning secretariat to foresee and solve any problems that arise during the planning of patients. Furthermore the use of two information systems is remarkable. As all information eventually needs to be entered in EZIS at some stage the question arises why an Excel sheet is used. The next chapter will explore this question by investigating what determines a successful information system. Subsequently the following chapter will explore what is needed for the effective management of the HCR planning process.

3 Literature review

Hospitals constantly try to optimize their processes to reduce costs, without reducing treatment quality and patient satisfaction [3, 22]. Hospital managers experience an increased pressure to improve processes [23], as the costs of medical care increase worldwide at an alarming rate. Although most of these costs can be attributed to the aging population and advances in techniques, a significant part of this increase is due to inefficient operations in the healthcare delivery, administrative, logistics and operational processes [24]. This also applies to the HCR which is not only one of the major financial drivers of the hospital [25], but also a critical procedure for patients both physical as mental [22]. This chapter will elaborate on three aspects relevant in a planning system. The first part of this chapter, 3.1, will briefly mention some popular process optimization techniques, after which section 3.2 will apply the D&M model to the HCR. In this section the interview model for the data collection is also generated. Subsequently section 3.3 explains what is needed to effectively control the HCR. Finally section 0 concludes this chapter.

3.1 Process optimization

In the manufacturing industry process optimization has been the subject of research since the late 1930s. Many of the techniques developed in manufacturing are nowadays used in health care. The strength of these techniques lies in their structured approach [26]. The most popular techniques in health care are two relative new techniques: Six Sigma and Lean [26, 27]. More recent Lean Six Sigma was developed as a combination using the best of two worlds [28-30]. Six Sigma focusses on the reduction of the variability in the process by using extensive data analysis and constant monitoring. Six Sigma projects consists of six steps: Define, Measure, Analyse, Improve and Control (DMAIC). Lean is a process method that focuses on the reduction of wasteful and unnecessary steps by standardizing and stabilizing processes [31]. Lean Six Sigma combines the best of both. It combines the techniques for reducing wasteful steps of Lean with the data analysis and variation reduction techniques used in Six Sigma. Cima et al. [6] conclude that Lean Six Sigma is applicable in a high-volume surgical situation. It can result in significant efficiency improvements and financial gains without increasing expenditures or change the infrastructure.

The main reason for the popularity of the above techniques is applicability both at the organizational as at the work unit level [32-34]. However, several authors have spoken their doubts about the evidence of their effectiveness in health care [31]. Although multiple articles found significant improvements [6, 25, 35-37], their supporting evidence is weak [31].

Berg [9] uses a sociotechnical approach to analyse hospitals and their information systems. According to him, three aspects are important in hospital processes. The first aspect is the primary work processes, which include all actions that directly influence the patients' care. The secondary work processes, which consists of all actions that support, complement and steer the primary process is the second factor. The third is the information system which consist of all IS used in the hospital [1]. The relation between the three aspects is displayed in Figure 8. The double arrows indicate that a change in one field will affect the entire network. A change should therefore be done simultaneously throughout the network [1, 9]. Most improvements however are made only in the primary and secondary processes and the information processes are neglected [31]. For the development of new information systems early involvement of personnel is essential [1, 38]. To start, a deeper insight is needed in the current work practices with the information system [18]. This has to be done on-site and not only via interviews and surveys elsewise it will be impossible to determine what IS functionalities should be available and in what form [39]. The following section uses the model explained in chapter 1.5 to examine IS in relation to the planning process.

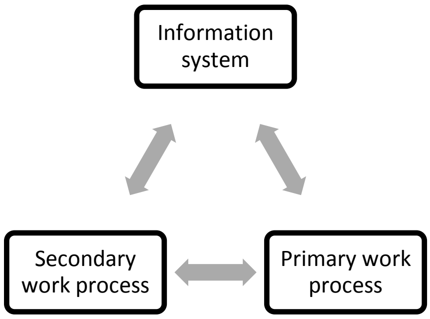


Figure 8 Process changes in hospitals [1]

3.2 Delone and McLean [2] model of IS success

3.2.1 System Quality

The system quality concerns the performance of the information in a technical and a design perspective. The success of an information system is determined by all levels of the organization, from the work floor till the top management [1]. This implies that all levels must be included in the research. Van der Meijden et al. [12] state that the most commonly used measure for an inpatient clinical information systems is *ease of use.* Gable et al. [16] found this as a validated measure as well. The importance of this measure seems obvious as personnel and specialist have to work with these systems on a daily basis.

Q1: How do you experience the use of the current planning system?

Other applicable measures validated by Gable et al. [16] are *requirements, features,* and *accuracy.* These three measures all focus on the capabilities of the system. Information systems should not attempt to replace the ad hoc nature of the work by the rationality given in a system, rather it should form a seamless web with the current processes [9]. For this the entire network in which the new system is developed needs to be known and the requirements of all the users must be defined [40]. The development of a new system should use the existing system as starting point and work from there, as much wisdom is already embedded in current practices [9, 41].

Q2: What (capabilities) do you expect from a planning system?
Q3: Where do you think the current planning system can be improved?

For the success of a new planning system all users must be involved to create willingness to change, which is quite different compared to the industry where changes are usually imposed by higher management [22]. For the optimal support of an IS in the care process it has to be meticulous interwoven in the current practices of the specialist and other personnel [9]. To succeed on this part a constant monitoring must take place during the development, implementation and use of a new system [1]. Also the generated schedules need constant monitoring and controlling in order to continuously improve them [42]. Therefore clear evaluation criteria have to be set, which can differ over the various stakeholders of the system [1].

Q4: How should the planning system be evaluated?

Van der Meijden et al. [12] found several studies indicating system use was lowered due to the complicated methods to enter data. Data entry by specialists is a well-known bottleneck in medical informatics [43]. Therefore the input for specialists must be clear and understandable. Hence input into the system must be done in by the right persons, at the right time in the right form. However, it is often unknown what the specific role is of a person at a given time which leads to unnecessary communication and interruptions [44, 45]. Coiera [46] found that up to a quarter of the calls in a hospital are made to identify who is the owner of a specific role at that moment. It must be clear who is responsible for which role and how this person should be reached [44].

Q5: What tasks, roles and responsibilities are there in the planning system and who owns them?

Furthermore Haux [8] expresses the need for strategic information management. As more and more information systems are used within the hospital there is a need for institutional, and possible regional or national information systems. Kaplan [47] adds to this by stating that the ‘fit’ of the IS with other aspects of the organization is crucial.

Q6: Which other parties should be involved in the planning system? (e.g. other departments or referrers)

3.2.2 Information Quality

Information quality is concerned with the output of the system in terms of reports and on-screen information. Measures for information quality include availability, usability, understandability, relevancy, format and conciseness [16]. For users the timeliness and availability of information are positively related to information quality [12]. Within the planning system three moments can be distinguished: prior to the scheduled day, during the scheduled day, and after the scheduled day. The first one gives insight into e.g. waiting lists, available slots, and planned slack. The second provides information during the day on e.g. progress of the program, slack, overtime, and emergency patients. The last one gives information on e.g. the performance of the actual schedule compared to the planned schedule.

Q7: What information do you require prior to the scheduled day?
Q8: What information do you require on the scheduled day?
Q9: What information do you require after the scheduled day?

How, when and what information is provided should be carefully organized, as giving to much information can work counterproductive [11, 38]. Medical professionals (specialists and personnel) report a loss of overview when to many screens must be addressed to enter or retrieve information [38]. Williams et al. [44] state that the mode of transmission should be appropriate for the information, which is often not the case in a hospital. Ash et al. [38] contribute to this by stating that communication is more than information transfer, it is about generating an effect. Van der Meijden et al. [12] found several studies using 'report completeness' as a measure for information quality. However, completeness does not always constitute efficacy [38]. So a clear view of the information needs of all users is necessary, in order to prevent information overload.

Q10: How do you experience the current information quality?
Q11: In what manner do you want the information to be available?

3.2.3 Use

The use IS is primarily researched by time and work studies concerning number of entries, frequency of use and duration of use [12]. Delone and McLean [2] state that the use of output generated in the form of reports is also considered as use. In case of the HCR planning this can be the day schedules and management reports. These latter reports can give valuable insights in the on-going operations. Multiple authors state that contextual issues must be taken into account when measuring the use of an IS [1, 13, 15, 38, 47, 48].

Q12: What other factors influence the planning system?

Dawes and Sampson [49] conclude that specialists tend to use printed over digital resources as these are readily available, and require the minimal costs in time and money. However, Ash et al. [38] found that fast access to relevant data is also important for specialists. Kaplan [47] further states that “users adjust their work routines to a system just as they adjust system use to their work environments”. This implies that users co-evolve with the information system and that information systems should fit the ecology of the work practices in order to perform optimally [38, 50]. Therefore the goals of the information system must be aligned with the perceived benefits of the users [51].

Q13: What do you see as the benefits of the system?

For managerial purposes it is necessary to require professionals (both specialists as personnel) to use more structured ways of data entering [38]. However, when the structuring of the information decreases its relevancy to the primary task the information becomes less useful [19]. So, next to the content of the output insight is needed in how the output is used.

Q14: How is the output of the system used?

3.2.4 User Satisfaction

User satisfaction concerns the response of the recipient on the output of an information system [2]. Ives et al. [52] define user satisfaction as “ the extent to which users believe the information system available to them meets their information requirements”. As the user satisfaction is associated with the use of computers, attitudes towards the computer system must be incorporated as well [2, 12].

Q15: How do you feel about using IS for a planning system?

The most used instruments for measuring satisfaction are the End User Computing Support (EUCS) instrument of Doll and Torkzadeh [53] and the User Information Satisfaction (UIS) instrument of Ives et al. [52]. Both the EUCS and the UIS contain items related to the all of the success dimensions of DeLone and McLean [14]. Petter et al. [14] state that because of this, several authors choose to only include those components which are not addressed in any of the D&M dimensions. Applying this to the EUCS instrument (displayed in appendix

9.4) reveals that the content component is the only one not addressed in any of the other dimensions. This component addresses users' satisfaction on the information presented by the system (see appendix 9.4).

Q16: How well does the current system satisfy your information needs?

Both Van der Meijden et al. [12] and Petter et al. [14] found that several authors only measure satisfaction by a single construct. This can reveal satisfaction on the performance of the other aspects of the system. For instance, personnel would like their shifts to start and end on time and surgeons want to start on time and work uninterruptedly until the last patient [42]. Several authors take users satisfaction as the only construct to measure information system success [53].

Q17: How satisfied are you with the current planning system?

3.2.5 Individual Impact

The individual impact concerns how the IS influences the effectiveness and capabilities of the individual on behalf of the organization [16]. However, it can also concern the users' better understanding of the context in which a decision is made, or change the users' perception on the usefulness and importance of the information system [2]. The measures of Gable et al. [16] are learning, awareness (of job related information), decision effectiveness and individual productivity. Van der Meijden et al. [12] found changed work practices, changed documentation habits and information use in daily practice as most studied aspects of individual impact. The aspects that van der Meijden et al. found all focus on behavioural aspects of the IS whereas the aspects found by Gable et al. focus on the impact on the capacities of the users. An IS can collect and aggregate data and create a new level of overview, both in real-time as afterwards [9]. This can create insight in the on-going operations. Giving insight through information can create awareness among specialists, personnel and management. For example specialists and personnel can be given insight in what impact different decisions have on the execution of the planning. For the management better insight in the performance of the planning can indicate opportunities for improvement and a tool for better steering.

Q18: What insight do you want from the planning system?
Q19: What insight do you get from of the planning system?
Q20: How does this insight affect you?

3.2.6 Organizational Impact

The organizational impact concerns the effect of the information system on the performance of the organization [2]. The validated measures of Gable et al. [16] on organizational impact applicable to the HCR are organizational costs, staff requirements (in terms of resources), cost reduction, overall productivity, improved outcomes and increased capacity. These measures can be seen as the effectiveness of the IS, which can be defined as the difference between the desired and achieved goals [54]. Within a planning system these goals are formulated in performance measures [7]. Measures on effectiveness and efficiency must be defined to compare the planned schedule with the executed schedule [42]. Cardoen et al. [3] define eight planning performance measures most used in literature: waiting time, throughput, utilization, levelling, make-span, patient deferrals, financial measures and preferences. Most of these measures have some interdependencies, e.g. increasing throughput will have influence on the utilization and financial measures. To evaluate the generated planning and to measure the effect on the organisation clear targets must be set.

Q21: What should the performance target of the planning be?

Van der Meijden et al. [12] found that other measures used for inpatient clinical information system success are communication between departments and impact on patient care. The collaboration of the HCR with other departments is not of the same size as, for instance, that of an operating theatre, it however does have an impact on their process. Therefore communication must involve all stakeholders within the domain of the planning [9, 40]. This is also reflected by the idea of Berg [9] that health care practices can be seen as heterogeneous networks in which all elements are closely interrelated. Changes within one of the elements will affect the entire network. Furthermore, changes in the network will inevitably have political impact [1].

Q22: What impact does the planning system have on the HCR / organization?
Q23: What impact does the organization have on the planning system?

IS enables organizations to increase the quality of the management decision making process and at the same time provide the ability to improve monitoring by performance measurement [55]. Finally an IS can create opportunities for new forms of management to improve the care process, which are not possible without the use of an IS [1].

Q24: *What organizational potential do you see in the planning system?*

Q25: *How can the planning system improve efficiency and productivity of the HCR?*

Q26: *How can the planning system support management of the HCR?*

3.3 System control

The previous section has elaborated on the determinants of an successful information system for the HCR. For a more effective and efficient planning system an information system alone is not sufficient. The complete process surrounding the planning must be carefully managed to maximize the effectiveness and efficiency of the HCR. De Leeuw [57] created a model of an to-be-controlled situation as displayed in Figure 9. According to De Leeuw a control situation exists of a to-be-controlled system (C.S.), a controlling body (C.B.) and an environment (E). The arrows represent the relationships between these aspects. The arrows from the C.B. to the C.S. and E. are the relations which realize the actual control. The relation between the C.S. and C.B. and E. are the information flows needed for control. The arrow from the C.S. to E. represents the behaviour expected form the environment by the C.B. And finally the relation between E. and the C.B. represents the influence the environment exerts on the C.B. on what their required behaviour is.

