Master thesis
The organisational structure as a cause for HIT problems

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Preface

This thesis is by far the biggest document that I’ve ever created. I remember my last year of pre-university education, where everyone including my mom and dad were saying that I was never going to graduate school, let alone that I was ever going to graduate university. And a few years later, here we are! I have to admit, I’ve never been good in studying and especially in my pre-university years I was a troublesome person (sorry mom and dad :-)), but being able to graduate university now and by doing it with this research, still feels a bit like proving everyone wrong. However, I also realise that I wasn’t be able to do so if I hadn’t had help of the following persons.

First of all, I want to thank you, Dirk. For all those zoom meetings in which you gave me direction and motivation to write this research. And when I wasn’t able to borrow a book due to the lockdown because of Covid-19, you even let me pick up one of your books at home. I have learned a lot during this research and you have been an inspiration for me to finish it. I also want to thank Bart and Martin for the opportunity to perform this research and the guidance along the way at the Radboudumc. Furthermore, I want to thank my family. My dad, Frank, for brainstorming with me and not to forget, the endless hours of grammar control you have put into my research. My mom, Sascha, for always cheering me up and giving me a place to study during Covid-19. And my girlfriend, Stephanie, for helping me with my grammar, and not to forget, for always being supportive, even while I was working during Christmas.

I hope you will enjoy reading my thesis.

Nick Roos - January 2021
Abstract

This research is conducted to explore whether the organisational structure of the operating rooms (OR) of the Radboudumc can be a cause for experienced healthcare information technology (HIT) problems. More specifically, this research aims at two things: 1) identifying which HIT problems play at the OR of the Radboudumc and 2) identifying a gap between a theoretical desired organisational structure in which an organisational structure cannot act as a cause for HIT problems, and the actual organisational structure of the OR of the Radboudumc.

The HIT problems are identified with use of several (healthcare) information technology theories. For the organisational structure, both the desired and actual situation are described with use of five design parameters. The desired situation can be defined as an organisational structure that is not causing HIT problems. In that case, the values of the design parameters are low. The desired situation is then compared to the actual situation of the OR of the Radboudumc. To capture the actual situation, several interviews and a document analysis have been conducted.

Several HIT problems have been identified in the three systems that are most used by the OR of the Radboudumc. In general, for HIT systems that are used by multiple departments (EPIC & T-DOC) more HIT problems could be identified than for HIT systems used by only one department (OVMA). Furthermore, several gaps have been identified by comparing the actual and desired situation. In general, the parameters used to describe the organisational structure of the OR of the Radboudumc have a combined value that is too high. In addition, for two parameters, the functional concentration and specialization & differentiation of operational activities, severe gaps could be established in comparison with the desired situation.

Based on the experienced HIT problems and the measured values of the structure parameters that have become manifest in the interviews of respondents, several conclusions can be drawn. Due to a combined overall parameter value that is too high, there is an unnecessarily increase in the demand of information, which has resulted in complex HIT systems. It may be expected that due to the complexity of these HIT systems, the probability of errors in information stored in these HIT systems increases.
Furthermore, due to high values on functional concentration and specialization & differentiation of operational activities, there is a direct increase in the demand of information. This has directly led to more complex HIT systems, in which more problems are experienced regarding the quality of information stored in those systems.

In general, it can be concluded that ideally one would design organisational processes based on self-provisioning production flows, with teams and regulatory capacity assigned to these flows. As IT systems are based on these flows, IT systems will cover the whole organisation. However, if deviated from this design principle, as in the case of the OR of the Radboudumc where the structure is functionally designed with use of compartments, the information structure and thus (H)IT systems will follow this design. As the structure is split up into different parts (in this case departments), IT systems will also be designed and optimized for these different parts. This forms no problem when information is shared within each departments, but will lead to problems when information needs to be shared between departments. And that is exactly what the OR of the Radboudumc is experiencing now.

This research is an attempt to identify organisational structure related causes for experienced HIT problems at the OR of the Radboudumc, and by doing so, provides a guideline for the HIT provisioning strategy of the Radboudumc in their search for optimized and properly functioning HIT systems: invest in new HIT systems or first take a closer look at the current organisational structure. The theoretical findings provide opportunities for future research on how individual parameter values can cause information quality issues in HIT systems, while the practical findings can serve as a guideline for other organisations who are experiencing the same problems.
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Chapter 1 - Introduction

Information Technology (IT) is becoming more and more important in the daily operations in healthcare. It is widely acknowledged that Healthcare Information Technology (HIT) can lead to an improvement in the quality of healthcare and, at the same time, it can lower the costs (Goh, Gao, & Agarwal, 2011; Hillestad et al., 2005; Hoque & Sorwar, 2017). HIT is the “application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making (Thompson & Brailer, 2004, p. 38).” Furthermore, these systems can facilitate the implementation of care guidelines and decision support tools, which can be valuable in preventing process errors (McCullough, Casey, Moscovice, & Prasad, 2010). HIT can even bring social benefits for patients, families and healthcare providers (Sligo, Gauld, Roberts, & Villa, 2017).

However, hospitals are lagging behind in their adoption of HIT, mostly due to concerns about performance impacts of HIT. More specifically, physicians have been reported to think that HIT systems will not fully meet their needs (Desroches et al., 2008) or think that HIT systems will even result in decreased clinical efficiency and effectiveness (Simon et al., 2007). Due to such concerns, more than 40% of these developments fail or will get abandoned (Kijsanayotin, Pannarunothai, & Speedie, 2009). It seems that HIT can bring advantages in healthcare, but at this moment, many HIT implementations do not function properly. However, it is not clear why these HIT developments and implementations fail. Therefore, understanding the causes for not functioning HIT is crucial for implementing a fluid transition towards HIT (Carayon, Smith, Hundt, Kuruchittham, & Li, 2009; Lawler, Hedge, & Pavlovic-Veselinovic, 2011).

For the operating rooms in the Radboudumc this is no different. Newly introduced HIT applications do not meet the criteria for functioning properly and lack the acceptance among staff, causing failures, missed opportunities and extra costs (B. Meij & M. Janssen, personal communication, 19 February 2020). Moreover, it leads to resistance among staff for future HIT innovations causing the organisation to fall further behind on HIT, while it could benefit from the technology that is available. Besides that, the Radboudumc is currently experiencing near errors in the operating rooms, for example operations that almost had to be cancelled due to misunderstanding and miscommunication between planning, logistics, transportation and sterilization.
Errors that may have been prevented with proper working HIT (B. Meij & M. Janssen, personal communication, 19 February 2020). Furthermore, suppliers like Medtronic, that make instruments used in surgery, are also demanding that the Radboudumc innovates on certain HIT systems, so that the quality of their instruments can be guaranteed in the future. On top of this, the government is also getting more demanding with the registration of healthcare information (B. Meij, personal communication, 4 May 2020). It is clear that the HIT systems for the purpose of supporting the operating rooms at the Radboudumc are problematic. The above mentioned problems, such as failures, miscommunication and misunderstanding, point towards problems regarding the quality of the information that is stored inside these HIT systems. As this information, stored inside HIT systems, has a quality that is too low, errors such as failures, miscommunication and misunderstanding arise. However, the cause of the experienced problems with the HIT systems has not been researched properly.

One of these causes is related to the organisational structure. As B. Meij, operational manager logistics OR states, there are some departments that have to work with each other, to make the operation rooms function, who are currently not working together in an effective way. For instance the department ‘CSA’ (responsible for the sterilization of instruments), the department OR logistics (responsible for the storage of instruments and goods used at the operation rooms), and the department ‘transportation’ (responsible for the transfer of the instruments from CSA to OR) need to cooperate closely to support the operation rooms. However, these departments have their own, separate management and budget and have their own software applications, and do not effectively share their information, goods, HR or HIT systems (B. Meij, personal communication, 4 May 2020). These departments are crucial for well-functioning operating rooms as they all contribute to the processes that are crucial for the operating rooms, and B. Meij assumes that it is this specialized departmental structure, that may be a cause for the HIT problems they are currently experiencing.

In general, it is assumed that the OR in the Radboudumc is experiencing HIT problems in the supporting processes of the OR. These HIT problems can be addressed by multiple factors, such as the system quality, information quality and service quality (DeLone & McLean, 2002). However, in this case, the underlying processes and organisational structure seems to play a role in the HIT problems the OR of the Radboudumc is experiencing. Improving the organisational structure of the OR of the Radboudumc may lead to less HIT problems.
Therefore, the starting point of this thesis will be the analysis of the structure of the processes of the OR as a cause for the HIT problems the OR is experiencing. Understanding why an organisational structure may cause HIT problems is not that hard as the Radboudumc is already experiencing HIT problems due to the fact that the CSA and the OR department are differentiated in the organisational structure, and thus use different HIT systems. B. Meij and M. Janssen imply that there are more cases in experiencing information problems due to the underlying organisational structure, and therefore to look at the structure first (B. Meij & M. Janssen, personal communication, 19 February 2020). Therefore, the goal of this thesis is to investigate the structure related causes of the experienced HIT problems in supporting the processes of the OR. When looking at the structure and processes, it is necessary to take a look at a broader perspective and investigate the whole organisation (in this case, the operating rooms can be seen as a stand-alone organisation) instead of a single department like for instance the ‘CSA’, because all elements of the organisation involved are by definition tied and coupled in time as a function of the systems structure (De Sitter, Den Hertog, & Dankbaar, 1997). Therefore, the research object of this paper will be all the processes and the structure of the operating rooms, instead of the processes and structure of a single department. Throughout this research, with the “OR of the Radboudumc” is indicated all those processes and not solely the OR department of the Radboudumc.