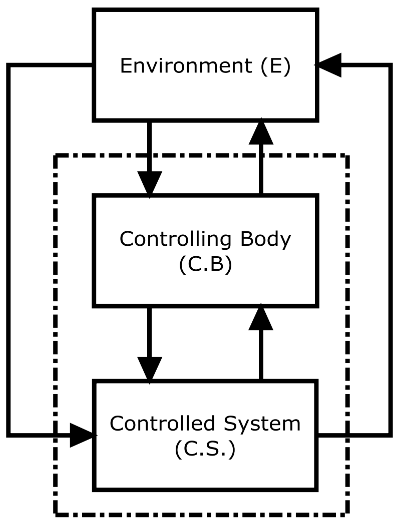


Figure 9 Model of a control situation following the control paradigm [56]

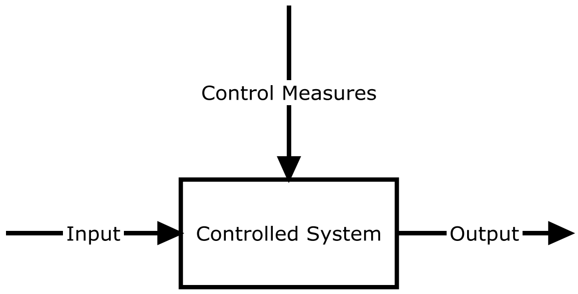


Figure 10 Model of controlled system[56]

The C.S. can be further modelled as in Figure 10. The input represents all variables which cannot be manipulated and the control measures are the variables used to manipulate the system. The controlled system together with the input and control measures determines the output of the system. To be able to effectively control the system Kramer and De Leeuw [58] determined five success conditions:

1) A target must be specified and known to the C.B.
   Without the presence of a target, there is nothing to steer on. Targets can be either quantitative or qualitative. The former one can be assessed by hard figures, where the latter one needs some sort of committee who can judge how far the target is met.
2) The C.B. needs to have a model of the C.S.
   Having a clear and complete model prevents that control measures are used because of a preference of the C.B.; instead control measures can be used because of their anticipated effect on the outcome.
3) The C.B. must have information on the input and state of the controlled system
   This condition is a logical consequence of the previous condition. The model has specified what the different variables are that influence the system, next information is needed about the condition of these variables. Based on this information the effect of control measures can be assessed.
4) The C.B. must have sufficient control variety
   In order to affect the outcome of the system the C.B. needs to have sufficient controlling options. According to Kramer [56] sufficient control variety is available when at least the same amount of control variables are presents as there are input variables.

A few years after the initial publication De Leeuw [59] added a fifth condition:

5) Enough information processing capacity must be present
   The information in the system must be converted, using the model of condition 2 and the targets of condition 1, into effective steering measures. For the optimal use of the information thy system needs sufficient processing capacity.

3.4 Conclusion

This chapter described two models which are relevant for planning at the HCR. The Delone and McLean [2] model describes six constructs that determine the success of an information system. The second model, of De Leeuw [57], describes three elements present in a control situation: the controlling body, the controlled system and the environment. Subsequently he defines five conditions which have to be met in order to effectively control the situation.

Berg [1] concluded that an optimal system reaches a synergy between the IT system, the primary process and the secondary process. Looking at the model of De Leeuw this elements are also present. In case of the HCR planning the environment represents the primary process, the controlling body represents the secondary process and the control of the C.B. on the C.S. is executed through the information systems. Figure 11 represents the relation between the D&M model and the model of De Leeuw for the HCR. The controlling body uses the IT to control the system. This concerns the system and information quality (the blue elements). The following three elements of the D&M model (depicted in green) relate to the human aspects of the information system, which in the De Leeuw model are included in the controlling body and environment. Finally the organisational impact resembles how the entire controlled situation is performing. Thus, the planning comprises of more than just an information system. To effectively manage the HCRs the entire process must be included. The next chapter will use both the model of Delone and McLean as the model of De Leeuw to assess the situation at the HCRs.

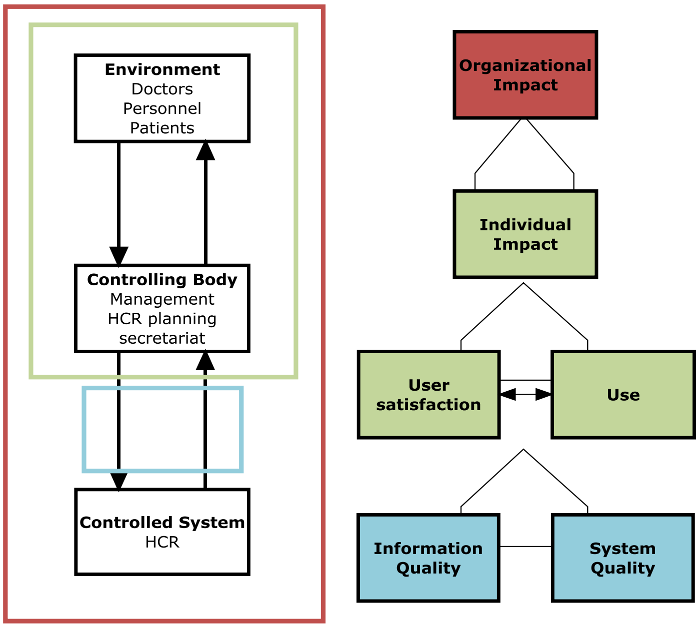


Figure 11 Relation of D&M with De Leeuw

SECTION 2

DATA COLLECTION AND RESULTS

4 Results

This chapter will present the results of the study. In section 0, the results of the observations will be elaborated. Observations were made at the heart team meeting preparation, the heart team meeting, the HCR planning and at the HCR procedures. In the following section, 0 the results of the interviews will be elaborated based on the six dimensions of the Delone and McLean model.

4.1 Observations

During the research several participative observations are done. The observations took place at the several steps of the process in the planning: the heart team meeting preparation, the heart team meeting, the HCR planning secretariat and the HCR procedure. The researcher was present at the HCR planning secretariat during several days to observe the work routines, and to get an insight in how the two information systems are used to create the planning. The researcher was present at two heart team meeting preparations, two heart team meetings and observed procedures at the HCRs during two days. During all observations field notes were taken.

4.1.1 Heart team meeting preparation

The HTM preparation is done at the heart team secretary. The secretary prepares the HTM by digitizing the applicants' request and filtering the important information from the application forms. This information is placed on the primary screen of the HTM in EZIS. If information is relevant is judged by the secretary, based on their experience and knowledge. No formal procedures are documented about what processes have to take place before the HTM. This makes it a sensitive part of the process. The information delivered to the heart team secretary is often not complete, which means that the secretary needs to contact the referrer. This mainly accounts for the external requests, which are all paper based. When the heart team secretary decides all information is present the patient is admitted to the HTM.

4.1.2 Heart team meeting

During the HTM a cardiologist and cardiothoracic surgeon assess all patients which are prepared by the heart team secretary. To assess the patient the HTM uses the preparation of the heart team secretary in EZIS, the paper based patient record, the paper application form of the referrer (if present) and medical movies (cardio angiographic and echoes). During the observation it became clear that the programs used for the medical movies can be extremely slow. Sometimes a movie was loaded within seconds, however most of the time it took several minutes. The cardiologist and the cardiothoracic surgeon estimate that during a single HTM an average of 25 minutes is spend on waiting until images are loaded. Which is high considering a HTM duration is between 2 and 3 hours (on average, also estimated by the cardiologist and cardiothoracic surgeon).

During the observations multiple patients could not be assessed because of missing information. Sometimes the information of the referrer was incomplete (e.g. no blood values were known) and sometimes there were no images which are essential for the assessment of the patient. It is remarkable that these patients were admitted to the HTM, as the HTM secretary should have checked if this information was present. Furthermore multiple patients were added to the HTM while the meeting was already in progress.

4.1.3 HCR planning procedure

The HCR planning secretariat is situated next to the coffee room of the HCR. Because of this the HCR planning is often interrupted. Several times a doctor entered the secretary to see if a scheduled procedure could be rescheduled, or to see if it was possible to get an additional day off (for instance for a conference). A few times a doctor came with the remark that a patient was not correctly planned; this could be easily solved by adjusting the procedure on the schedule. However in one case, the patient needed to be rescheduled because the correct procedure was significantly longer than the planned procedure.

For the planning of certain procedures a paper request is used. This has to be signed by a cardiologist. Multiple times a request form was handed in by a resident without the signature of a cardiologist. As a result the patient could not be planned; however, due to its location the secretariat can easily get a signature by asking a cardiologist in the coffee room. The planning secretariat regularly confirms certain actions with a doctor or resident in the coffee room. For instance questions on specific medical pre-conditions of a patient, if a patient can continue with certain medication or if a specific procedure can be executed by one of the residents.

4.1.4 HCR procedure

During one of the observations the day starts with a short presentation of a supplier of medical instruments, therefore the first procedure starts at 08.30. In the Excel sheet this presentation was announced, however, in the schedule of EZIS the first patient was planned at 08.00. At the second observation the first procedure was also scheduled at 08.00, and the actual procedure started at 08.20. A recent internal investigation [10] showed that all HCRs generally start after 08.00, although they are planned to start at 08.00.

A total of 8 procedures are observed, and during the observations the time registration by the HCR personnel was closely monitored. The observer registered three times 1) the time which was entered in the system by the HCR personnel, 2) what time should have been entered (the actual time), 3) and *at* what time the HCR personnel entered the information.

The observations can be found in appendix 9.5, in Table 5 to Table 12. The HCR personnel has to enter five moments in to EZIS: p*atient at room, start procedure, end procedure, patient from room* and *patient to ward*.

The first two times were mostly entered after the start of the procedure. This implies that the times were estimated. The only observed reason for this inaccurate registration is that during these moments the HCR personnel is working with the patient. The HCR personnel brings the patient into the room, then immediately start preparing the patient for the procedure. Once the patient is prepared for the procedure the HCR personnel has to enter several patient related information in different systems. Somehow, the time registration is not seen as essential, so other information is entered first. Even though it is merely clicking on the specific time moment, and press F3 to enter the current time.

For the remaining three times similar observations are done. Just before, or after the end of the procedure, an estimate is made on the *end of procedure, patient from* room and *patient to ward* times. Again the personnel is busy with the patient at these moments, which can explain why they do not enter the times correct. The *patient to ward* time is always an estimate, as the patient is picked up by the ward personnel out of sight of the HCR personnel. One of the reasons why the estimates of the HCR personnel derive too much from the actual time is because of the timespan between the actual time and the time of entry in the system. During the observations the longest time between an actual time and the time when the HCR personnel registered it was 42 minutes (16.02 was the actual *end procedure*, it was entered as 16.15 in EZIS at 16.44).

Already admitted (in another hospital) urgent patients are transported to the CZE by ambulance. As these patients return to their own hospital after the procedure the ambulance has agreed to remain at the HCR to transport the patient back immediately after the procedure. In this case, the CZE does not have to use an additional bed. However, to minimize the occupation of the ambulance, there is an agreement that an HCR must be free at the moment the ambulance arrives. If this is not the case, the ambulance will leave, and the patient needs to be admitted at the CZE. During the observation, one already admitted patient was planned after the lunch break but arrived 30 minutes after the lunch break. This caused one HCR to be idle for 30 minutes (which is enough time to execute certain procedures).

4.2 Interviews

During the study 10 interviews are held. Different stakeholders of all levels were included, as suggested by Berg [1]. The interviewees consisted of 2 cardiologists, 2 planners, 2 managers, 2 HCR employees and 2 employees of other departments who are affected by the HCR planning. The interviews were held in Dutch, to avoid miscommunication or misinterpretation of the questions and answers. Confidentiality is promised to increase the openness during the interviews [20]. All interviews were recorded and field notes were taken. Directly after the interview the field notes were elaborated. Subsequently the audiotape was played and the field notes were adjusted if necessary. This method was adapted from Halcomb and Davidson [60]. The field notes are send back to the interviewee, who is allowed to revise the given answers. This member checking increases the validity of the data [61]. After the approval of the interviewees (1 respondent made some small changes) the field notes were coded using the dimensions of the D&M model.

4.2.1 System Quality

The most mentioned aspect on system quality concerns the design of the planning system. All 10 interviewees state that the current system is underperforming. Two major reasons for this underperformance are given by the interviewees. Firstly two separate information systems are used. One interviewee states (freely translated): *"Information has to be entered multiple times, and across different systems. This is not only time consuming, but also leaves room for error".* The second factor is the lack of coherency within the planning system. *"What [the heart team secretary] enters [in EZIS], we have to enter again [in EZIS] and when the patient receives a second procedure everything has to be entered again [in EZIS]".* The number of interviewees mentioning these two aspects is displayed in Figure 12.

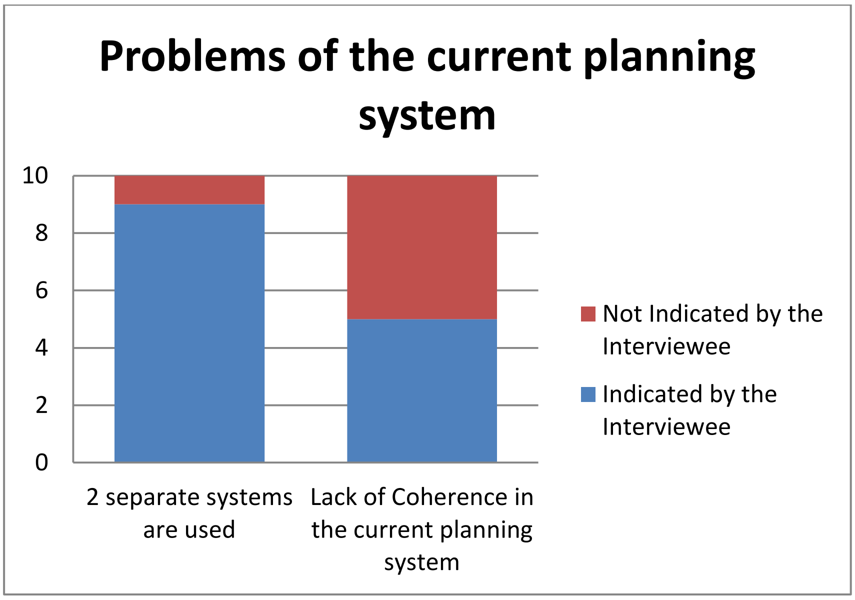


Figure 12 problems of the current planning system

Next more clarity is expected from the system. Several interviewees mentioned the lack of overview on for instance what the day schedule is (3 interviewees), or what the progress of is (3 interviewees). Furthermore it is not clear what the different conditions are on which decisions are based. For instance, "*it has to be clear what activities must be done before a patient can be scheduled and which information needs to be provided in order to plan a patient."* Most interviewees indicated (see Figure 13) that creating the planning in a single system is the largest improvement potential for the current system. A second improvement, which is mentioned by four interviewees, is making more use of the information which the planning system can provide. The planning system can already provide data on, for instance, procedure times or the number of times the schedule is exceeded. However, these times are not used.

Another major factor in the current system quality is the fact that there is a lot of knowledge at the planning secretariat. For instance, the secretariat has knowledge on the prerequisites of patients. During the observations at the secretariat it occurred multiple times that the secretariat noticed that no recent blood values were known for a patient. Although the blood values are a responsibility for the doctors, the fact that the secretariat needs to check this is an indication that the responsibilities of the different persons involved in the planning are not clear. But because the secretary continually checks these prerequisites, "[*which] is done to make sure that certain tasks will be executed",* it is seen as the current way of working. However, *"the planner has the responsibility to report deviations, not to solve them".* The current system relies too heavily on the expertise and know-how of the planning secretariat, which creates a high risk at the moment the planning secretariat is not available.

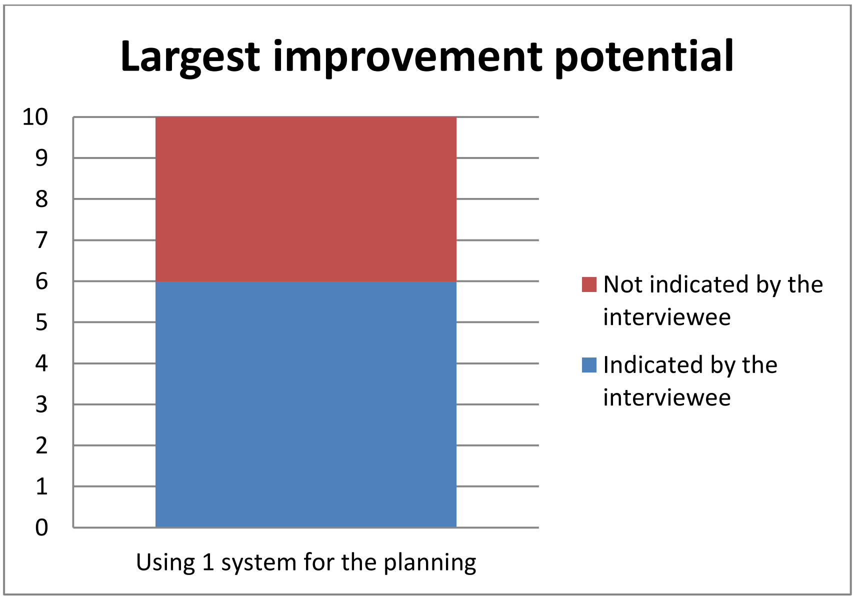


Figure 13 largest improvement potential

How the planning process takes place *exactly* and who is responsible for which part is not clear to all involved. *"It is not clear who is allowed to make decisions, and, at the moment,* *too many people are involved in the planning",* was the reaction of one of the interviewees. Another stated that "*among the doctors it is not always clear who made what decision, and what the grounds for those decisions are".* Also, several tasks of the doctors are being done by secretaries, although it is not their responsibility. Closely linked to this problem is the correct delivery of information to the planning secretariat. *"The basis of the planning is the supply of correct information"* was the opinion of one of the interviewees, another elaborated on this by saying that *"because it is not clear who is responsible for what registration, miscommunication occurs. This miscommunication leads to irritations, which is unnecessary".* As can be seen in Figure 14, this is supported by the majority of the interviewees.

Two interviewees mention that the planning system is currently not being evaluated. One interviewee explains that this is because of the confidence in the know-how of the planning secretariat; another states that evaluating the planning is not useful due to the large disruptions. Two interviewees relate the evaluation to the quality of the information. They state that the information generated by the planning system should be assessed by the different stakeholders who use the output. This should include comparison of the actual versus the realized planning.

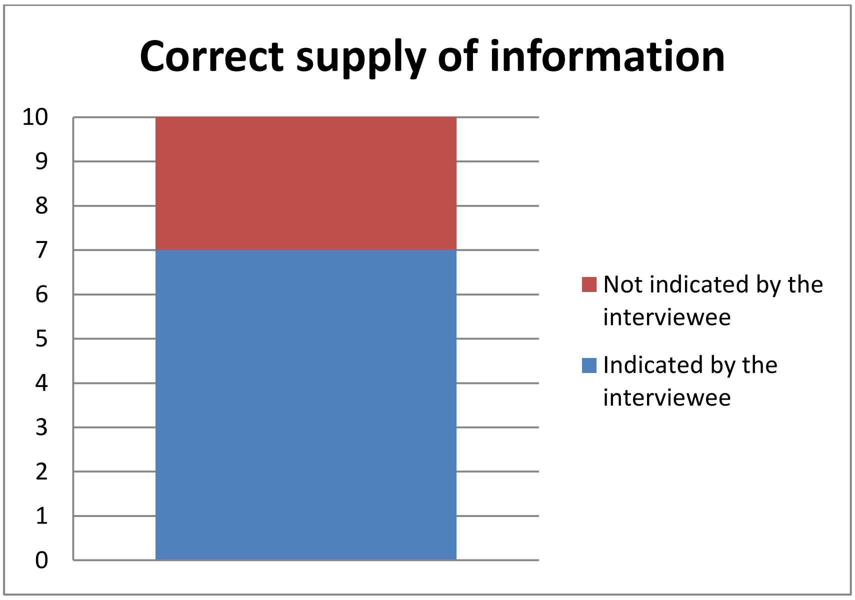


Figure 14 Task, roles and responsibilities

4.2.2 Information Quality

All interviewees doubt the completeness of the information. This is a major issue, and several interviewees mention it multiple times during the interview. The completeness is being questioned on multiple fields. First all information delivered to the planning secretariat must be complete and clear, which is currently not always the case according to four interviewees. The most mentioned aspect is the procedure indication by the doctor. These indications are sometimes incomplete - *"regularly a request is made for a single vein, and during the procedure it appears to be a closed vein. This is something which I assume was seen at the HTM, but not reported"* - or inaccurate - *"it is frustrating that you want to inform a patient about their procedure date of a simple CAG* [a 30 minute procedure], *when the patient responds with: oh, the doctor said it would be a difficult PCI* [a 90 minute procedure]". During the procedure the registration by the personnel at the HCR is also done inaccurately. This was already observed in the previous section, and now 3 interviewees confirm these observations.

The information needs prior to the scheduled day primarily concern the HCR planning secretariat. Two interviewees state that the prerequisites of a patient must be clear. *"It must be clear (…) which actions have to be executed before the planning secretariat plans a patient. Also it has to be clear what information is needed before a patient is planned".* Furthermore, multiple interviewees (see Figure 15) state that the planning should be based on data regarding what procedure is done by what doctor. "*If a doctor needs 15 minutes for a procedure with a standard time of 30 minutes, is it ridiculous to plan 30 minutes. This also applies the other way around".*

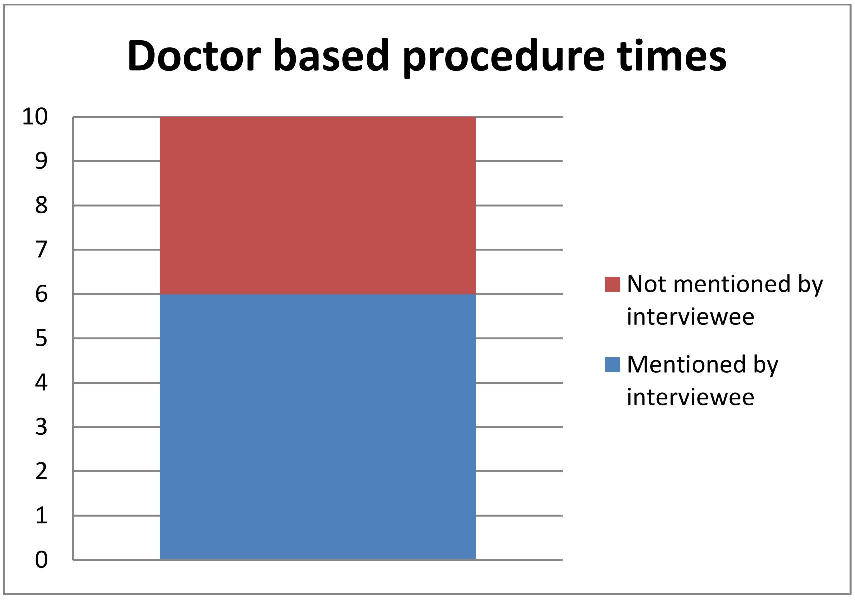


Figure 15 Procedure times

Currently the planning secretariat plans procedures based on their experience with the procedure times of different doctors. "*Six weeks in advance the doctor planning is known and if certain doctors works, the master schedule is immediately adjusted, based on the knowledge of the planning secretariat".* Multiple interviewees further mention that the planning system does not yet anticipate enough on emergency patients. *"We try to save room for emergency patients, by planning 1 or 2 procedures less. However, in practice, these rooms are often used to reschedule patients who have been cancelled earlier that week".* Four interviewees (see Figure 16) state that the planning should incorporate room for emergency patients. *"At the moment the planning is to ad hoc, room is held available [for emergency patients], however the amount of room held available is not yet substantiated".* Two other interviewees state that it is impossible to plan for emergency patients, as their arrival rate is too diverse: *"One day we have 5 emergency patients and the next day we have zero emergency patients. It is not possible to plan on this, and we don't want to reserve capacity for emergency patients, because it could cause the HCR to be idle"*. The information needs of the doctors and personnel prior to the scheduled day are confined to basic information, e.g. *with whom do I work tomorrow* or *what procedures do we execute tomorrow*.

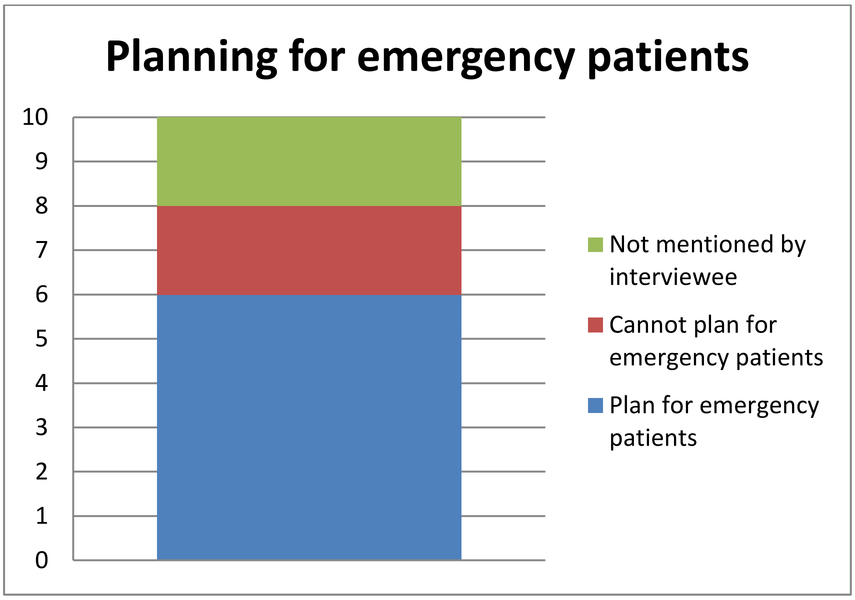


Figure 16 emergency patients

The progress of the schedule is the major information requirement during the scheduled day. The number of patients already done, the number of patients still to be done (including what procedure) and the number of emergency patients is how the progress of the schedule is currently monitored. During the day information on the actual times is entered directly into EZIS. However, as paragraph 4.1.4 showed, these times are often inaccurate. Other information needs during the day concern the origin of the patient (other hospital or ward), information of emergency patients (arrival and condition) and the slack in the program.

After the scheduled day the information quality is primarily for management functions. *"At the moment enough data is available, however the reliability of the information is unknown".* For instance *"not all emergency patients are labelled as such in EZIS, this withholds us from analysing the arrival of emergency patients".* Other information needed in the management reports are: deviations between the actual and planned schedule, number of patients cancelled and number of patients rescheduled.

4.2.3 Use

“The current system works because the current users are the people who designed, specified and improved it”, was indicated by one of the interviewees. This is shared by another interviewee stating that *“the only benefit of the current system is that it aligns with the current users. But it costs a lot of energy, a lot of double work has to be done, and it has too little benefits”.* Three interviewees gave similar answers. Two interviewees state that another benefit of the system is the flexibility of both the system and the personnel. *“At the moment we have very flexible personnel at the HCR, this is why emergency patients do not always cause major problems”.* Another interviewee elaborated: *“when everything is bound by rules the execution of the program will sometimes come to a stop because the formal rules are not met. The flexibility of the current system prevents this stop”.*

This flexibility is part of the culture which is present at the HCR. Three interviewees stated that this culture is the reason why the information quality is low at the current moment. *“The current users do not know why the information is needed, and they do not get feedback on the information entered”,* was the explanation of one of the interviewees. Another one stated that *“the personnel have their priorities with the patient. That is why they first completely prepare the patient before doing the administrative tasks, which then becomes guesswork”.*

The output of the system (the Excel sheet, and the planning overview in EZIS), are used in mixed ways. Some people use only EZIS (*“I prefer to use EZIS, as this displays the actual program”*), and others use the Excel sheet (*“I prefer to work with the paper print-out, primarily because I always used paper”).* Another person stated that the current output of the system is made in such a way that it is workable for everyone, but it is not the most optimal way.