1.1 Organisational Structure and HIT problems

In this thesis, it is assumed that the structure of the OR processes at Radboudumc may be a cause for the experienced HIT problems. According to Achterbergh & Vriens (2019) an organisational structure can be best described as a network of related tasks, in which a task is a set of sub-activities allocated to an operational unit. There are different ways of how these tasks can be divided and allocated to units. Different ways of differentiation and allocation of tasks to units have different consequences for the information provision and therefore places different demands on IT systems (De Sitter, Naber, & Verschuur, 1994). For some of these structures it is harder to get the IT aligned with its structure than for other structures.

For instance, so-called bureaucratic structures (with many dependent tasks, a large hierarchy and much formalization) need more coordination than structures that do not, due to the fact that these structures have more tasks and require more alignment between these tasks.
This increases the information need inside such a structure, which also enlarges the margin of errors of this information (Galbraith, 1973). Building an IT system for such a structure will not fix these problems: instead an IT system will reinforce such a structure (Achterbergh & Vriens, 2019; De Sitter et al., 1994). Furthermore, it is likely that in such a structure, departments work apart from each other on their own process, with their own systems and own information needs. It therefore should be expected that it is difficult to design only one IT system that fits multiple information needs from different departments (De Sitter et al., 1994).

For less bureaucratic structures (with little dependent tasks, little hierarchy and little formalization) it may be expected that there are less tasks and thus less alignment needed between these tasks. This lowers the required coordination and thus information needed, which also reduces the margin of errors of shared information. Furthermore, as departments are working together more and are more aligned, it may be expected that there is a more centrally shared information need, which makes it easier to design an IT system that fits this need (De Sitter et al., 1997). In line with the above reasoning, it therefore may be expected that the underlying organisational structure may be a cause for not properly functioning IT systems.

De Sitter (1997) proposes several design parameters for describing organisational structures that will, if they are low, provide a proper structure in which the goals of that organisation can be achieved. De Sitter identifies two sub-structures: the production structure and the control structure. De Sitter proposes several design parameters for each structure, and one design parameter to describe the relation between the production and control structure. Furthermore, De Sitter states that certain structures, that have so called high parameter values, can be more problematic for the information provision than other structures, that have low parameter values (De Sitter et al., 1997). This research will investigate if a high parameter structure at the operating rooms of the Radboudumc is indeed a cause for the experienced HIT problems at the Radboudumc.
1.2 Research objective

In view of the above, the main goal of this thesis is to conduct a research on the HIT implementation failures at the operating rooms in the Radboudumc and to find out whether the organisational structure is a cause of these failures. This gives the following conceptual model:

![Figure 1.1 - conceptual model](image)

To do so, a diagnosis will be performed at the operating rooms in the Radboudumc, where, based on interviews, observations and documents, research will be conducted. This thesis will provide insight in (1) which HIT related problems occur at the operating rooms in the Radboudumc and (2) if and how the structure of the operating rooms of the Radboudumc is a cause for the HIT problems that the operating rooms is experiencing. In addition, this thesis will give recommendations to the operating rooms of the Radboudumc on how to improve on their structure and HIT innovations.

1.3 Research question

The above leads to the following research question that will be central in this research:

*Which HIT problems do occur at the operating rooms of the Radboudumc and how are these problems related to the underlying structure and processes of the operating rooms of the Radboudumc?*

1.3.1 Sub questions

To help answering the main research question, this thesis will be divided into three smaller sub questions:

- *Which HIT related problems do occur at the operating rooms of the Radboudumc?*
- *What is meant by an organisational structure?*
- *How is the structure a cause for the HIT problems that occur at the operating rooms of the Radboudumc?*
1.4 Relevance

As this research aims at identifying which HIT related problems occur at the operating rooms of the Radboudumc and if and how the organisational structure of the operating rooms of the Radboudumc can be a cause for the experienced HIT problems, this thesis is mostly relevant from a practical perspective. First of all, this research will help the OR department of the Radboudumc with the identification of the different HIT problems. Second, this research will help the OR of the Radboudumc with the identification of their organisational structure. And third, most important, this research will help with the understanding of how both are related to each other. This new knowledge can help the Radboudumc with future decision making and implementation strategies of new HIT systems. Knowing the cause for the problems with their HIT systems will improve future implementations of new systems. Furthermore, this thesis will help the OR department of the Radboudumc with their challenge in either buying new IT systems or improve the organisational structure first.

On the other hand, this thesis serves a theoretical perspective as well. As in most research the focus with HIT problems is mainly on the HIT systems themselves, this research aims at the empirical testing of an existing model in which an organisational structure can serve a cause for HIT problems. Both Carayon et al. (2009) and Lawler et al. (2011) underline the importance of such socio-technical factors in the successes of HIT systems. This research contributes to the understanding and addressing of such factors in the successes of HIT systems. Furthermore, this framework can be used in future research to address similar research questions.

1.5 Outline

In chapter 2, a theoretical framework will be provided in which it will be conducted how to discover and assign HIT problems, how to describe an organisational structure and how the structure can be a cause for the HIT problems that occur at the operating rooms of the Radboudumc. The research methodology will follow in chapter 3. In chapter 4, the results and findings will be given. The conclusion of this thesis will follow in chapter 5, as well as a discussion and directions for further research.
Chapter 2 - Theoretical background

The aim of this research is to provide insight in which HIT related problems occur at the OR department of the Radboudumc and to see if the current structure of the operating rooms at the Radboudumc plays a role in the HIT problems that the operating rooms are experiencing. To do so, three questions must be answered: (1) Which HIT related problems do occur at the operating rooms of the Radboudumc, (2) what is meant by an organisational structure and (3) how is the structure a cause for the HIT problems that occur at the operating rooms of the Radboudumc? To answer these questions, first a theoretical framework must be laid. In this chapter, the theoretical framework will be provided that is used throughout this thesis.

In section 2.1 it is first explained what HIT is, how HIT problems can be defined and which HIT criteria will be used in this thesis to map the HIT problems at the operating rooms of the Radboudumc. Section 2.2 will be used to outline what an organisational structure entail. With help of the design parameters from De Sitter (1994) the organisational structure will be defined. Furthermore, based on the same theory, a desired value of these parameters will be given, to which the situation of the Radboudumc can be compared. In section 2.3, the theoretical framework will be given in which it will be defined how an organisational structure can be a cause for HIT problems. Furthermore, a desired situation will be given: that is, a situation in which the organisational structure cannot serve as a cause for the experienced HIT problems.

2.1 HIT problems

In order to answer the first question: “Which HIT related problems do occur at the operating rooms of the Radboudumc?”, it is necessary to first explain what HIT entails. After that, it must be defined when HIT works properly. To do so, different theories and models that try to identify criteria to address properly functioning (H)IT problems will be explained. Lastly, the HIT criteria that will be used in this thesis to map the HIT problems at the operating rooms of the Radboudumc will be explained and outlined. Deviations from these criteria are in this thesis seen as HIT problems.
2.1.1 Defining HIT

To define what HIT problems are, it first has to be found out what HIT is. As mentioned in chapter 1, HIT can be best defined as systems that deal with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making (Thompson & Brailer, 2004, p. 38). Furthermore, these systems can facilitate the implementation of care guidelines and decision support tools, which can be valuable in preventing process errors (McCullough et al., 2010). However, these are quite broad definitions, that do not translate exactly in what a HIT system should encompass.

What is known is that a good working information system should somehow fit appropriate to the processes it supports, by De Sitter (1994) defined as the production and control structure. Inside this production and control structure information is needed: information that is stored, retrieved and shared with use of IT systems. An IT system functions properly if this information meets certain standards. De Sitter defines these standards as quality aspects of information: if they are met, an IT system meets these standards. First of all, information must be reliable: when a thermometer shows a temperature, we must be sure that it is really this temperature. Second, the information must be actual: when a thermometer shows a temperature, we must be sure that this is the temperature that is measured within the timeframe that is defined as actual (for instance when measuring temperature, this could be five minutes). Third, the information must be complete: in a particular situation, we must have an overview of all the current conditions and information of that particular situation who are needed for the decision making in that situation. Without complete information, we cannot make a good decision. And lastly, the information must be relevant: information can be reliable, but is the information that is shown also the information that you must know? This is also known as validity: the extent to which the shown information is also the information that one wants to know (De Sitter et al., 1994).

To conclude, HIT are systems, such as electronic health records, inventory management systems and track & trace systems that are designed to improve the storage, retrieval and sharing of information between different users in a healthcare organisation. To do so, a HIT system should fit appropriate to the processes it supports. This entails that the information structure, where HIT is part of, must be a derivative of the production and control structure.
When designing this information structure, there are four aspects of information quality that play an important role: the reliability, actuality, completeness and relevance of information. Properly functioning HIT can then be defined as the timely delivery of information conform the four quality aspects in the purpose of supporting the production and control structure inside a healthcare organisation. But how can these aspects of quality be translated to what a successful IT system should encompass?

2.1.2 Criteria for properly working (H)IT systems

Now that HIT is defined, it has to be to find out which criteria define properly working HIT systems. One could say that the users of these systems define the success of an information system. Cyert and March (1963) introduced the concept of user information satisfaction as a key measure of information system success. User information satisfaction, nowadays better known as end user information satisfaction, can be best described as “the IS end-user’s overall affective and cognitive evaluation of the pleasurable level of consumption-related fulfilment experienced with the IS (Aggelidis & Chatzoglou, 2012, p. 566)".

Based on this end user computing satisfaction, Doll & Torkzadeh (1988) created a questionnaire based on 5 factors in which end user computing satisfaction can be measured. This end user computing satisfaction model includes the factors content, accuracy, format, timeliness and easy to use. In other words, does a system provide the precise information you need (content), is the system free of errors (accurate), is the output of the system presented in a useful format (format), is the system user friendly (ease of use) and does the system provide the user the information they need on time (timeliness) (Doll & Torkzadeh, 1988). The model of Doll & Torkzadeh has many similarities with how De Sitter measures information quality, as in their model, relevance is measured in the content construct with “Do you find the output relevant?”, reliability is measured in the accuracy construct with “Do you feel the output is reliable?” and actuality is measured in the timeliness construct with “Do you get the information you need in time?” (Doll & Torkzadeh, 1988, p. 267).1 This model has been extensively tested and instrument validity, internal and external validity have been widely proven (Doll et al., 1995; Doll, Xia, & Torkzadeh, 1994; Straub, 1989).

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1 Note that the first two questions are nowadays not part of the EUCS anymore, that is, because factor analysis showed that these two subjects are measured within the two constructs with use of other questions and thus the concepts are still covered in the EUCS questionnaire (Doll, Raghunathan, Lim, & Gupta, 1995).
Although the names of these constructs change depending on the theory, the content that is captured within these constructs seem to be the basis, as they are recurring in different models that try getting hold of measuring IT success (Gable, Sedera, & Chan, 2003).

Recently, Aggelidis & Chatzoglou (2012) proposed an extension of the EUCS that holds specifically for HIT. They propose a model based on information and system quality, that will lead to overall satisfaction. Information quality is measured by content, format, accuracy and timeliness. System quality is measured by ease of use, and is supplemented by Aggelidis & Chatzoglou with training, documentation, interface and system speed. This is measured in terms of the time that elapses from when an activity starts until the results are displayed (system speed), is there a proper working environment for importing, processing and exporting information (interface), is there a user documentation concerning what the application does, how it works and how to use it (documentation) and is there a training provided before and during system’s usage (training) (Aggelidis & Chatzoglou, 2012).

In addition, Moores (2012) tried to implement the EUCS into the technology acceptance model. The theory of TAM suggests that there are two factors, perceived usefulness (PU) and perceived ease of use (PEOU), that lead to an attitude towards using a system (ATT), that will lead to the intention to use a system (INT), that will ultimately lead to the actual use of a system (USE) (Legris, Ingham, & Collerette, 2003; Moores, 2012). Perceived usefulness is the user’s conception of that using the system will lead to an increased job performance. Perceived ease of use is the degree of effort that a new user thinks that it takes to learn the new system (Davis, 1989). Moores (2012) has developed a version of the TAM model that applies specifically for health IT, by extending the model with two constructs: information quality that leads to perceived usefulness and enabling factors that lead to perceived ease of use. And to define information quality, Moores uses the same topics as the topics of the end user computing satisfaction questionnaire. For measuring the enabling factors, Moores proposes two constructs: the extent to which an organisation provides technical support for users (computing support) and the extent to which the user believes they have the capability to use the system (self-efficacy) (Moores, 2012).
Support and self-efficacy seem to be important factors for measuring IS success as well, as they are recurring factors in the IS success model of Delone & McLean (2002) and the evaluation model for the acceptance of hospital information systems by Lu, Hsiao & Chen (2012): Delone & McLean (2002) propose a model in which the outcome of IS success can be predicted. It uses three constructs: system quality, information quality and service quality, to predict the intention to use the system and the user satisfaction, that will eventually lead to the net benefits, in other words the success of a system (DeLone & McLean, 2002; Petter, DeLone, & McLean, 2008). System quality has many similarities with the models presented by Aggelidis & Chatzoglou and Moores. System quality as defined in the model of Delone & McLean is measured in terms of ease of use, system flexibility, system reliability and ease of learning, as well as system features of intuitiveness, sophistication, flexibility, and response times (Petter et al., 2008). Information quality also presents many similarities with the models presented before, as it is measured with relevance, understandability, conciseness, accuracy, completeness, usability, and timeliness. The service quality is defined as “the quality of the support that system users receive from the IS department and IT support personnel” (Petter et al., 2008, p. 239), and measured in terms of responsiveness, accuracy (of the support), reliability (of the support) and technical competence (Petter et al., 2008). This construct is comparable with the enabling factors construct that Moores (2012) proposes for his model.

Lu, Hsiao & Chen (2012) propose a combination of original TAM model as designed by Davis (1989) and the IS success model as designed by Delone & McLean (2002). They use the quality constructs from the IS success model to predict the perceived usefulness and perceived ease of use from the TAM model, that will lead to system acceptance. As Lu, Hsiao & Chen (2012) measure the quality constructs as proposed by Delone & McLean (2002), and as the primary interest of this research is what proper HIS systems should entail and thus the focus is mostly on measuring the quality of HIS, this model will not be described in more detail.

Another way to measure IS success is to look at the usability of IS. The usability of a product can be considered as a pre-condition for the usefulness of a product (Hamborg, Vehse, & Bludau, 2004). Usability can be defined as “the extent to which the product can be used by specific users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specific context of use.” (ISO 9241 Part 11, 1998).
Based on the ISO 9241, which stands for the ergonomic requirements for office work with visual display terminals, Hamborg, Verse & Bludau (2004) have created a questionnaire to measure the usability of a health information system. This questionnaire is based on the 7 dialogue principles according to the ISO 9241 standard: does it support the user to realize his tasks effectively and efficiently (suitability for the task), is every step understandable in an intuitive way (self-descriptiveness), is the user able to start the sequence and influence its direction as well as its speed till he reached his aim (controllability), is it conform the user expectations in terms of consistency and characteristics (conformity with user expectations), is the intended deliverable reached with no or just minimal additional effort despite of obvious faulty steering or wrong input (error tolerance), does the system allows customizing according to the task as well as regarding the individual capabilities and preferences of a user (suitability for individualization) and is the user accompanied through different states of his learning process and is the effort for learning as low as possible (suitability for learning) (Hamborg et al., 2004).

To conclude, there are several models that try to describe and predict what a proper IS should look like. They all do that with different names for the constructs, by predicting end user computing satisfaction, technology acceptance, IS success and the usability of an IS system, but in the end, they seem to have three constructs in common: Information Quality, System Quality and Service Quality. In this thesis, the Information Quality construct will be central, as there is a presumption that there are problems with the information quality at the OR in the Radboudumc. Although an organisational structure can for instance affect the service quality in terms of responsiveness and reliability, the service quality itself only affects an information system in times of a breakdown and does not affect the transfer of information directly. This still is an important research object, but it is not the question that this research tries to answer, and therefore not processed in here.