4.2.4 User Satisfaction

In general the users are moderately satisfied by the system. The main reason for dissatisfaction is the discrepancy between the two systems being used at the moment, as can be seen in Figure 17. However, the users have become used to working with the system, which is why the system still operates. *“Looking at the means we have, the planning system is good. However, looking at what is desirable, I think we should have a more professional planning system”* was the reaction of one of the interviewees. Another interviewee said: *“I am not happy with the current system because a lot of information has to be entered multiple times, which is error-prone. We are used to the system which is why it works. But the system does not link information, which is a major pitfall”.* This lack of information linking by the system is also mentioned by another interviewee stating: *“[The system] can, and must, be improved. At the moment there are too many moments on which [a HCR] is empty and procedures are not aligned”.*

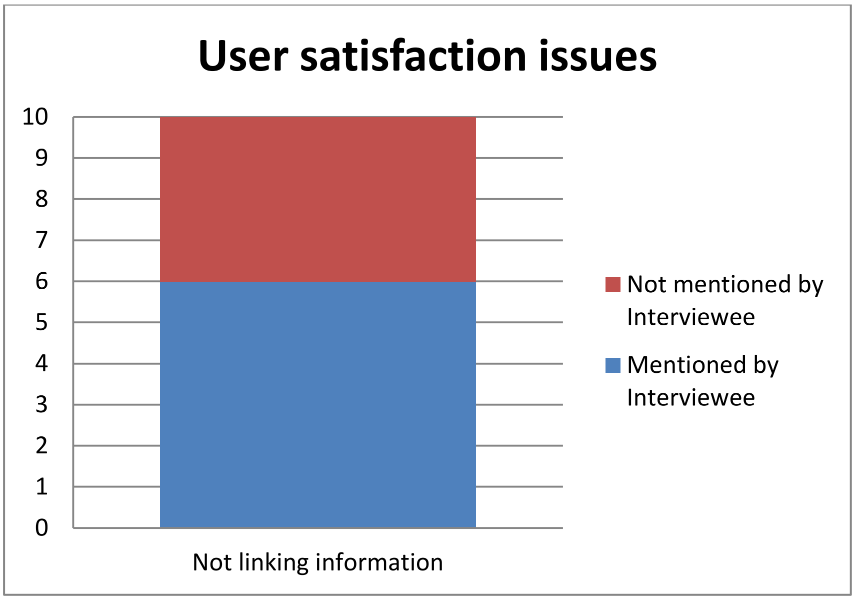


Figure 17 User Satisfaction

As can be seen in Figure 18 all respondents state that IT should be used for a planning system. However, four interviewees state that it is essential that it aligns with the current work processes. *"We should work in a more automated way, however our experience with it is not so good, as the system is not yet capable of generating an overview which is usable for planners, personnel and doctors".*

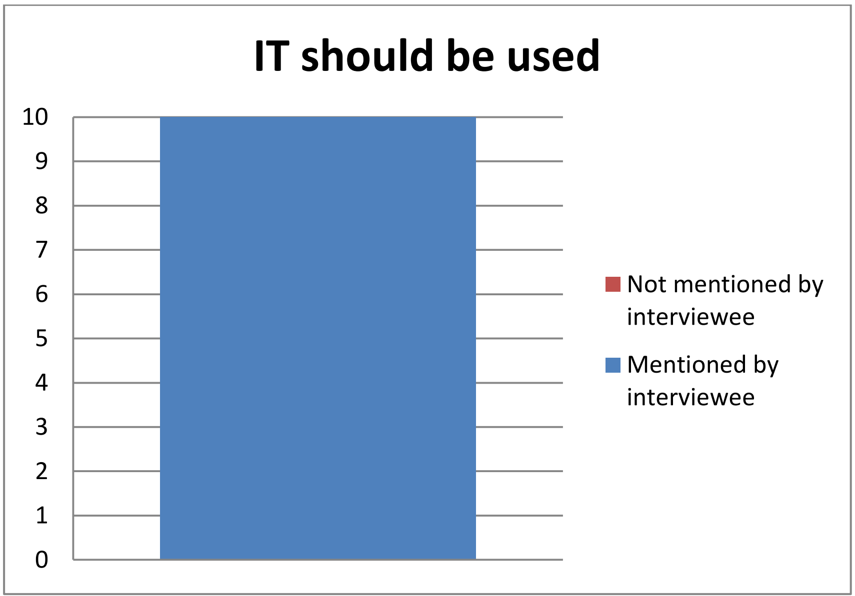


Figure 18 Using IT

On the provision of the right information by the system the users are divided, as shown in Figure 19. Three interviewees state that the current planning system satisfies their information needs. One interviewee said *"I can find all information I need within the current system, however sometimes a lot of actions are needed before the information is found".*

One other interviewee shared this opinion. Four interviewees declared that the current system does not satisfy their information needs, due to the fact that certain information was missing in the system.

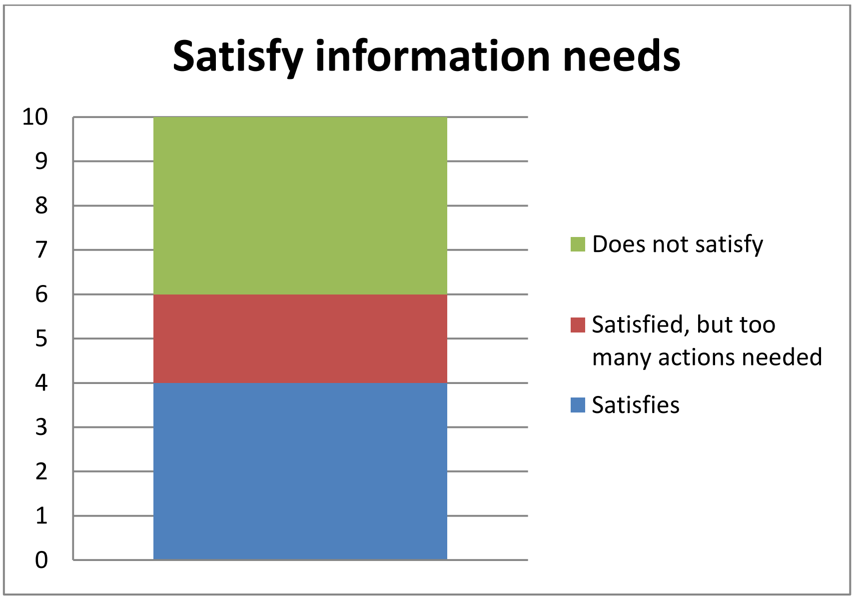


Figure 19 Satisfy information needs

4.2.5 Individual Impact

Seven respondents state that they use the planning system for a controls. For instance, during the day the progress of the schedule is checked twice on disturbances. If the actual schedule deviates significantly from the planned schedule, adjustments are made. *“Which patients are moved is assessed by looking at the procedures, the doctors, the personnel and the remaining time”.* However, with the current system rescheduling cannot be done optimally: *“the system should give insight in what procedures still need to be done, who is performing them, and how long it will take”.* At the moment, the HCR works overtime to prevent the cancellation of procedures.

An example of afterward control is given by another interviewee: *“Afterwards we can look back on the efficiency of the HCR, check for strategic maintenance moments or manage our waiting lists”*. Three interviewees mentioned that the efficiency of the room is not optimal due to the breaks of the personnel. *“The break times should be stricter because the personnel does not have the insight what the consequences are when they take a longer break*”.

As mentioned before, the information is not always complete when it arrives at the planning secretariat. This enhances the need of the control function of the planning secretariat mentioned before. Because this is not officially their responsibility “*the planning secretariat has to use different (sometimes difficult) channels to gather all incomplete information”.* Furthermore displaying (correct) data on the execution of for instance a procedure or a schedule can motivate both personnel and doctors, according to three interviewees. Several interviewees also stated that the schedule regularly exceeds the planned end-time. This may be caused by wrong estimates of the procedure time, or due to the bad alignment of procedures.

4.2.6 Organizational Impact

There is a large consensus on the performance target of the planning system. As Figure 20 displays, patient friendliness and room efficiency are the two most important targets. Some interviewees linked these two targets: *"When you increase your efficiency you reach a higher patient friendliness as you can treat patients faster".* Another interviewee defines patient friendliness as *"executing the right procedure, at the time the patient was scheduled, by the doctor who requested the procedure, and [with] well-informed [patients].* The overall performance of the planning is the organisational impact. Higher efficiency and patient friendliness lead to a better reputation and more efficient use of resources. Both can lead to financial gains for the hospital.

Other sections of the hospital are also affected by the HCR planning. The biggest impact is on the wards on which the HCR patients are administered. *"Patients are often being accelerated or slowed down. Sometimes [the ward] receives a call that a patient who was scheduled for the afternoon has to be done in the morning. This means that the ward has to prepare the patient in a shorter time span than planned (…) this is a huge disturbance in [the wards'] process, which results in reducing its efficiency".*

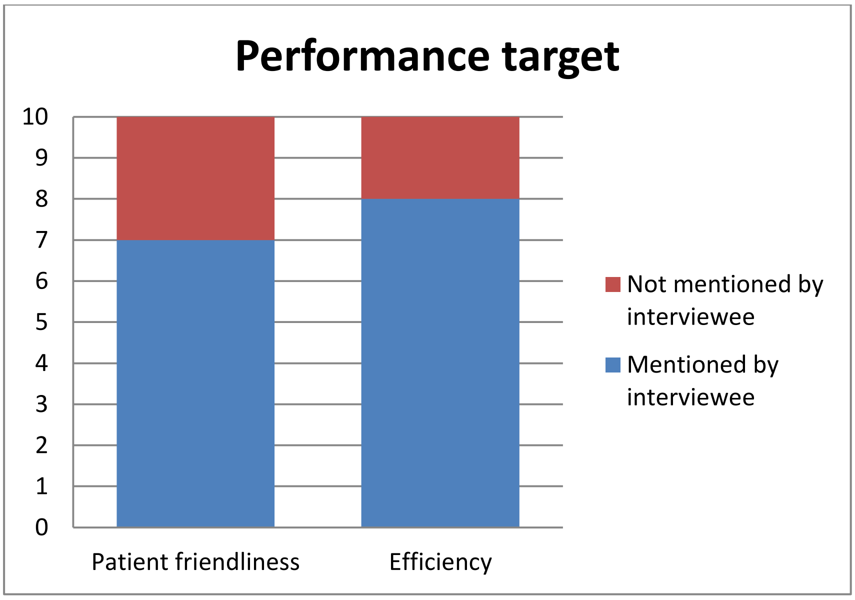


Figure 20 Performance target

Furthermore there is an organizational impact of the planning system related to the culture of the personnel at the HCR. One interviewee said *"The impact of the planning on the HCR-personnel is large (…); it has an impact on the behaviour of the personnel. When they see a full day schedule, they immediately think 'were never going to make it', and this influences* *them the entire day".* However, another interviewee stated that *"The culture of the HCR personnel and the cardiologists prevents easy changes in the system (…) there is very little flexibility for changes, because the production has the highest priority.* Lastly the planning system can support the management of the HCR by providing accurate information for steering purposes, as mentioned before.

5 Analysis

In this chapter the results of the interviews and observations will be analysed using the models of Delone and McLean and De Leeuw explained in chapters 1.5 and 3.3 respectively. Subsequently section 5.3 will answer the sub-research questions as a conclusion to this chapter.

5.1 Planning system success

5.1.1 System Quality

It is alarming that all respondents state that the current planning system is underperforming. The two most mentioned problems of the current system, the lack of coherence and having two systems, are closely linked to each other. Due to the fact that two systems are used, creating coherency between the two systems is difficult. The underperformance of the current system could be attributed to the fact that the primary and secondary processes are not aligned with the information system. At the moment, the secondary process (the planning) is using their tacit knowledge to create a workable situation between the primary process and the information system. Which seems logical as "users adjust their work routines to a system just as they adjust system use to their work environments" [47]. However, the fact that these processes are not aligned prevents optimal functioning of the planning system [1]. Another threat lies in the fact that the planning process and the division of responsibilities is unclear as having a clear model of the process is one of the conditions for effective management [58].

5.1.2 Information Quality

Again it is alarming that all interviewees doubt the completeness of the information. The inaccurate information entry of doctors and personnel becomes clear in both the observations as in the interviews. This is a well-known bottleneck [1], but it has great impact on the planning itself. The observations showed that the planning secretariat regularly needed to contact doctors to check certain information or decisions. This can seriously delay the process and imposes a risk as verbally transferred information is error prone and results in serious degradation of information accuracy [44].

The information requirements prior, during and after the scheduled day are not a big revelation. What stands out is the need for doctor based procedure times and how to account for emergency patients. Significant differences exist between the procedure times of different doctors [10]. The application of management science methods to surgical planning have already showed, both in practice as in theory, they can significantly improve the planning [42]. However, this requires accurate historical data over an extensive period of time [42]. The observations however clearly showed that the procedure times are registered with low accuracy. The uncertainty caused by emergency patients is also significant [3], and to reduce the impact of their disturbance historic data is also needed [7, 42]. At the moment steering at the HCR is not yet possible based on hard figures. Although this is desirable, the reliability of the information prevents the management form using them for managing the HCR. But it is exactly this reliable information which is one of the prerequisites for effective steering [58].