### 2.1.3 Criteria for addressing HIT problems at the OR

Previous section gave an overview of different criteria by which properly functioning HIT systems can be evaluated. The HIT criteria that will be chosen to investigate HIT problems at the OR department of the Radboudumc will be given in this section.
Central in measuring information quality will be the concepts provided by De Sitter (1994): reliability, actual, relevance and completeness. Now one may have noticed that the definition for actual that De Sitter gives and timeliness as stated in the EUCS are the same. Wang & Strong confirm, as their definition of timeliness is “the extent to which the age of the data is appropriate for the task at hand” (Wang & Strong, 1996, p. 32). Furthermore, according to Doll & Torkzadeh (1988) the concept reliability is covered inside the accuracy construct of the EUCS questionary. Wang & Strong agree, as their definition for accuracy is “The extent to which data are correct, reliable and certified free of error” (Wang & Strong, 1996, p. 31) and thus matches the definition of De Sitter (1994), as De Sitter defines reliable as when certain information is shown, it must be sure that the information that is shown is correct. Furthermore, Kahn, Strong & Wang’s definition of free of error “the extent to which information is correct and reliable” (Kahn, Strong, & Wang, 2002, p. 187) matches the EUCS definition of accuracy in which free of error is a part. Gable, Sedera & Chan agree, as “only information that is accurate is reliable and vice versa” (Gable et al., 2003, p. 583). Furthermore, Wang & Strong define relevance as “the extent to which data are applicable and helpful for the task at hand” (Wang & Strong, 1996, p. 31), which gives it the same definition as the content construct of the EUCS questionary from Doll & Torkzadeh (1988). Gable, Sedera & Chan (2003) agree, as information can only be relevant if the right content is used and vice versa. This matches the definition of De Sitter, as De Sitter describes relevance as “the extent to which the shown information is also the information that one wants to know” (De Sitter et al., 1994, p. 337). Completeness is also a construct that is widely recognized inside the IS theories by multiple actors, and will be measured according to the definition of Wang & Strong: “the extent to which data are of sufficient breadth, depth, and scope for the task at hand” (Wang & Strong, 1996, p. 32)."

Now one may notice that understandability, format, conciseness and usability are also mentioned in different IS theories but are not mentioned by De Sitter (1994). This is where a distinction can be made: the data quality aspects of information from De Sitter can be directly linked to, and thus affected by structure characteristics (De Sitter et al., 1994). The concepts that define the user-friendliness of a system such as understandability, format, conciseness and usability cannot be directly linked to, and thus cannot be directly affected by structure characteristics. In section 2.3 it will be shown how the information quality aspects can be directly linked to structure characteristics.
Now, one may recognize that the definitions in which the Information Quality construct is measured is still quite broad and can differ dependent on the processes and systems one looks at. As it is yet unknown how the processes will look like, some examples are given now and the operationalization of these concepts will follow later. The next example is based on a HIT system in a hospital that has to deliver the information concerning the instruments that are needed in surgery. As for every type of surgery, one need specific instruments for that surgery, so the information shown by the system must be presented in the right way and must have no faults in it. More clarification on the constructs are provided in table 2.1 below with use of the definitions and examples.

Table 2.1 - chosen HIT criteria

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevance / Content</td>
<td>The extent to which the shown information is also the information that one wants to know (L. De Sitter et al., 1994)</td>
<td>Is the relevant necessary patient data displayed so that one now which instruments will be used during the surgery?</td>
</tr>
<tr>
<td>Reliability / Accuracy</td>
<td>The extent to when showing information, it is also for sure that the information that is shown is correct and free of errors (L. De Sitter et al., 1994)</td>
<td>Is the necessary patient data displayed with the right accuracy so that there can be no error in which instruments will be used during the surgery?</td>
</tr>
<tr>
<td>Actual / Timeliness</td>
<td>The extent to which the age of the data is appropriate for the task at hand (Wang &amp; Strong, 1996)</td>
<td>Is the necessary patient data displayed at the right time so that one now which instruments will be used during the surgery without causing delays?</td>
</tr>
<tr>
<td>Completeness</td>
<td>The extent to which data are of sufficient breadth, depth, and scope for the task at hand (Wang &amp; Strong, 1996)</td>
<td>When looking at the patient data, is all the necessary data shown to conclude which instruments will be used during the surgery?</td>
</tr>
</tbody>
</table>

To conclude, this section was about defining HIT. Furthermore, based on different theories and models, multiple criteria to address properly functioning (H)IT systems have been defined. One may notice that in the section above, only IT in general is mentioned, and not for HIT specifically. Now, when looking at HIT and indicating problems with HIT, this is done with use of the same criteria as when indicating IT problems. The only difference is the sensitivity of information, which makes the information quality even more important. For instance, actuality, completeness and relevance play an important role in HIT, as acting with wrong information can cost lives. Lastly, the HIT criteria that will be used to identify HIT problems at the OR in the Radboudumc were given. One may speak of HIT problems when the measured situation of the OR in the Radboudumc shows a derivation with one or more of the above-mentioned concepts. Now that the theoretical framework has been laid out to answer the first sub question: “Which HIT related problems do occur at the operating rooms of the Radboudumc?”, it is necessary to first find out what an organisational structure is, to show later on how an organisational structure can be a cause for HIT problems.
2.2 Organisational structures

Now that is clear how to identify HIT problems at the OR of the Radboudumc, it is necessary to find out how the organisational structure can be a cause for these HIT problems. Before it is possible to answer that question, first it has to be found out what an organisational structure entails. Therefore, the following sub question will be answered in this section: “What is meant by an organisational structure?”. To do so, first the definition and purpose of an organisational structure will be given. After that, the design parameters as described by De Sitter (1994) will be given and explained, which are used to describe organisational structures. For each parameter it is first described what this parameter entails. Second, with use of some examples the behaviour of a high and low parameter value will be explained. Last, the desired value of each parameter will be given.

2.2.1 How to define an organisational structure

There are many ways to define an organisational structure. One of the best-known definitions is that from Mintzberg: “The sum total of the ways in which it divides its labour into distinct tasks and then achieves coordination among them” (Mintzberg, 1979, p. 2). Mintzberg’s principle in designing structures is that one should first decompose the main organisational activity into sub-activities, then assemble these smaller sub-activities into tasks and lastly, coordinate the resulting tasks (Achterbergh & Vriens, 2019). According to De Sitter (1994), all activities can be decomposed into sub-activities in at least two ways: decomposition with respect to parts and decomposition with respect to aspects. The decomposition of an activity into parts is to define two or more sub-activities, that sequentially realize the end-state of the main activity. The decomposition of an activity into aspects is to define a characteristic of the whole activity, which is then used to define two or more sub-activities (Achterbergh & Vriens, 2019; De Sitter et al., 1994). These sub-activities then have to be assigned to operational units, also known as defining the tasks. There are two types of activities that define tasks: the activities of the process itself so that the task can reach its end goal (operational) and all the activities that enable the smooth performance of the operational activities (regulatory). But when starting the decomposition of activities in smaller sub-activities and starting the creation of tasks by assigning sub-activities to operational units, there are also dependency relations created between these tasks. This is also known as a network of tasks (Achterbergh & Vriens, 2019). De Sitter (1994) states that it is the grouping of the sub-activities into tasks and the relations between these tasks that is called the organisational structure.
But now that is known what a structure entails, what should a structure achieve?
As discussed in the introduction, organisations are social systems and everything that happens inside an organisation is socially embedded. These organisational interactions are not just interactions: they need to have a particular focus to achieve meaningful survival, something that all organisations strive at (Achterbergh & Vriens, 2019). This focus can be derived from 4 basic activities that an organisation needs to perform: 1) performing primary processes, 2) operational regulation, 3) strategic regulation and 4) regulation by design. With the last one, regulation by design, the right infrastructure is set in terms of Human Resource, Technology and Structure, that conditions the other 3 basic activities to be performed. These basic activities have two purposes: 1) realizing and adapting the organisational contribution in terms of Quality of Organisation and Quality of Work, and 2) reflecting on and adapting interaction premises in terms of Goals, Infrastructure and Basic assumptions. In this way, a structure has a dual purpose: it should contribute to a right infrastructure in which the basic activities can be achieved so that the organisational contribution can be realized and it should enable reflection and adaption of the interaction premises in such a way that it can change the infrastructure itself too (Achterbergh & Vriens, 2019). Now that is known what an organisational structure entails and what it should achieve, it is necessary to find a way to describe organisational structures. The theory used in this thesis is from De Sitter (1994).

Following the principle of two types of activities as stated earlier, De Sitter (1994) defines two types of sub-structures: the production structure (for grouping of operational tasks) and the control structure (for grouping of regulatory tasks) (Achterbergh & Vriens, 2019). Based on these two types of sub-structures, De Sitter (1994) proposes seven design parameters to describe organisational structures. The for this thesis most important ones will now be discussed and used. The degree of functional concentration, differentiation of operational activities and specialization of operational activities are related to the production structure. The degree of specialization of regulatory activities is related to the control structure. The degree of separation describes the relation between the operational and regulatory activities (De Sitter et al., 1994). Achterbergh & Vriens (2019) argue that, although parameters can have different values for different organisations resulting in different lay-outs, every organisational structure can be described by means of these parameters. Additionally, there is one more parameter that is not described by De Sitter (1994), formalization, that is important for this research.
This parameter describes the degree to which rules and procedures dictate how tasks should be executed (Becker & Neuhauser, 1975, p. 11). This parameter is useful for this research, as in hospital organisations, there is the contradictory of the need for flexibility (in for instance emergency situations) on the one hand and the need for rigid authority (in for instance accountability) on the other hand (Hetherington, 1991). The, for this research, most important parameters from De Sitter (1994) and the degree of formalization will be discussed in detail now.

### 2.2.2 Functional concentration

The first design parameter that is important for this research is the degree of functional concentration. This parameter refers to the relation between operational tasks and order types, or in other words, the degree to which operational tasks are related to all order types (Achterbergh & Vriens, 2019; De Sitter et al., 1994). An order type in this sentence is a demand from an (internal) client for a type of product or service, a sub-set of all orders. For instance, in the operating rooms in the hospital the order is the surgery itself. An order type then could be all the orthopecadic surgeries that are performed in the operating rooms.

A high level of functional concentration then means that all operational tasks are related to all order types. For instance, that all the surgery assistants are involved by all the types of surgery performed in the operating rooms. According to Achterbergh & Vriens (2019), it is typical for organisations with high functional concentrations to have operational units in which tasks are clustered based on the similarity of activities, knowledge or skill, something as what Mintzberg (1979) refers to as functional grouping.

A lower degree of functional concentration means that every order type has its own operational tasks with its own personnel and equipment. For instance, that the subtype orthopecadic surgeries has its own equipment and personnel that only perform orthopecadic surgeries. This functional concentration could be lowered even more by decomposing the subtype orthopecadic surgeries into sub-subtypes of orthopecadic surgeries and assigning own equipment and personnel per sub-subtype. As Mintzberg (1979) mentions, identifying order types based on output, such as types of healthcare, fits healthcare organisations quite well. This is due to the tasks that are related to the type of healthcare.
When tasks are related to all types of healthcare, there will be a high functional concentration. However, when tasks are only related to one type of healthcare, these tasks do not belong to other types of healthcare, which lowers the functional concentration.

### 2.2.3 Separation

The second parameter that will be important for this research is the degree of separation. This parameter combines the operational and regulatory components and describes the relation between these two activities (De Sitter et al., 1994). According to De Sitter (1994), every task has an operational and regulatory aspect. The degree of separation refers to the amount in which these two activities are separated from each other being assigned to different tasks.

If high, an operational task contains no or almost none regulatory aspects in its tasks and vice versa (Achterbergh & Vriens, 2019). An example of this could be that during surgery extra instruments are needed. Instead of someone who is participating at that surgery walks to the warehouse and get the instruments themselves, they need to call the logistics department and give the order to bring them the extra instruments. If there are no extra instruments needed during that surgery, this won’t be a problem, but if there are instruments needed, there are a lot of people involved to get the instruments from the logistic department to the surgery room, which can cause problems. For instance, when the instruments that has been asked for are not available anymore. Then the logistics department does not have the regulatory capacity to deal with this, and has to call the surgery assistant, who in her turn, has to ask the surgeon what to do. The separation between the logistics department, who perform the operational tasks, and the employees at the OR (for instance surgery assistants), who perform the regulatory task in getting extra instruments to that OR, is visible.

If the degree of separation is low, a task contains both an operational and regulatory aspect, so that they are performed by the same people (Achterbergh & Vriens, 2019). An example of a low degree of separation at the operating rooms could be the ordering of disposables that are needed for surgery. When an employee of the logistics department notices that during the refilling of boxes the wrong product is supplied, this same employee can perform the regulatory tasks to make the call and change this product with the correct product. In this action, both the refilling (operational) and the arranging of the correct product (regulatory) are done by the same person.
2.2.4 Specialization of operational activities

The third parameter that will be central in this research is the degree of specialization of operational activities (De Sitter et al., 1994). This parameter refers to the degree of which operational activities are divided into smaller sub-tasks, also known as job specialization (Mintzberg, 1979) or division of labour from Smith (Rosenberg, 1965).

If this parameter is high, employees only perform small parts of the production process in a sequence, often referred to as conveyer-belt processes (Achterbergh & Vriens, 2019). An example of this could be the sterilization of instruments that are used in surgery. This is done by a single department, that receives used instruments from the operating rooms. The employees of this department then unpack the instruments, clean them and do the re-packing before the clean instruments are shipped back to the operating rooms. This is a tiny part in the whole surgery process and is performed over and over again in this sequence. Another organisation form that has a high parameter value is the functional organisation, which is divided into different departments in which employees perform the same activities over and over again.

If the degree of specialization of operational activities is low, the whole production task is performed by the same people. For instance, the surgeon who performs the whole surgery, and not only a small part of it.

2.2.5 Specialization of regulatory activities

The fourth parameter that is important for this research is the degree of specialization of regulatory activities (De Sitter et al., 1994). This parameter has basically the same function as the specialization of operational activities, but then for the regulatory activities. Regulatory activities can be broken down and divided into smaller sub-tasks as well.

If this parameter is high, there are a lot of different people responsible for small regulatory tasks, super visioning small groups of people and therefore, this group has a small scope of the operational process. An example of this could be that there are multiple departments involved for the processes that are performed at the operating rooms.
They all have their own management with regulatory capacity without having insight in each other departments. And because they can only see what their own department is doing, they can create a lack of overview of the total process.

If this parameter is low, there is a small group of people responsible for larger regulatory tasks, super visioning larger groups of people and therefore, this group has a larger scope of the operational process (Achterbergh & Vriens, 2019). For instance, in the operating room during surgery, there is only one person responsible. Because there is only one person responsible, this person has a good overview of the surgery and can act fast in case of emergency.

### 2.2.6 Differentiation of operational activities

The fifth parameter that is important for this research is the degree of differentiation of operational activities (De Sitter et al., 1994). According to De Sitter (1994), an operational activity can be differentiated into production, preparation and support activities. Operational activities can be divided into the activities that are needed to perform actual task (production), the activities required to gather the necessary equipment, information and materials (preparation) and the activities that support the production and preparation (support).

If there is a high degree of differentiation of operational activities, the operational activities are separated into production, preparation and support tasks (Achterbergh & Vriens, 2019). For instance, when performing surgery, the surgery itself is done by surgeons, the collecting from the equipment is done by the logistics department and the planning of the surgery is done by the staff personnel.

When there is a low degree of differentiation of operational activities, the production, preparation and support activities are all done by the same person, performing the complete task.

### 2.2.7 Formalization

The last parameter that is important for this research is the degree of formalization. This is a parameter that is not described by De Sitter but is recognized by multiple other authors.
Formalization has a lot of definitions, such as: “the degree to which work is a series of planned activities” (Becker & Neuhauser, 1975, p. 11), “the specification of procedures” (Neuhauser, 1971, p. 38) and “the degree to which procedures defining a job are spelled out” (Aiken & Hage, 1968, p. 926). This parameter describes the degree to which rules and procedures dictate how tasks should be executed (Becker & Neuhauser, 1975, p. 11) and is useful for this research as there is in hospital organisations the contradictory nature in which there is the need for flexibility and at the same time the need for rigid authority (Hetherington, 1991). Lawrence & Dyer (1983) were one of the first to notice this contradictory. One the one hand, personnel must be given some room so that they have the flexibility to adapt to the circumstances of each individual patient so that they can provide care that is designed for that patient. On the other hand, hospitals tend to implement formalized procedures to ensure predictability and co-ordinated action in situations when people’s lives are at stake (Hetherington, 1991; Lawrence & Dyer, 1983). This is closely related to bureaucratization and the ongoing process of creating procedures and rules for hospitals. Where management and other instances want more rules and procedures, healthcare providers want the exact opposite: more freedom to provide customized healthcare.

Instead of the parameters mentioned before, this parameter does not necessarily have to be low to have a positive or negative effect on the processes in that organisation. This is for the following reason. A high degree of formalization reduces variety and creates order, something that is wanted in an organisation to be effective (Wright, Sturdy, & Wylie, 2012). At the same time, a high degree of formalization blocks the pathway to innovation, something that every organisation needs in order to reinvent themselves and to stay competitive (Kanter, Jick, & Stein, 1992). However, having a low degree of formalization and thus suggesting that innovation is centrally concerned, there is the possibility that key qualities are lost (Wright et al., 2012). Furthermore, having some degree of formalization could even lead to “improved performance via routinization, simplification and cost economies” (Wright et al., 2012, p. 653). Moreover, some degree of formalization could also lead to learning by doing through the creation of common languages and methodologies for experimentation and incremental change (Adler & Borys, 1996). And to add, having no degree of formalization will be impossible, as there is a certain degree of formalization through regulation. Organisations adopt externally determined guidelines to bring their activities in line with other organisations and to apply to professional norms that are set as the standard (Anderson, Daly, & Johnson, 1999).
Regulation may come from both formal and informal pressure on organisations by other organisations upon which they are dependent, cultural expectations from the society or even from government mandate when a set of new rules is developed by the government (DiMaggio & Powell, 1983). And in highly skilled, complex organisations like hospitals, accountability plays a role too. Accountability is the need to being answerable to someone, for meeting defined objects (Emanuel & Emanuel, 1996). One can distinguish three types of accountability in healthcare: fiscal accountability to payers, clinical accountability to patients and accountability to the public (Deber, 2014). These types of accountability are all the result of regulation, and thus lead to a certain degree of formalization. The degree of formalization must be then something in the middle, not too low and not too high. It is all about organisations to both exploit existing knowledge and explore or create new knowledge (Raisch, Birkinshaw, Probst, & Tushman, 2009).