5.1.3 Use

The current planning system works because all users are used to it. However most of them do see that the system needs improvement. The time efficiency of the planning system is acceptable for the doctors and personnel, but low for the personnel involved in the creation of the planning. For doctors a system is effective if it reduces their documentation time [50], and they prefer printed schedules over digital [49]. As the schedules are printed, and the planning system currently requires little time for the doctors, it is understandable that the use is appropriate for them. However, the use for the planning personnel is low due to all the extra actions needed. Assuming the causality of the D&M model, this low score on use would be caused by the information and system quality. This is only partially true. Most of the extra actions can probably be prevented if information is entered in an earlier stage. However, the system also works because of a certain work culture. Van der Meijden et al. [12] reported that time and work studies were the most used methods to measure system use. Though the observations were not designed as this kind of study, they did shine a light on it. The usage was reasonable for the doctors and the personnel, as they primarily use the generated Excel sheet for that days' procedures. The Excel sheet provides overview, all the information and it easy to apprehend. The creation of this Excel sheet however requires several different screens and systems, and frequent communication to confirm the reliability of some data. This can result in a loss of overview for the planning secretary [38]. If the planning secretary cannot keep a good overview, it will only be a matter of time before serious mistakes are made.

5.1.4 User satisfaction

The reasons the interviewees give for their moderate satisfaction with the system can be directly derived from the D&M model. They indicate that the lack of coherency and missing information, which are elements of the system quality and information quality, are the main reasons for the lower satisfaction. Delone and McLean [2] indicated that user satisfaction can be positively or negatively affected by use, which explains that users are less satisfied because of the limitations in its use. The fact that all interviewees see the use of IT as necessarily is a positive fact, as the acceptance of IT is essential for its success [12, 43, 62].

The indication that the system is currently not aligned with the processes causes lower satisfaction, which is understandable, as the alignment with the process is essential [1, 38, 47].

5.1.5 Individual Impact

The individual users of the system is largely affected by the planning system. The planning secretariat currently has a large controlling function to ensure the continuity of the planning. This is primarily caused by the unclear division of responsibilities, which is caused by the low system quality. However it is necessary to “assign specific tasks and responsibilities to providers in a clear and unambiguous manner” [44]. The planning secretariat executes several tasks which are not their responsibility. Due to the fact that they take this responsibility other users neglect to execute their tasks as they assume that the planning secretariat will handle it. The planning system rather than the planning secretariat should support the users in decision making [38].

Improving the planning system will have a large impact on the users. As was found in section 4.2.2 there is a need for doctor based procedure times. A recent internal investigation already showed the large potential of implementing doctor based procedure times [10]. The use of these times could create an undesired affect among the doctors , as their performances become quantifiable. Several cardiologists, including the head cardiologist, have however indicated that they support using doctor based times, and they do not foresee any conflicts. For the HCR personnel improving the planning system would result in better schedules which lessens the risk of overtime.

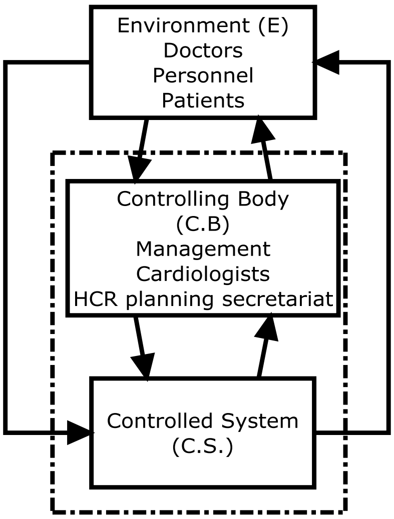
5.1.6 Organizational Impact

The largest impact on the organization is the performance of the planning system. The planning system is responsible for utilization and throughput, and optimizing those has a large impact on the organization [3]. The interviewees agree on this part but also add patient friendliness to the performance criteria. Although most literature uses only the former as performance target, Cardoen et al. [3] stress the need to incorporate patient preferences for on optimal planning. The aforementioned internal report [10] showed that the HCRs do not function at full capacity. Reflecting on the previous steps of the D&M model this could be expected due to the causality in the model. Since the HCR is one of the largest profit drivers of the hospital [5] the planning system is essential for its viability.

The underperformance of the current planning system is primarily caused by the underperformance of both thy system quality as the information quality. As these two aspects are the root dimensions of the D&M model, this should reflect throughout the other dimensions as well. The results of the interviews indicate that this causal effect is indeed present in the HCR planning process. Both the lack of coherency and the double system impede the use of the system, which in turn affects the users' satisfaction of the system. The current work culture influences the use of the system. Both observations and interviews showed that the division of tasks and responsibilities within the system are unclear. As a result the planning secretariat performs certain (inefficient) extra steps to maintain a workable system. This does not only affect the user satisfaction of the secretariat, it also implies that there is a large amount of tacit knowledge at the planning secretariat. A large risk for errors exists in case the planning secretariat is unavailable, as their knowledge is not embedded in the planning system.

5.2 System control

Looking at the management of the HCR, the model of De Leeuw [57] is applied. Figure 21 displays the model of the control situation at the HCR, and Figure 22 represents the model of the controlled system. What is remarkable in the former model is that the cardiologist are at the moment part of both the controlling body, and the environment (*Doctors* includes both cardiologists as residents and fellows). Next to the cardiologist the



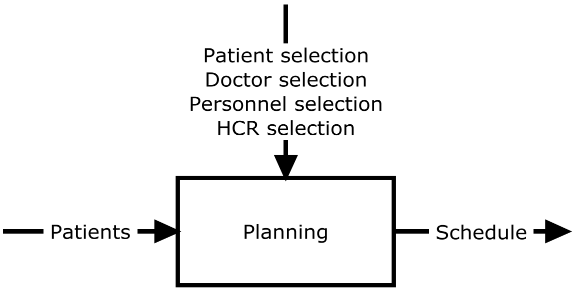


Figure 21 Model of control situation HCR

Figure 22 Model of controlled system HCR

management and the planning secretariat is part of the C.B. These users all have their own vision on management of the HCR due to their different interests in the system [4]. As explained in chapter 3.3 there are five prerequisites for effective steering [58]. Regarding the HCR these prerequisites are barely met.

A target must be specified and known to the C.B.

Section 4.2.6 showed that there is consensus on the targets of the HCR. These are, however, not been clearly specified. Without a clear target it is not possible to evaluate on the performance, and thus to steer toward a certain performance [56]

The C.B. needs to have a model of the C.S

There is no exact model available of the planning process at the HCR. The basic outlines and process flows are known to everybody, however a clear model of the decision making process and owners of this process is not available. Creating this model will at the moment be difficult, as section 4.2.1 indicated that there is no consensus on who is responsible for what part of the process, and for what information.

The C.B. must have information on the input and state of the controlled system

As was already concluded with the D&M model, the information quality of the planning system is not sufficient. This automatically implies that this prerequisite is also not met. The patients are the input of the system, as displayed in Figure 22 and only some general knowledge on the arrival of the patients is known. The numbers of procedures executed each year are estimated, as well as the number of emergency patients. These estimates are done using the information stored in the system of which the accuracy is doubtful.

The C.B. must have sufficient control variety

The C.B. does have enough control variety. At least the same amount of control variables must be present as the amount of input variables, to have enough steering variety [56]. As Figure 22 shows, this is the case. However, due to the different interests in the C.B., the control variables are used inconsistently. Furthermore, the control variables are not yet used to their full capacity. Significant time differences exist between procedures and who executes them. The planning accounts for these differences, but only using tacit knowledge and experience rather than hard figures. This can be clarified due to the fact that the above prerequisites must be completed in this specific order [58] and the first three prerequisites are not met.

Enough information processing capacity needs to be present

The current planning system EZIS does have enough information processing capacity. The low information quality and lack of coherency between the systems, however, prevents the delivery of the correct information. This subsequently prevents the generation of complete and understandable information to the C.B. which prevents them from optimally managing the HCR.

5.3 Sub-research questions

In chapter 1.3 the following sub-research questions were defined to answer the main research question:

1) What determines a successful planning system for the HCR?
2) How is the current planning system performing at the HCR?
3) What are the needs and requirements of the different stakeholders of the HCR planning for a planning system?
4) What improvements can be made to the planning system at the HCR?

Based on the previous chapters these sub-research questions are answered in the upcoming section.

What determines a successful planning system for the HCR?

The success of a planning system is determined by multiple factors. The core of the planning system is its underlying information system. The information system of an hospital must be interwoven in the process and not be seen as an separate system [9]. The widely used Delone and McLean model of information system success identifies six dimensions to determine a successful information system. System quality, information quality, use, user satisfaction, individual impact and organizational impact. Their causal relation is depicted in Figure 1 on page 14. Next to a successful information system an organization must be able to effectively steer. As can be found in chapter 3.3, De Leeuw [57] created a control paradigm stating that every system can be seen as a controlling body, a controlled system and an environment. The controlling body must be well defined and should satisfy five conditions to be able to effectively steer the controlled system [58]. It should 1) have a well-defined target, 2) have a clear model of the controlled system, 3) receive information about the input and state of the system, 4) have enough controlling variety and 5) have enough information processing capacity. Besides these conditions of effective control a synergy must be reached between the primary process, the secondary process and the information system [1]

How is the current planning system performing at the HCR?

The planning system is underperforming in two fields. First, the planning is created with two different systems (an Excel spread sheet and EZIS). And second, the current flow of information through the planning system is not optimal, which leads to unnecessary extra communication. These are System Quality and Information Quality issues, which are the two primary dimensions of the causal Delone and McLean [2] model of information system success. The fact that the current planning system leads to utilization of 75% [10] at the

HCR, compared to the utilization of 94% at the OR, confirms that the planning system is underperforming. The planning system is furthermore largely dependent on the tacit knowledge of the planning secretariat. The model of the system is embedded in the tacit knowledge of the planning secretariat. This also accounts for information on the input of the system. These are both criteria of the model of De Leeuw [57] which need to be met to accomplish effective control. So the current planning system is underperforming in both the information system quality as the ability to effectively control.

What are the needs and requirements of the different stakeholders for a planning system?

In chapter 4 the requirements of the different stakeholders of the planning have been determined. The common target for the planning of all stakeholders is efficiency and patient friendliness. Two important requirements can be distinguished as information needs prior to the scheduled day. First the information throughout all steps of the process must be *complete* and *accurate*. Second more insight is needed in the arrival of emergency patients. The arrival of emergency patients is random, therefore they can significantly disturb the program. The quantity of resources needed to prevent major disturbances in the schedule should be substantiated with quantitative data instead of the experience of the planning secretariat. During the scheduled day the requirement is a clearer overview of the progress of the schedule. This overview can be used to better adapt the schedule in case of emergency patients, or procedures exceeding their scheduled times. After the scheduled day the needs lie in management reports. Having a clear view on what the performance of the HCRs is and what complications arise is needed to better control the HCR.

What improvements can be made to the planning system at the HCR?

Based on the interviews and observations of chapter 4, several improvements can be proposed. First more automated information flows are to be used. With automated flows the accuracy and completeness of information can be better guaranteed, for instance by making essential information mandatory in the request forms. Second, the scheduled times per procedure need to become flexible. They should be based on more specific information about the procedure and the times needed by the different doctors. The reliability of the planned schedule will increase using these times, which in turn will improve the efficiency of the planning system [3]. Third the information quality in the entire planning process needs to become more valid and reliable. Especially information entry by the specialists and the HCR personnel must be improved. Data entry by specialist, however, is a known bottleneck and therefore needs special attention [1]. Early involvement in a change process has a large potential to prevent this from happening [1, 9, 12, 43].

The following chapter will describe four alternatives to improve the current planning system. A task group defined four criteria on which the planning system has to conform. Based on these criteria the best alternative is selected and a basic outline for the implementation is given.

6 Improvement alternatives

This chapter will elaborate on four improvement alternatives for the planning system of the HCR. The management of the HCR have already started a task group to improve the planning system, in which the researcher is participating. The task group consists of a HCR planner, the coordinators of the HCR, the HCR management and a cardiologist. With the task group brainstorm sessions are held to define criteria and alternatives using the results of chapter 4 and 0. As a result four criteria are defined in section 6.1, and section 6.2 describes the four proposed alternatives. These alternatives are subsequently assessed and an alternative is selected in section 6.3. Finally section 6.4 gives a preliminary vision on the implementation of the selected alternative.

6.1 Alternative selection criteria

With the task group a brainstorm session is held to identify criteria which have to be met by the new planning system. The researcher has consolidated the findings of this brainstorm session in four criteria which are explained in the following section. The criteria are integration, complete and accurate information, ease of use and costs.

6.1.1 Integration

The task group revealed two kinds of integration as being essential in a planning system. First the planning system should integrate with the information flows which are present in the CZE, second the planning system must integrate with the work processes within the HCR.

The first point is essential as, obviously, a substantial amount of information is needed for the planning of the HCR. The planning system should be able to fit the current information flows, or, it must be possible to alter the information flows to fit the planning system without negatively influencing other processes. This implies that integration has a direct impact on the information quality of the system.

The second point concerns the fact the planning system should fit the specific work practices at the HCR, or, as with the previous point, it must be possible to alter the work processes to fit the planning system without negatively influencing other processes. This implies that integration has a direct impact on system quality as well as on individual impact.

Both aspects are also highlighted in literature. Berg [1] states that a meticulous interrelation is needed between IS, primary and secondary work practices. Information technology should be seen as being interwoven in the organization, rather than being a separate technology [9]. It is often the fitting of care processes with information processes which causes problems [47]. Delone and McLean identified integration as an important attribute of system quality in their initial study [2], and confirmed this in their ten year update [13].

6.1.2 Complete and accurate information

The second criterion is information completeness and accuracy. Both input and output of the planning system need to be complete and accurate throughout the process. This will ensure a correct construction and execution of day schedules. Furthermore, according to De Leeuw [63], information is essential in all five requirements of effective control. Next to that it follows directly out of the D&M model as one of the root dimensions for IS success [2]. Both accuracy and completeness are attributes of information quality according to van der Meijden et al.[12] and Gable et al. [16]. These latter author also found that more reliable information increases system quality as well [16]. For the creation of efficient schedules sufficient information quality is also essential, according to Cardoen et al. [3]. Furthermore complete and accurate information increases satisfaction among the users [2, 12], Doll and Torkzadeh [53] identified information completeness and accuracy as one of the main determents of end-user satisfaction. Finally complete information will increase the accuracy and effectiveness of communication and hereby reduce errors and the time needed to create the planning [44].