An example of a high degree of formalization in a hospital could be the pre-incision time out checklist before a surgery. This is a standardized checklist that has been formalized into the surgery procedure. This checklist must be completed and finished before the start of a surgery, otherwise surgery cannot proceed. This is a checklist that is always the same, for every procedure, for every surgeon, even during trauma surgery.

An example of a low degree of formalization in a hospital could be the planning of the surgeries. Although one would expect that the planning process is a formalized procedure, this actually is not. Every specialism has its own planning technique, based on best practice, and there is no formalized way to plan surgeries. Some do it with a pencil and notebook, some do it through Epic, and in the end, they are all responsible for their own specialism.

### 2.2.8 Design parameters used in this research

This section was about answering the sub question “What is meant by an organisational structure?”. In this research, with a structure is meant the decomposition and grouping of the sub-activities into tasks and the relations between these tasks (De Sitter et al., 1994). De Sitter (1994) defines two sub-structures: the production and control structure. Based on these sub-structures, De Sitter has defined several design parameters that describe the behaviour of an organisational structure (De Sitter et al., 1994). The ones that are, given the context, most important for this research will be used to define the organisational structure.
This includes the functional concentration, differentiation and specialization of operational activities (which will be measured as one parameter instead of two separate parameters due to their close relation), separation of operational and regulatory activities and the specialization of regulatory activities. Furthermore, the formalization is added as a parameter too, as it may be an important parameter for the type of organisation that is being researched. Now that is known how an organisational structure of the OR of the Radboudumc can be described in terms of the above presented design parameters, it must be find out how a low or high parameter structure can lead to HIT related problems in an organisation.

### 2.3 Hit problems and organisational structures

The six design parameters as described in the previous section can be used to describe what the organisational structure looks like. However, these parameters can also be used in a normative way: based on the certain values of the parameters in an organisation, one can describe how an organisational structure functions (Achterbergh & Vriens, 2019). Therefore, the first part of this section is about describing how an organisation structure can lead to problems. However, in this thesis, the assumption is that an organisational structure can lead to not just problems, but HIT problems in particular. Therefore, the second part is about describing in detail how structures can lead to different types of HIT problems. As mentioned in section 2.1, this will only involve the information quality aspects of HIT problems, as it may be expected that the information quality does get affected by different types of structures. This in contrast to the user-friendliness aspects of HIT problems, that most likely will not get affected by different types of structures. In this section, it is outlined how each individual parameter can cause different HIT (information quality) problems. This will lay the theoretical foundation for answering the third sub question: “How is the structure a cause for the HIT problems that occur at the operating rooms of the Radboudumc?”.

#### 2.3.1 High parameter value structures as a cause for problems in general

De Sitter (1994) and Achterbergh & Vriens (2019) state that the structure of an organisation should support the four basic activities that an organisation needs to perform. They use cybernetics to explain how these four activities can be supported by a structure. According to De Sitter (1994) and Achterbergh & Vriens (2019) a structure should have 2 characteristics:

- A structure should not be a source of disturbances
- A structure comprises the means to deal with disturbances
De Sitter states that, as a structure is a network of related tasks, the probability of disturbances in a structure can be affected by two variables: 1) the number of relations in the network and 2) the variability of these relations (Achterbergh & Vriens, 2019, p. 65). According to De Sitter (1994) each relation can be a source of something that could go wrong, and therefore is a possible source of disturbance. If there are more relations connected to a task, the possibility to become a source of disturbance also rises. And, as a structure is a network of tasks, if the relations in a network rise, the probability of disturbances also rise. Furthermore, De Sitter (1994) states that the variety of the content of these relations also play a role. This can be illustrated with giving ‘values’ that a relation can transfer. If a certain relation can only transfer two values, say 0 or 1, the chance that the wrong number is transferred is relatively low. But if a certain relation can transfer ten values, say between 0 and 9, the chance that the wrong number is transferred is a lot higher, and therefore, the chance of possible disturbances also rises.

A structure should also comprise the means do deal with disturbances. De Sitter (1994) states that, although a structure itself should not be a source of disturbances, not all the disturbances affecting the organisation can be prevented. Therefore, organisations should have regulatory capacity to deal with these disturbances. That means that tasks should be organized in such a way that they have the regulatory potential to deal with disturbances themselves. This can be done in three ways: dealing with disturbances in the current organisational infrastructure and its goals (operational regulation), dealing with disturbances by changing the infrastructure (regulation by design) and by redefining goals so that disturbances can be dealt with (strategic regulation) (Achterbergh & Vriens, 2019).

Achterbergh & Vriens (2019) state that, when the values of the parameters as described before rises, the network of tasks also grows. And, as stated by De Sitter (1994), when the network of tasks grows, the probability of disturbances also rises. And when the probability of disturbances rises, the need for regulatory potential to deal with these disturbances also rises. This is due to that when there is a high probability of disturbances, people inside an organisation must have more capacity to deal with these disturbances. However, if there is a high degree of separation in which operational and regulatory tasks are separated, people who perform the primary activities, do not have the regulatory capacity to deal with these disturbances themselves.
So, when there is a high degree of separation, will there be any regulatory potential in operational tasks left to deal with these disturbances? Therefore, De Sitter (1994) states that the values of the design parameters must be as low as possible. If the values of the design parameters rise, the probability of disturbances also rises and the regulatory potential to deal with this disturbances will decrease, resulting in a structure that will not be able to support the four basic activities an organisation should perform (De Sitter et al., 1994).

However, in this thesis, it is expected that a high parameter value (HPV) structure does not only lead to problems in general, but also to HIT problems in particular. But how can a HPV structure lead to HIT problems?

2.3.2 High parameter structures as a cause for HIT problems in general

To find out why a HPV structure can cause HIT problems, the following reasoning is important. According to De Sitter (1994), HIT falls within the information structure, which can be defined as: "The content and form of the to be registered information and the way in which it is stored, processed and transferred" (De Sitter et al., 1994, p. 101). This information structure should be derived from the production and control structure; thus the design of an information system should also be derived from the production and control structure (De Sitter et al., 1994). Therefore, it could be said that properly working HIT systems are systems, that are designed based on the production and control structure, and fulfil the demands stated from the production and control structure in such a way that all the relevant information that is stored in the production and control structure is observed, captured and transferred. Now, if the design parameters as mentioned earlier have high values, the number of relations that are connected to a task, and therefore the number of relations in a network, will increase. Furthermore, the variability of information shared between these relations will also increase. Consequently, this will lead to problems concerning the information provision as well.

First of all, a HPV structure that covers many relations will have a more complex information need than a LPV structure that covers less relations. As a HIT system is a derivative of the information need inside a structure, a HPV structure will also lead to a more complex information provision. This enlarges the chance on errors in HIT systems.
Second, high parameter values will also cause higher variability between relations in such a structure. This will enlarge the volume of information that needs to be transferred. This will not only result in a more complex information need; it will also enlarge the chance of errors inside that information. And as a HIT system is a derivative of the information need inside a structure, this will result in more complex HIT systems and also enlarge the chance on errors in HIT systems. Furthermore, the combination of both parameters having a high value will also increase the need for more coordination and planning inside such a structure, which will also increase the information need, causing a more complex information provision. Lastly, as due to a growing network of tasks the probability of disturbances increases, the need for regulatory capacity to deal with these disturbances also increase. To deal with these disturbances, extra information on top of the already needed information on that process is needed. This will make the information need, and therefore the information provision even more complex (Achterbergh & Vriens, 2019; De Sitter et al., 1994). These 3 problems will eventually lead to problems with the HIT systems, which are reflected by the quality aspects of information as stated by De Sitter (1994). It may be expected that if there is a HPV structure, the above three problems will occur, which will cause problems with one of the following quality aspects: the reliability, actuality, completeness and relevance of information (De Sitter et al., 1994). To find out how exactly, it is now per sub structure (production/control) described how a HPV value affects this structure and its information provision. After that, an exposition for each parameter is given, in which both high and low parameter values are described with use of an example, and how they can cause problems with the information provision and quality aspects in such a structure.

2.3.3 Production structure parameters as a cause for HIT problems

According to De Sitter (1994), the design of the production structure is all about designing a structure that is itself is not a source of disturbances. This can be done by changing two variables: bringing down the relations in a structure and bringing down the variability between these relations. The number of relations in a network and the variability of these relations are determined by the functional concentration, specialization and differentiation of operational tasks. Both variables have, if high, consequences for the information provision. In a production structure with many relations there will be more information shared, which will result in a more complex information need. This will lead to a more complex information provision, which enlarges the chances of errors in a HIT system.
Furthermore, an increasing variability between relations will cause an increase in the transferred volume of information. This will result in a more complex information need and this will also enlarge the chance of errors inside that information. And as a HIT system is a derivative of the information need inside a (production) structure, this will result in more complex HIT systems and this also enlarges the chance on errors in HIT systems (De Sitter et al., 1994). Furthermore, it may be expected that when in a production structure both variables are high this will further increase the need for more coordination and planning, resulting in an even higher information need and thus an even more complex information provision. Therefore when both variables are high, it may be expected that the above problems will occur, which will cause problems with one of the following quality aspects: the reliability, actuality, completeness and relevance of information (De Sitter et al., 1994). This may sound theoretical, but imagine that you have a lot of tasks, and that all these tasks apply to a lot of different patients. Consequently, there will be more information transferred and during this transferral of information, the volume of the transferred information will also be higher. This will increase the probability of mistakes made during this transfer of information.