6.1.3 Ease of use

The third criterion which comes forward from the task group is ease of use. The planning system is used by management, doctors, HCR personnel, ward personnel and the planning secretariat. Due to the fact that so many different people use the system its ease of use must be high. Ease of use is closely related to the integration within the work practices as "optimal utilization of IT applications (…) is dependent on the meticulous interrelation of the system's functioning with the skilled and pragmatically oriented work of health care professionals" [9]. This is consistent with the findings of several studies indicating that ease of use, similar to integration, is an important attribute of system quality [2, 13, 16]. Van der Meijden et al. [12] even found several studies in which ease of use was the single measure for system quality. They also found that ease of use is strongly correlated with user satisfaction [12]. Doll and Torkzadeh [53] share this conclusion and further say that if an application is easy to use, "[users] may become more advanced (…) and therefore better able to take advantage of the range of capabilities the software has to offer. Also, ease of use may improve productivity(…)."

6.1.4 Costs

The final criterion, costs, is not directly related to the D&M model, but it is the most used criteria in project management. The costs of a new planning system, using traditional cost models, can be divided in fixed and variable costs. Costs which have to be made regardless if the HCR and the planning system are operating are called fixed costs. These include the initial investment (both in hardware, software and hours), but also software licenses. The variable costs are the costs generated by the use of the system. This includes the time efficiency planning process, as well as the efficiency of the generated planning. Creating a more effective planning can, for instance, increase throughput and utilization and reduce overtime. Costs are also one of the most used performance targets in (OR) planning [3].

6.2 Alternatives

The four alternatives resulting from the task group are: continuing with the current way of working, make Excel the primary planning system, make EZIS the primary planning system or get a new planning system. Each of these alternatives will be introduced below.

6.2.1 Continuing with the current planning system

The first option is continuing to plan as is done at the moment. This means that both EZIS and Excel are used for the planning at the HCR. The current process is elaborated completely in chapter 2 so this will not be explained any further in this part. There are several improvements possible with the current system which, if this alternative is chosen, will be elaborated in section 6.4.

6.2.2 Excel as primary planning system

In the second alternative Excel would become the leading tool for the planning. In this alternative Excel would be used for waiting list registration, patient and personnel planning and monitoring the progress of the day. This would require several Excel sheets and work routines to be adjusted. This will require a lot of work because, as can be seen in Figure 6, most of the planning process is currently executed without the use of Excel.

6.2.3 EZIS as primary planning system

The third alternative is using EZIS as the primary system for planning at the HCR. This would mean that all steps which are made to plan a patient are done using EZIS. As can be seen in Figure 6 in chapter 2.3.3 only the procedure planning is currently not done in EZIS. However, the steps which are already done in EZIS are not all aligned with each other. This will have to improve as well for the planning system to work optimal. A special module of EZIS is going to be used for the planning at the HCR. This module is already licensed to the hospital for the OR planning. The HCR will use the same license which implies that there are some limitations in the tailoring of EZIS as this will affect the OR as well.

6.2.4 New planning system

The last alternative is a complete new planning system. This can be accomplished in two ways: buying a new planning system, or creating a new planning system. The former possibility however is not an option. The management of the hospital has indicated that at the moment there is no other suitable software available in the European market. There is one software package available in the United States, but this will not be released on the European market within an acceptable time frame. The second possibility, creating a new planning system, will consist of developing a new planning system from the bottom. This implies creating the software, designing the interface and creating links with other systems for the exchange of information (for instance financial data or patient records).

6.3 Alternative assessment

In a group meeting with the task group the four alternatives were assessed based on the criteria set in chapter 6.1. Each alternative was discussed and rated on all criteria by the task group. For the grading a five-point scale was used (low, moderate-low, moderate, moderate-high, high). Table 1 displays the scores of the different alternatives on the different criteria.

Table 1 Assessment of the different alternatives

	Integration	Information completeness	Ease of use	Costs
Continue	-	-	+ / -	+/-
Excel	- -	- -	- -	-
EZIS	+	+ +	+ +	+ / -
New	+	+ +	+	+ / -

The second alternative, Excel, is immediately excluded as it scores low on almost all criteria. To continue with the current planning system is also not perceived as a viable solution, and thus excluded as alternative. The two remaining alternatives score almost equally. Both alternatives are discussed in more detail below. Subsequently one alternative will be selected.

6.3.1 EZIS as planning system

Integration

EZIS is already the primary information system of the hospital which makes the integration of the planning system in the information flows of the hospital easier. Most information needed for the patient planning is already entered in EZIS somewhere in the process. Furthermore, personnel and doctors already use EZIS for the majority of their tasks, which makes EZIS also easy to integrate into the work processes of all involved users. As mentioned before the tailoring of EZIS will be bound due to the fact that the planning module has to be shared with the OR. However, both EZIS specialists, HCR management and the OR key users indicate that this will have no large consequences for the integration of the HCR planning.

Information completeness

This alternative scores high on information completeness. It starts at the input in the system by the different users. One of the current problems is that information is often not complete. With EZIS, custom made forms can be created in which all necessary information can be entered. Completeness in input can be better guaranteed by the use of mandatory input fields. Another advantage of EZIS is that already entered information can be recalled. This prevents the manual re-entering of information which decreases the possibility of information incorrectness. Furthermore, as all information can be recalled, more opportunities for management exist.

Ease of use

The largest advantage of EZIS as a new planning system is that both doctors and personnel are already used to work with EZIS. Although the screens for the different users will have to change to some extent, the basic principle of the system is already known to everyone. This drastically shortens the time needed for the users to adapt to the new planning system. Finally EZIS offers to possibility to graphically support the planning system with different functions as the ‘schipholbord’, and the planning overview screen (samples can be seen in respectively Figure 28 and Figure 29 in appendix 9.2).

Costs

To use EZIS as planning system several costs have to be made. First the system will need to be tailored for the planning at HCR. Investment in software can be kept low as the hospital is already licensed for the required module in EZIS. However, the time investment will be larger, as a significant amount of time will be needed to tailor EZIS to the HCR planning. The variable costs however will be significantly lower. If EZIS is used the planning process will become much more effective and the planned programs will become much more efficient. The planning can be based on better data, which improves the reliability of the planning. Also a real-time overview of the progress of the schedule can be generated which gives the possibility for early detection of deviations. This way idle time or overtime can be better prevented.

6.3.2 New planning system

Integration

The obvious advantage of this solution is that it can be completely fitted to the needs of the HCR. This causes this alternative to score high on integration with the work processes, as it can be tailored exactly in these processes. However, it will be the question if it is possible to fully integrate within the current information flows, as this requires the new planning system to communicate with the hospitals information systems. This will require some altering of the already existing software and information flows which is not guaranteed to work.

Information completeness

As was with the previous criterion, information completeness also scores high due to the fact that the system can be tailored to the exact needs of the users. The entire input and output of the system can be designed to fit the exact information needs. Furthermore, as with the EZIS alternative, automated checks can be part of the new planning system to ensure the accuracy of the information. This however does depend on the successful integration with the information systems.

Ease of use

On the ease of use criterion this alternative initially scores high. The system can be completely built to the needs and requirements of all users. Initially users will need to get used to working with a new system. As was mentioned in chapter 6.1 ease of use is closely related to integration. If the system cannot be completely integrated within the current information and work flows the ease of use of the system will drastically decrease. If this integration fails the planning system will again consists of two different information systems. This was exactly one of the main disadvantages of the current planning system.

Costs

Obviously a large investment has to be made to create a new planning system. For the development of a new planning system three major fixed costs can be distinguished. The first factor is the external party who will develop the new planning system. The second factor is the time investment by the CZE; for the new planning system to succeed the different users and the IT department will have to be heavily involved in the development. The third factor is the provider of EZIS; for the new planning system to completely integrate with EZIS, it is foreseen that EZIS' developers will need to make several adjustments as well. The variable costs of this alternative are similar to those of the EZIS alternative. Both effectiveness and efficiency of the planning process are expected to increase.

6.3.3 Alternative selection

The main points of the above analyse are summarized in Table 2. Looking at the integration criteria both alternatives initially score relatively high. As mentioned before, EZIS is the primary information system of the hospital. Essential information will eventually have to be entered into this system (e.g. for the financial administration or patient records) so integration with EZIS is crucial. It is however very doubtful is the integration will succeed for the second alternative. Substantial amounts of time and money will have to be invested to create this integration, and even then success is not guaranteed. Regardless of the costs for the integration, the investment costs for a new system are significantly larger than the investment cost for using EZIS. Assuming that both alternatives improve the efficiency of the planning process and the generated planning equally, the break-even point for the initial investment will be met sooner with the EZIS alternative as with the new system alternative. Furthermore, the time needed to create, implement and start optimally using a new system will be significantly longer than tailoring EZIS and start using it for the planning of the HCR. Also, the fact that EZIS is already known to the users and the hospital is a main advantage of this alternative. People will adapt more easily to this system, as they are already familiar with it. Based primarily on the high investment costs and the uncertainty in the integration, the new planning system alternative is declined. The recommendation is to use EZIS as the primary planning system. The following section will give a preliminary vision on the implementation of this alternative.

Table 2 EZIS as planning system versus new planning system

	EZIS as planning system	**New planning system**
Integration	+ EZIS is already primary information system + Easy integration in work processes	+ Can be fully tailored to fit both information as work processes - Questionable if this integration is possible
Information completeness	+ Automated links prevent re-entering of information + Mandatory fields can increase completeness and accuracy	+ Automated links prevent re-entering of information + Mandatory fields can increase completeness and accuracy
Ease of use	+ Personnel already used to EZIS - Tailoring limited due to shared license with OR	+ Can be fully tailored to the needs of the HCR - Personnel will need to learn a new system
Costs	+ Will improve efficiency and effectiveness of planning + No additional license needed - Large investment in time	+ Will improve efficiency and effectiveness of planning - Large investment in software - Large investment in time

6.4 Implementation plan

This section gives a basic outline on the implementation of EZIS as the planning system. Berg [1] concluded that implementing an information system within a hospital is more than just 'rolling out' the system, and that it should be seen as an organizational development which has both technical and social issues. Aarts et al. [64] concluded that IS implementation in hospitals is unpredictable by its very nature. For successful implementation all users must be involved at an early stage of the process [1, 18, 38, 43]. For the implementation of EZIS as planning system three phases have to be completed (see Figure 23). 1) EZIS must to be tailored to fit the planning process of the HCR, 2) the work practices around the planning system need to be rearranged and 3) the new planning system must become operational.

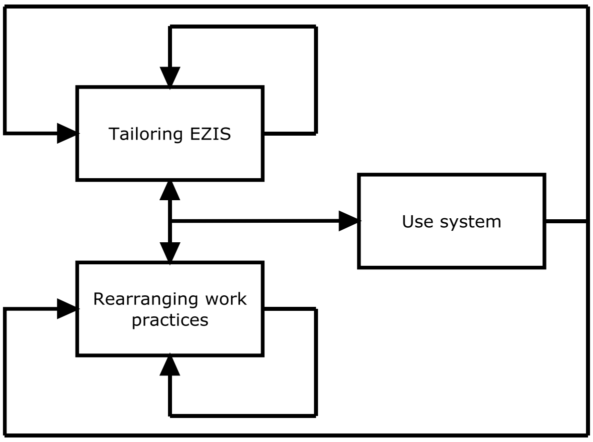


Figure 23 Implementation process

The first step concerns the 'technical' development, where the second step comprises of the 'social' development of the new planning system. As these two aspects have to be mutually developed [1, 64] they are connected via a feedback loop. This approach is also known as the sociotechnical approach [66], which seeks to optimize both aspects simultaneously [67]. The final phase can be started when the former two phases are in balance. IS implementations often fail because of a lack of feedback [47] which is why the last phase should give new input in the first two phases to optimize the system. The entire implementation process then becomes iterative. Using a sociotechnical approach the analysis, design, implementation and evaluation then start overlapping each other [9, 66, 67].

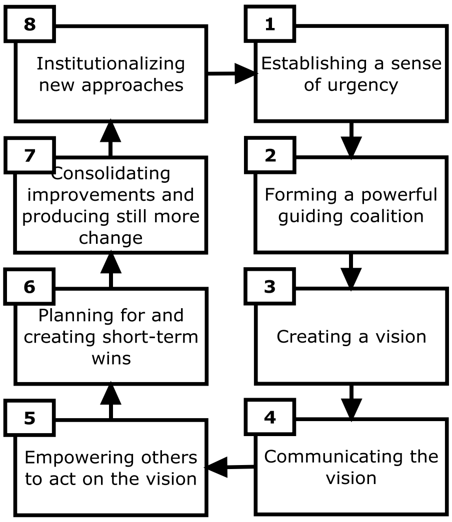


Figure 24 8 steps of Kotter [65]

Widely used in the field of organizational change are the eight steps of Kotter [65], briefly displayed in Figure 9 (the complete model can be found in appendix 9.6). The first step, creating a sense of urgency, is "essential because just getting a transformation program started requires the intense cooperation of many individuals, without motivation, people won't help" [65]. Within the hospital this step is perhaps even more important due to the different stakeholders, or 'four faces' of care: the *cure* (doctors), the *care* (HCR personnel), the *control* (HCR planning secretariat/management) and the *community* (the board) [4]. Some sense of urgency is already present as most stakeholders agree on the fact that the current planning system is underperforming (see chapter 4 and 0). They are, however, not necessarily convinced about EZIS being the solution.

6.4.1 Tailoring EZIS to the HCR planning

The process of tailoring EZIS consists of seven steps as displayed in Figure 25. The first step is the composition of a project team which has authority [65] and the support of (top)management [1]. The project team is already composed during this research and consists of a HCR planner, the HCR coordinators, a project leader and a cardiologist. The first task of this project team can be a combination of three steps of Kotter. As already a sense of urgency is present, the project team can translate this sense into a vision (which is: using EZIS) and start to communicate this vision to the employees. By doing so it will simultaneously increase the sense of urgency. It is essential that the entire project team shares the vision [65]. During the course of this research several appointments have been made with the key users of the OR planning system. This gave a preliminary insight in the possibilities of the EZIS planning module. At the OR a dedicated key user is responsible for the reliable information input and output of EZIS, as well as the screens used throughout the OR planning process. For the HCR planning system a similar key user must be assigned. The key user must become completely familiar with the planning module of EZIS before the tailoring can start. As it will be the same module as the OR already uses, the dedicated key user should tap out of the knowledge present at the OR key users. The first task of the project team will be to determine the exact information needs and responsibilities in the different steps of the planning process. This must include what the prerequisites of patients are and who is responsible for the completion of this prerequisite. Next to that the exact capabilities of all cardiologists, residents and personnel must be made clear. Based on this information the forms and screens that are already being used can be reviewed, and only relevant information for all parties must be included.

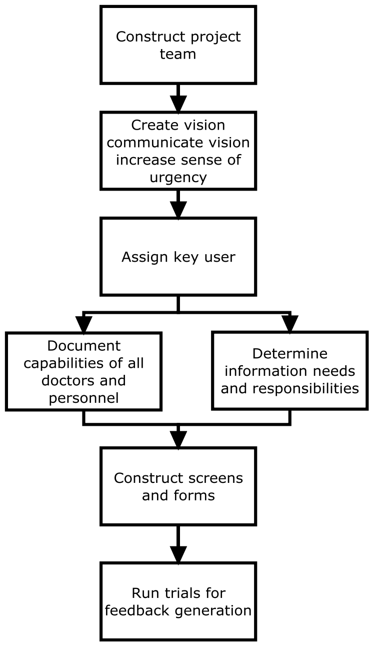


Figure 25 Tailoring EZIS

Now the key user can make a first tailoring of EZIS, starting at the first process step (the heart team preparation) and then working upwards in the process (ending at the information entry at the HCR). This will ensure all information is always entered in the earliest stage possible. Mandatory fields in all input screens improves the completeness of the information. The first tailoring should be presented to all users of the planning system for feedback. This communication to all users is essential for multiple reasons. Firstly it gives insight in the expected performance of the system, secondly keeping everyone informed is essential for the success of implementation [65], and lastly it increases the sense of urgency as the importance of IS is often discovered *during* the implementation process [9].

6.4.2 Rearranging the process

Parallel to the technical design of the system the processes around it must be rearranged. It is important to realize that “formal tools (…) only survive because of the skilful work of health care professionals” [9]. Rearranging the process should therefore be done in consideration with the primary and secondary processes [1]. The ‘technical’ success of the planning system depends on the information entry in the system. It therefore is essential that the project team can rearrange the process to ensure that the right person enters the right information at the right time. To create workable new processes the end users must participate in this redefining [66]. By documenting the new work processes no disagreement or discussion can arise afterwards. As Berg [1] concluded, the rearrangement of the processes must be done simultaneously with the tailoring. Communication is important, as “employees will not make sacrifices (…) unless they believe that useful change is possible” [65]. Regular feedback meetings with (a representation of) the users will ensure that the new processes comply to the needs.

6.4.3 Using the new HCR planning system

As mentioned above the information entry is a key issue in the success of the new planning system. Two categories of data entry can be distinguished; information entry prior to the planning of a procedure, and information entry after the planning of a procedure.

The first category concerns the information entry primarily by the doctors. As mentioned before the use of mandatory fields will improve the completeness of the forms. Furthermore the key user can generate reports of incorrect data entries (if they occur). With these reports the task group has a substantiation which they can present to the doctors and inform them about the direct consequences of their incorrect data entry.

The second category concerns the data entry primarily by the HCR personnel and more specifically the time registration at the HCRs. The OR experienced similar issues during its transition to EZIS as main planning system. They found that the key user has an important role in the first period of use. Again he can generate reports on the information entry of the end users. These reports can be used by the (personnel)coordinator of the HCR to give feedback to the personnel. This will be an intensive, but essential, task in the beginning. The substantial amount of information can be analysed by EZIS to easily create real-time feedback, by for instance the ‘schipholbord’, or performance reports. Giving this feedback has already proved its value at the OR and can further optimize the management of the HCR [57]. Next to that it will be possible to constant evaluate and improve the system to ensure that it will remain optimal [1].

7 Conclusion & Limitations

7.1 Conclusions

Both System Quality and Information Quality are underperforming which results in a low performance of the entire system, as was concluded in chapter 0. The low system quality is primarily caused by a low integration of the different systems used in the planning, but also a low integration with the processes. Berg [1] concluded that an information system should, together with the primary and secondary work processes, seek to create synergy and take the organization to a higher level. For this to succeed, integration with the primary and secondary processes is essential.

The second factor, information quality, has to be improved in both completeness and accuracy. Completeness is needed to improve the efficiency of the planning process, and accuracy is needed to improve the output of the planning system. To improve the information quality it must be determined what information is needed in what stage of the process and who is responsible for this information. Next to that reliable quantitative data is needed on the arrival of (emergency) patients and the different procedure times. With more reliable information better schedules can be constructed leading to a more efficient use of resources.

The cause of the current low information quality lies in the entry of information into the planning system. Information accuracy is currently not seen as a priority or a responsibility, primarily because of the unclear division of tasks and processes surrounding the planning. Having a clear model of the process is essential for effective steering [58], and giving feedback on the results of the entered information the awareness of its quality and its relevance can be increased.

Improving the information quality will give more opportunities for effective control. The procedures can be better aligned and as a result the utilization of the HCRs can be improved. To effectively control the HCR insight is needed in the arrival of (emergency) patients [58]. Furthermore the procedure times should become flexible and based on the doctor performing the procedure. By doing so the steering variety of the HCR increases, which allows better control of the planning system [58, 59].

Four alternatives to improve the planning system of the HCR were proposed and assessed in chapter 0: continuing with the current system; completely work in Excel; completely work in EZIS; or create a new system. Chapter 0 revealed that working completely in EZIS is the best alternative. As EZIS is already used widely in these processes in the hospital it will integrate more easy in both the information flows as the work processes.

However, only improving the used system will not be the only necessary action. In his thesis, De Leeuw [57] created a model of a to-be-controlled situation. This model includes a controlled system (the planning system) but also a controlling organ and an environment. The controlling organ in the planning system should consist of the planning secretariat and the HCR management, the environment then becomes the doctors, the personnel and the patients. As the environment in this case is responsible for the majority of the information input of the controlled system, they are of great importance to its success. It is therefore necessary to create awareness about the need for change in the environment. This is partially done by creating transparency about the upcoming change, but also by continuing this transparency in order to keep the environment stimulated and motivated about the new planning system. What should be kept in mind is that not matter if you are a doctor, personnel or a manager, all that matters is the wellbeing of the population "this is one issue, nothing more, nothing less, and nothing apart" [4].

7.2 Limitations

Several limitations exist for the conclusions drawn by this report. A single researcher has executed the interviews and analysis of this research. Furthermore the observations were also done by a single observer (the researcher). This can be a limitation to the reliability of the research, as it is based on the view of the researcher [20]. A second limitation lies in the number of interviews held. A very specific sample was taken which prevents the results of this research to be generalized. Finally the observations made at the HCR planning secretariat can be biased as the Electro Physiology (EP) planning, which was excluded from the research, is also done at that location. For the application of this research in practice this is also a limitation, as both the EP as intervention planning are done at the HCR planning secretariat.

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SECTION 3

APPENDIX

9.1 Excel spread sheet

Table 3 Tuesday master schedule HCR 1 and 2

					DINSDAG		**Hartteam 8,00 - 10,00 u**				
OPN DAT.	**TIJD**	AFD.	**BEH. DAT.**		NAAM	GEB. DAT.	BEHANDELING	ARTS	BIJZONDERHEDEN	PERSONEEL	HER-KOMST
KAMER 1											
	14,00	7w		**1**			PCI	Fuente			
	20,00	7w		**1**			CAG	Fuente	**prehydratie**		
	8,00	kvb1		**2**			CAG	Fuente			
				3			CAG	Fuente			
				4			CAG	Fuente			
		7o		**2**			PCI	Botman/Fuente		**op en neer**	
	8,00	7w		**3**			PCI	Botman/Fuente			
	9,00	7w		**4**			PCI	Botman/Fuente		**nog opr**	
KAMER 2											
	14,30	7w		**1**			CAG	Koolen/Erdem			
	20,00	kvb1		**1**			CAG	Koolen/Erdem	**prehydratie**		
	8,15	kvb1		**2**			CAG	Koolen/Erdem			
	8,45	kvb1		**3**			CAG	Koolen/Erdem			
				4			CAG	Koolen/Erdem			
		7o		**2**			PCI	Peels/Erdem		**op en neer**	
	9,30	7w		**3**			PCI	Peels/Erdem			
	10,30	7w		**4**			PCI	Peels/Erdem		**nog opr**	

Table 4 Example Tuesday planned schedule HCR 1 and 2

DINSDAG							Hartteam 8,00 - 10,00 u Dr. de la Fuente		NP + CAP Dr. Post		
OPN DAT.	**TIJD**	AFD.	**BEH. DAT.**		NAAM	GEB. DAT.	BEHANDELING	ARTS	BIJZONDERHEDEN	PERSONEEL	HER-KOMST
KAMER 1										***RS***+PB+AB+EH	
31-xx	**14,00**	7w	**01-11**	**1**	xx	xx-xx-'xx 16514	PCI FFR RCX	Tonino/Erdem			
31-xx	**14,30**	7w	**01-11**	**1**	xx	xx-xx-'xx 85518	PCI D1 RCX	Tonino/Erdem	**prehydratie, INR prikken**		
01-xx	**8,15**	kvb1	**01-11**	**1**	xx	xx-xx-'xx 13017	FFR RDA RCX	Fuente/Erdem			
				3			CAG	Fuente/Erdem			
				4			CAG	Fuente/Erdem			
01-xx		7o	**01-11**	**2**			PCI	Botman/Erdem		**op en neer**	
01-xx	**8,00**	7w	**01-11**	**3**	xx	xx-xx-'xx 73010	PCI RDA RCX RCA	Botman/Erdem	**CJB prehydratie**		
01-xx	**9,00**	7w	**01-11**	**4**	xx	xx-xx-'xx 89015	FFR RCA evt PCI CX	Botman/Erdem	spoed PCI gehad	**nog opr**	**Helmond**
KAMER 2										***LL***+MJ+KB	
31-xx	**20,00**	kvb1	**01-xx**	**1**	xx	xx-xx-'xx 59018	CAG	Weevers	**prehydratie, med-**		
01-xx	**7,45**	kvb1	**01-xx**	**2**	xx	xx-xx-'xx 20018	CAG	Weevers			
01-xx	**8,00**	kvb1	**01-xx**	**2**	xx	xx-xx-'xx 57016	CAG	Weevers	**med-**		
01-xx	**8,45**	kvb1	**01-xx**	**3**	xx	xx-xx-'xx 15516	CAG	Weevers	**med-**		
				4			CAG	Weevers			
01-xx		7o	**01-xx**	**2**			PCI	Fuente		**op en neer**	
01-xx	**9,30**	7w	**01-xx**	**3**	xx	xx-xx-'xx 64017	PCI RCA	Fuente			
01-xx	**10,30**	7w	**01-xx**	**4**	xx	xx-xx-'xx 79017	FFR LAD evt PCI RCA	Fuente		**nog opr**	**Roermond**

9.2 EZIS

Dossier: Hartcentrum Catharina 2011	
1 van 1	
2012 | ARTS |	| HCC Hartteam bespreking
Datum Bespreking	[redacted]
Bent u de ingelogde arts	ja
Ingelogde arts	[redacted]
Bespreekcollega	[redacted]
Creat	116 ([redacted])
MDRD	52
Pre-hydratie	Ja
Memo diagnose	- -
Omschrijving behandeling	CAG
Planner HCK	HCC HCK te plannen (Te plannen)
Patiënt opgenomen?	Nee
Opmerkingen	Matig vitale man. G6PD deficientie; icc internist. Verwijzer gebeld. CAG door JK of CJB.
CATHETERISATIE	
LAD mid	70 - 90
Aantal takken	1-taks
Opmerkingen	RCA niet afgebeeld.
KLEPPEN (OOK ECHO- BEVINDINGEN)	
Gradient Aorta	3.5
HAEMODYNAMICA	
PA	35
LV functie	Goed (EF > 50%)
Methode	ECHO
Opmerkingen	CT angio onsuccesvol ivm te hoge calciumscore.
| |	| HCC Hartteam aanmelding
| ARTS |	| CAR Poliklinische decursus
| |	| CAR Administratieve aantekening
| ARTS |	| CAR Poliklinische decursus
| ARTS |	| CAR Poliklinische intake

Figure 26 HTM procedure request form

Hartcatheterisatie: Order, CAR Hartcatheterisatie plannen(ordernr) van CAR op 2012	Definitief		
Algemene gegevens			
Sein aanvrager			
Verantwoordelijk specialist	[redacted]	Cardiologie	
Aanvraagdatum	[redacted]		
Gewenste termijn	___ dag(en) ___ we(e)k(en)	___ maand(en)	___ jaar
Poliklinisch / klinisch	(•) Poliklinisch	( ) Klinisch	
Spoed			
Naam ziekenhuis + verwijzer	cazi		
Hartcatheterisatie verrichting			
Indicatie	[x] angina pectoris	[ ] kleplijden	[ ]
Te verrichten behandeling door aanvrager zelf	( ) Ja	(•) Nee	
Verrichting	[ ] rechtscatheterisatie [x] linkscatheterisatie [ ] femoralis [ ] radialis/brachialis	[ ] status na PTCA [ ] status na OHO [ ] flowmeting [ ] radi	[ ] farmacologische functietest [ ]
Antistolling			
Bloedverdunners	[ ] Geen [ ] Clopidogrel	[ ] Coumarine derivaten [ ] Persantin	[x] Salicylaten [ ]
Vòòr CAG stoppen	( ) Ja	( ) Nee	
Anamnese jodiumhoudend contrastmiddel			
Heeft bij de patiënt in het verleden een matig ernstige tot ernstige reactie op contrastmiddel plaatsgevonden?	( ) Ja	(•) Nee	
Zijn bij patiënt verhoogde risicofactoren aanwezig op contrastnefropathie?	( ) Ja	(•) Nee	
Gebruikt patiënt metformine medicatie?	( ) Ja	(•) Nee	
Geen contra indicatie voor jodiumhoudend contrast.			
Kreatinineklaring	( ) nee	( ) ja	(•) onbekend
Bijzonderheden			