However, when these parameters are as low as possible, the number of relations of tasks and the variability of relations will be as low as possible. This will result in a decrease of transferred information and in a decrease in volume of processed information, and thus result in a less complex information need. Furthermore, it will result in a decrease on need for coordination and planning, resulting in a lower information need. Therefore, a low parameter value production structure will make the information provision, and thus the HIT systems, less complex, which will lead to less errors in terms of the quality of information inside those systems (De Sitter et al., 1994). Referring back to the same example, you will now have less tasks, and these tasks apply to less patients. Consequently, there will be less information transferred and during this transferral of information, the volume of the transferred information will also be lower. This will lower the chance of mistakes made during this transfer of information. In the next sections it is shown why low parameter values will result in less complex HIT with less experienced errors in terms of the quality of information. For each production parameter it is now with use of an example shown what a high and a low parameter value does with a HIT system in terms of the quality of information. Furthermore, for each parameter, the desired value will be given.
2.3.4 Functional concentration as a cause for HIT problems

A high level of functional concentration means that all operational tasks are related to all order types (Achterbergh & Vriens, 2019). If there is a high degree of functional concentration, the variability of the relations in that network will increase (Achterbergh & Vriens, 2019). Due to the increasing variability of the relations in that network, the volume of information to process will also increase (De Sitter et al., 1994). This has two consequences: it will increase the information need and it will increase the probability of errors inside that information, resulting in a more complex information provision. And as a HIT system is a derivative of the information need inside a structure, this will result in more complex HIT systems and this also enlarges the probability of errors of information in HIT systems. It may be expected that this will result in a problematic quality of information in those HIT systems, becoming visible in terms of the reliability, actuality, completeness and relevance of information (De Sitter et al., 1994). It can therefore be stated that if there is a high functional concentration, there will be an increase in the transferred volume of information, which result in a more complex information provision and also in an increase in the probability of errors in information shared in such a structure. Both result in a problematic quality of information in terms of the reliability, actuality, completeness and relevance of this information (De Sitter et al., 1994). Furthermore, De Sitter (1994) gives as a general design rule that one should decrease the lead time of information in order to keep information actual. With a high degree of functional concentration, one may expect that as the volume of processing information increases, the lead time of information will also increase, which causes direct problems with the actuality of the information (De Sitter et al., 1994).

Referring back to the example of the surgery assistants that are involved by all the types of surgery performed in the operating rooms, the surgery assistants must know all the information about all types of surgery. This results in a high variability of the relations in that network, resulting in a high volume of information that the surgery assistants need to transfer and process. This will increase the information need and it will increase the probability of errors in the shared information, resulting in a more complex information provision. This will result in more complex HIT systems and this also enlarges the probability of errors of information in those HIT systems. This will eventually become visible as one (or all) of the four quality aspects will become problematic. And due to the high volume of information that the surgery assistants need to process, the lead time of information also increases.
This will directly affect the actuality of the information that the surgery assistants receive, causing problems for the quality of the information. Therefore, it may be expected that with a high degree of functional concentration, not only the transferred volume of information increases, which result in a more complex information provision and also in an increase in the probability of errors in information shared in those systems, but that also the actuality and thus the quality of the information will be directly affected by a high degree of functional concentration.

On the other hand, one may expect that if there is a low degree of functional concentration, the variability of the relations in that network will decrease and therefore, the volume of information to transfer will also decrease. This will decrease the need for information and the probability of errors in the shared information, resulting in a less complex information provision. This will result in less complex HIT systems with a lower probability of errors of information in those HIT systems that may become visible in one or more of the four quality aspects of information (De Sitter et al., 1994).

Referring back to the example of the surgery assistants that only perform orthopedic surgery, these surgery assistants only have to know information about orthopedic surgeries. This will lower the variability of the relations in that network, resulting in a lower volume of information that these surgery assistants need to process. This will lower the need for information at the OR and therefore will make the information provision, and thus the HIT systems, less complex. There will also be a lower probability of errors of the information that is shared between the surgery assistants, which will also lower the chance of errors of that information shared with HIT systems. This will result in a higher quality of the information shared with HIT systems. And as the surgery assistants have a lower volume of information to process, this will also decrease the lead time of this information, which makes the information more actual and therefore, improves the quality of the information even further. Therefore, one may expect that with a low degree of functional concentration, there will not only be a decrease in volume of processing information resulting in a less complex information provision with less errors in the information shared in those systems, but also a direct improvement in the quality of that information in terms of actuality.
2.3.4.1 Norm value of functional concentration

Based on the above and the desired relation between functional concentration and the quality of information shared in HIT systems, that is for functional concentration to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value can be established: *The level of functional concentration must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems.*

2.3.5 Specialization and differentiation of operational activities

A high level of specialization and differentiation of operational activities means that operational tasks are divided into smaller sub-tasks and employees only perform a few of these sub-tasks of the production process in a sequence (Achterbergh & Vriens, 2019). If there is a high degree of specialization and differentiation of operational activities, the number of relations in that network will increase (Achterbergh & Vriens, 2019). This will result in an increase of the amount of transferred information, which will result in a more complex information need. This will lead to a more complex information provision, which enlarges the chances of errors in a HIT system, becoming visible in one of more of the quality aspects of information. It can therefore be stated that a high degree of specialization and differentiation of operational tasks will lead to a higher need of information, resulting in a more complex information provision and thus HIT systems, which enlarges the chance of errors in information in those HIT systems, becoming visible in one or more of the quality aspects of information (De Sitter et al., 1994). Furthermore, De Sitter (1994) gives as a general design rule that one should strive for completeness of information by shortening the distance between production, support and preparation. If there is a high degree of specialization and differentiation of operational activities, one may expect that as the number of relations in a network increases, and as there will be more differentiation of production, support and preparation, the distance between production, support and preparation will also increase, resulting directly in less complete information (De Sitter et al., 1994).

Referring back to the cleaning instruments example that only covers a tiny part of the whole surgery process, there must be an information transfer between the surgery assistant and the person who cleans the instruments, on for instance which instruments belong to which instrument set.
Therefore, there will be a higher amount of transferred information in this type of structure than when the preparation, support and production would be performed by the same persons, or when tasks cover a larger part of the process. This will result in an increase in information need, resulting in a more complex information provision, and thus more complex HIT systems. This enlarges the probability of errors in information in those HIT systems, becoming visible in one or more of the quality aspects of information. Furthermore, by assigning someone to clean the instruments that is not involved at all in the surgery, some essential information could be missing that would have been there if the person was involved in the surgery itself. Therefore, it might be expected that with a high degree of specialization and differentiation of operational activities, not only the information need increases, which makes the information provision and thus HIT systems more complex, of which it may be expected that more errors in information occur, becoming visible in one or more of the quality aspects of information, but that also the completeness and thus the quality of the information will be directly affected by a high degree of specialization of operational activities.

On the other hand, if there is a low degree of specialization and differentiation of operational activities, one may expect that as the number of relations in a network decreases, the amount of transferred information also decreases, which lowers the information need in such a structure. This will make the information provision and thus HIT systems less complex, which will result in less errors in the quality of information in those systems. Furthermore, one may expect that as the number of relations in that network decreases, the distance between tasks and the production, support and preparation will also be smaller, which should improve the completeness and thus the quality of the information (De Sitter et al., 1994). For instance, when the person that cleans the instruments is involved in the surgery, this person knows all the information about the surgery that is performed, and therefore, no information has to be transferred. Furthermore, the chance of missing information will be a lot smaller, as there is no information transfer where this could go wrong. Therefore, it might be expected that with a low degree of specialization and differentiation of operational activities, not only the information need will decrease, resulting in less complex information provision and thus HIT systems, which decrease the chance of errors in information in those systems and therefore improves the quality of information, but that also the completeness and therefore the quality of the information will improve (De Sitter et al., 1994).
2.3.5.1 Norm value of specialization and differentiation of operational activities

Based on the above and the desired relation between specialization and differentiation of operational activities and the quality of information shared in HIT systems, that is for the specialization and differentiation of operational activities to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value can be established: The level of specialization and differentiation of operational activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems.