Figure 27 Internal procedure request form

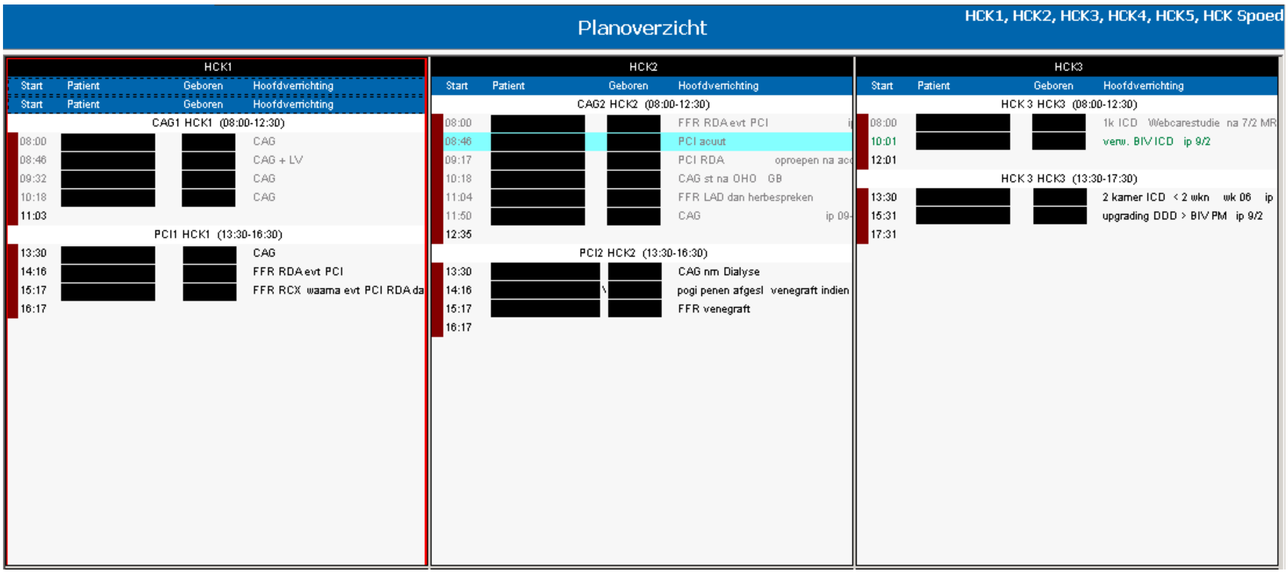


Figure 28 Day schedule HCR

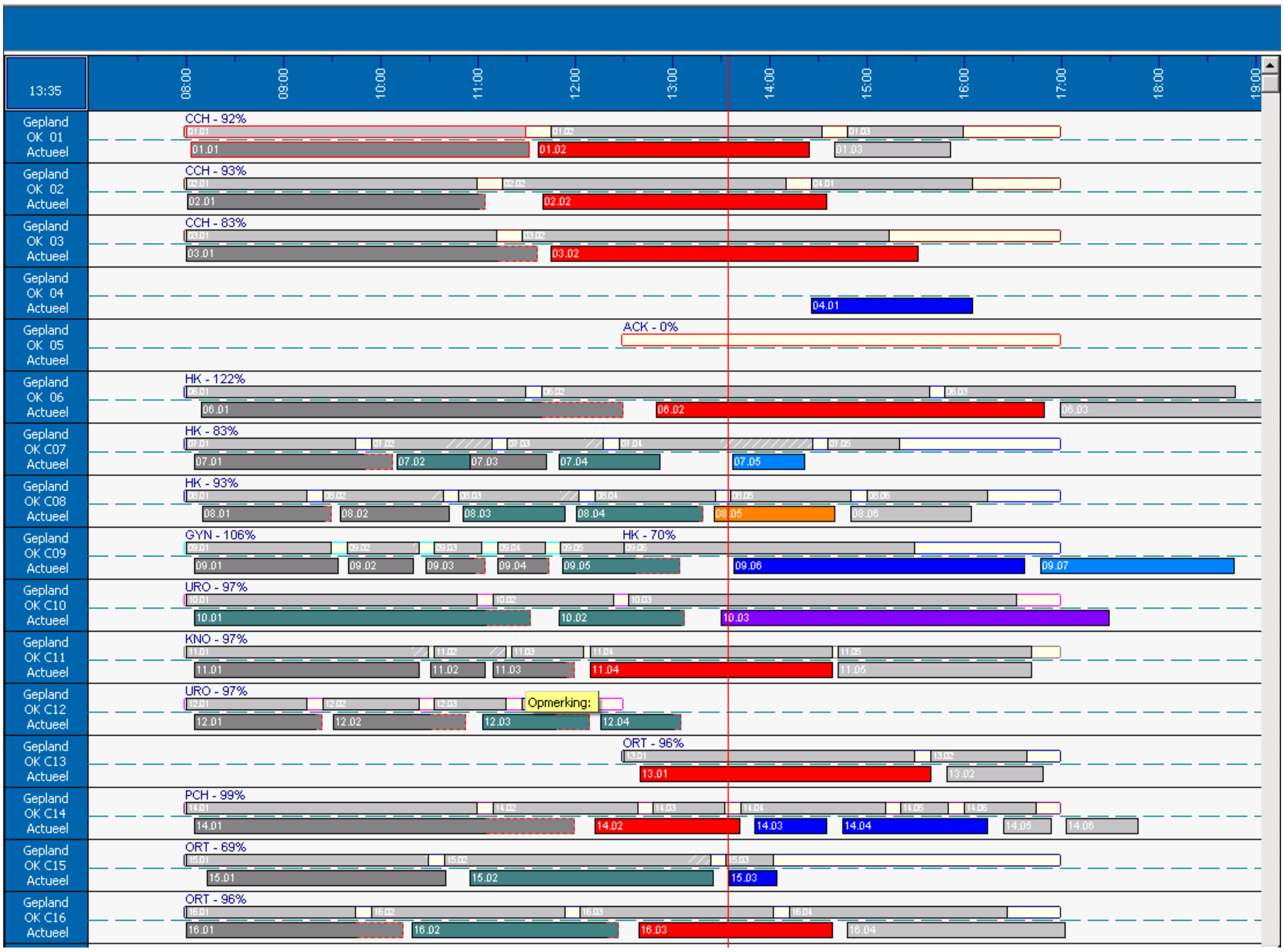


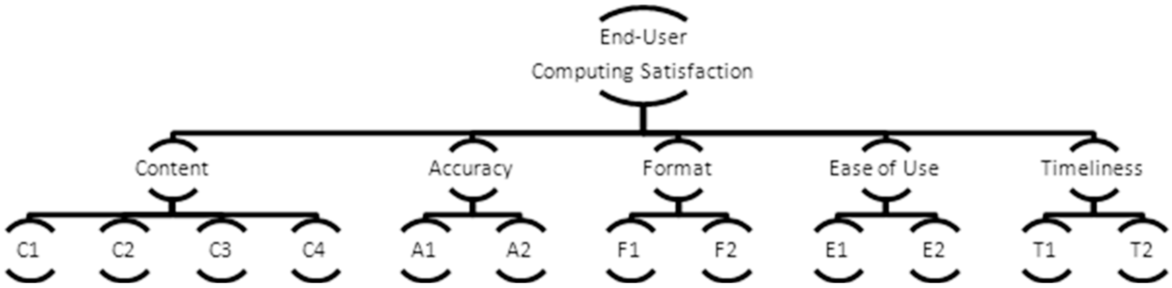
Figure 29 "Schipholbord" OR

9.3 Pool of IS-Impact Measures © [16]

Dimension	Measure	Question
System Quality	Ease of use	(The IS) is easy to use
	Ease of learning	(The IS) is easy to learn
	User requirements	(The IS) meets requirements
	System features	(The IS) include necessary features and functions
	System accuracy	(The IS) always does what it should
	Flexibility	(The IS) can be easily modified, corrected or improved
	Sophistication	(The IS) requires only the minimum number of fields and screens to achieve a task
	Integration	All data within (the IS) is fully integrated and consistent
	Customization	(The IS) user interface can be easily adapted to one' s personal approach
Information Quality	Relevance	(The IS) provides output that seems to be exactly what is needed
	Availability	Information needed from (the IS) is always available
	Usability	Information from (the IS) is in a form that it is readily usable
	Understandability	Information form (the IS) is easy to understand
	Format	Information from (the IS) appears readable, clear and well formatted
	Conciseness	Information from (the IS) is concise
Individual Impact	Learning	I have learnt much through the presence of (the IS)
	Awareness / Recall	(The IS) enhances my awareness and recall of job related information
	Decision effectiveness	(The IS) enhances my effectiveness in the job
	Individual productivity	(The IS) increases my productivity
Organizational Impact	Organisational costs	(The IS) is cost effective
	Staff requirements	(The IS) has resulted in reduced staff costs
	Cost reduction	(The IS) has resulted in cost reductions
	Overall productivity	(The IS) has resulted in overall productivity improvement
	Improved outcomes/outputs	(The IS) has resulted in improved outcomes or outputs
	Increased capacity	(The IS) has resulted in an increased capacity to manage a growing volume of activity
	E-government	(The IS) has resulted in better positioning for e-

		Government/Business
	Business process change	(The IS) has resulted in improved business processes

9.4 Model for measuring End-User Computing Satisfaction [53]



Content

C1: Does the system provide the precise information you need?

C2: Does the information content meet your needs?

C3: Does the system provide reports that seem to be just about exactly what you need?

C4: Does the system provide sufficient information

Accuracy

A1: Is the system accurate?

A2: Are you satisfied with the accuracy of the system?

Format

F1: Do you think the output is presented in a useful format?

F2: Is the information clear?

Ease of Use

E1: Is the system user friendly?

E2: Is the system easy to use?

Timeliness

T1: Do you get the information you need in time?

T2: Does the system provide up-to-date information?

9.5 Procedure Observations

Table 5 Observation 1

1	Registered	Actual	Time at registration
Patient at room	08.38	08.21	08.38
Start procedure	08.45	08.30	08.38
End procedure	09.26	09.32	09.51
Patient from room	09.32	09.41	09.51
Patient to ward	09.37	09.44	09.51

Table 6 Observation 2

2	Registered	Actual	Time at registration
Patient at room	09.45	09.45	09.56
Start procedure	09.46	09.51	09.56
End procedure	10.10	10.12	10.10
Patient from room	10.15	10.33	10.10
Patient to ward	10.20	10.45	10.10

Table 7 Observation 3

3	Registered	Actual	Time at registration
Patient at room	10.47	10.51	11.07
Start procedure	10.50	10.58	11.07
End procedure	11.53	11.53	12.07
Patient from room	11.57	12.01	12.07
Patient to ward	12.05	12.08	12.07

Table 8 Observation 4

4	Registered	Actual	Time at registration
Patient at room	12.09	12.09	12.09
Start procedure	12.10	12.15	12.09
End procedure	12.21	12.25	12.21
Patient from room	12.30	12.41	12.21
Patient to ward	12.30	12.51	12.21

Table 9 Observation 5

5	Registered	Actual	Time at registration
Patient at room	13.32	13.18	13.37
Start procedure	13.32	13.32	13.37
End procedure	13.47	13.47	13.47
Patient from room	13.55	13.55	13.55
Patient to ward	14.05	14.07	13.55

Table 10 Observation 6

6	Registered	Actual	Time at registration
Patient at room	15.03	14.50	15.09
Start procedure	15.04	15.04	15.09
End procedure	15.16	15.20	15.16
Patient from room	15.20	15.33	15.16
Patient to ward	15.25	15.45	15.16

Table 11 Observation 7

7	Registered	Actual	Time at registration
Patient at room	16.12	15.59	16.12
Start procedure	16.12	16.12	16.12
End procedure	16.46	16.44	16.46
Patient from room	16.50	16.54	16.46
Patient to ward	16.55	17.02	16.46

Table 12 Observation 8

8	Registered	Actual	Time at registration
Patient at room	14.09	14.09	14.09
Start procedure	14.22	14.22	14.22
End procedure	16.15	16.02	16.44
Patient from room	16.30	16.18	16.44
Patient to ward	16.30	16.22	16.44

9.6 Eight steps to transforming your organization [65]

1

- **Establish a sense of urgency**
  - examining market and competittive realities
  - identifying and discussing crises, potential crises, or major opportunities

2

- **Forming a powerful guiding coalition**
  - assembling a group with enought power to lead the change effort
  - encouraging the group to work together as team

3

- **Creating a vision**
  - creating a vision to help direct the change effort
  - developing strategies for achieving that vision

4

- **Communicating the vision**
  - using every vehicle possible to communicate the new vision and strategies
  - teaching new behaviours by the example of the guiding coalition

5

- **Empowering others to act on the vision**
  - getting rid of obstacles to change
  - changing systems or structures that seriously undermine the vision
  - encouraging risk taking and nontraditional ideas, activities, and actions

6

- **Planning for and creating short-term wins**
  - planning for visible performance improvements
  - creating those improvements
  - recognizing and rewarding employees involved in the improvements

7

- **Consolidating improvements and producing still more change**
  - using increased credibility to change systems, structures, and policies that don't fit the vision
  - reinvigorating the process with new projects, themes, and change agents

8

- **Institutionalizing new approaches**
  - articulating the connections between the new behaviors and corporate succes
  - developing the means tho ensure leadership development and succession