2.3.6 Control structure parameters on HIT problems

As one should first design the production structure and then the control structure, it may be assumed that the production structure is designed in such a way that it has the lowest number of relations possible and the lowest variability between these relations, resulting in both a reduction in volume of the information that needs to be transferred and processed and a reduction in the information need in such a network. This will result in a less complex information provision, with less errors in information that is shared inside those systems. Furthermore, it may be assumed that when the production structure is designed in that way, the need for regulatory capacity and thus the information need for regulatory capacity will also be lower, which also results in a less complex information provision (De Sitter et al., 1994). De Sitter (1994) states that this implies an improvement on managerial efficiency and that with the design of the control structure, the focus can be on one goal: improving the quality of the available information on process variation. After all, the information need is now as low as possible, and with the design of the control structure, it is only possible to improve on the quality of the needed information inside a structure (De Sitter et al., 1994).

However, it should be noted that although it is advised to design the control structure based on the production structure, it is no strict rule. If the control structure is not designed based on the production structure, one should take in mind that the design is being done with the same principles as designing the production structure, that is: with the lowest number of relations possible and with the lowest variability in a network of relations possible. If not, also the control structure can be a cause for a higher information need and more errors in information shared, causing a more complex
information need with a higher chance of errors and thus problematic information quality values (De Sitter et al., 1994). However, in this thesis it is assumed that the control structure is a derivative of the production structure, and therefore the focus can be on how the control structure can improve the quality of information. But how does a low degree of separation of operational and regulatory activities and specialization of regulatory activities lead to an improvement in quality of the information needed in an organisation?

2.3.7 Separation of operational and regulatory activities

As mentioned earlier, there are according to De Sitter (1994) four aspects that define the quality of control information: reliability, actuality, completeness and relevance. De Sitter states that a high degree of separation of operational and regulatory activities lead to problems with all four quality aspects of information. The separation of operational and regulatory activities into separated tasks implies that there will be information that needs to be transferred between these tasks, which may give problems with the actuality of this information. Furthermore, the information that is transferred between these tasks requires encoding and decoding. The more information that is shared, the more encoding and decoding, which implies that there might be more deformation, which makes the information less reliable. Third, separation suggests that between the observation and execution there will always be a small time window, or as De Sitter states: dead time. Within this dead time, anything can happen, and therefore, this dead time will affect the completeness of the information. Lastly, because information will be affected by the reliability, actuality and completeness, based on this information, a good decision cannot be made, which in turn will affect the relevance of the information (De Sitter et al., 1994; De Sitter et al., 1997).

Let’s head back to the real example at the OR of the Radboudumc of the surgery assistant ordering extra instruments for the surgeon during surgery. First of all, due to the separation between the logistics department that collects the extra instruments and the surgery assistant and surgeon that only pass on information, this information can already be outdated when passed on to the logistics department. At the moment of calling the logistics department, the surgeon could have found another solution to continue the surgery without the extra instruments. The extra instruments are then delivered to the operating room and are immediately returned because the surgeon has found another way to continue.
Furthermore, the surgeon has to pass on to the surgery assistant which instrument he needs which requires encoding and decoding, and as there are a lot of instruments that more or less have the same name, this can cause mistakes, which may make the information less reliable. Third, there is a gap between the surgery assistant making the call for extra instruments and the logistics department delivering the extra instruments. Within this time window, or this dead time as De Sitter describes it, the situation of the surgery may change, and information that could be crucial for the logistics department may not be passed on the logistics department. Therefore, it can also affect the completeness of the information. And lastly, when the information that is provided to the logistics department is having quality problems in terms of actuality, reliability and completeness, how big is the chance that the information that is delivered to the logistics department is the right information? Therefore, it will make the information less relevant: the logistics department will never be 100% sure that the instruments they deliver, are at that point in time still the right instruments and at that moment needed for that surgery. Therefore, it might be expected that a high degree of separation of operational and regulatory activities affects all the quality aspects of information as stated by De Sitter (1994), and therefore, will negatively affect the quality of the shared information in HIT systems, resulting in poor HIT systems.

This works the other way around as well. If there is a low degree of separation, there will be less tasks in between information needs to be transferred and therefore, there will be less information transferred making the information that is transferred more actual. Furthermore, less information transferred means less encoding and decoding, which implies less deformation, which makes the information more reliable. Third, less separation means no time between observation and execution, because they are done by the same person. This means less dead time, improving the completeness of the information. And lastly, because information is more actual, reliable and complete, a better decision can be made, making the information more relevant to act on (De Sitter et al., 1994; De Sitter et al., 1997). For example, the employee of the logistics department that does both ordering and refilling, it is known that when this person does order something, it is based on his own observation that the wrong product is delivered. There is no transfer of information, just his own observation and therefore, his decision is based on actual information. Furthermore, due to the fact that there is no transfer of information, there can be no misunderstanding in the article that has to be ordered, which makes the information more reliable. Third, due to the fact that it is his own observation, there is not a lot of time between the observation and the ordering of the product,
which improves the completeness of the information. And lastly, due to the fact that the information is actual, reliable and complete, the right product can be ordered, which makes the information that this person has gathered more relevant. Therefore, it might be expected that a low degree of separation of operational and regulatory activities will improve the quality of information and therefore, will positively affect the quality of the shared information in HIT systems (De Sitter et al., 1994; De Sitter et al., 1997).

2.3.7.1 Norm value of separation of operational and regulatory activities
Based on the above and the desired relation between the separation of operational and regulatory activities and the quality of information shared in HIT systems, that is for the separation of operational and regulatory activities to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value can be established: *The level of separation of operational and regulatory activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems.*

2.3.8 Specialization of regulatory activities
According to De Sitter (1994), a high degree of specialization of regulatory activities will affect the quality of the information in three ways. First, if there is a high degree of specialization, tasks will be divided in many sub-tasks, which makes the scopes of these tasks smaller. It becomes harder to oversee the whole process, and therefore, one may assume that within this small task, it will be very hard to have all the information of the whole process. Therefore, a high degree of specialization of regulatory activities will affect the completeness of the information. Second, if there is a high degree of specialization, information has to pass a lot of persons, which will affect the actuality of the information. And lastly, because persons often have to make decisions for a process in which they are not involved and that they have to do this based on information that is not complete and not actual anymore, this will affect the reliability of the information too (De Sitter et al., 1994; De Sitter et al., 1997).
Referring back to the example of the multiple departments that are involved in the processes that play at the operating rooms, it is for instance very hard to see for the department that cleans instruments which instruments are needed the next day during surgery. It will be very hard for this department to have all the information of the total surgery process, while they only perform the part in where they clean the instruments for surgery. Furthermore, the information that this department receives, is passed on from surgery assistants, which takes time. During this time, information can change. For instance, instruments need to be cleaned with high urgency due to an emergency patient. The time that it takes to transfer this information, will affect the actuality of the information. And lastly, how can someone at the instrument cleaning department decide which instruments should be cleaned first, when they are not involved in the surgery process itself and lack the information that is needed to decide which instruments should go first? In this way, it does affect the reliability of the information too. Therefore, it might be expected that a high degree of specialization of regulatory activities will negatively affect the quality of information in terms of actuality, completeness and reliability, and therefore, will negatively affect the quality of the shared information in HIT systems, resulting in poor HIT systems (1994).

On the other hand, it may be expected that a low degree of specialization of regulatory activities will positively affect the quality of information in terms of actuality, completeness and reliability. First of all, with a low degree of specialization, regulatory tasks have a big scope and therefore, it will be easier to oversee the whole process. Therefore, it will be easier to have all the information of that process, which makes the information more complete. Second, due to that tasks have a bigger scope, there are less people responsible for the same tasks, which implies that there has to be less information shared between these people. This will make the information that is shared more actual. And lastly, because people do make decisions for the processes they are involved in, and they have complete and actual information, it makes the information where this decisions are based on more reliable (De Sitter et al., 1994; De Sitter et al., 1997). Referring back to the example of the surgery where only 1 person is responsible in the operating room, it can be seen that this person has a big scope, namely the surgery itself, and therefore, oversees the whole process. It will be easier for this person to have all the information needed to make a decision during surgery, which implies that he has complete information. Furthermore, he is the only one responsible, so for taking decisions during surgery, there is no transfer of information needed, and therefore the information is always actual.
And lastly, because this person is involved in the surgery and has complete and actual information, the decisions that this person makes are based on reliable information. Therefore, it might be expected that a low degree of specialization of regulatory activities will positively affect the quality of information in terms of actuality, completeness and reliability, and therefore, will positively affect the quality of the shared information in HIT systems (De Sitter et al., 1994; De Sitter et al., 1997).

**2.3.8.1 Norm value of specialization of regulatory activities**

Based on the above and the desired relation between the specialization of regulatory activities and the quality of information shared in HIT systems, that is for the specialization of regulatory activities to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value can be established: *The level of specialization of regulatory activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality and completeness of the information that is stored, shared and retrieved in HIT systems.*

**2.3.9 Formalization on HIT problems**

As mentioned earlier, the degree of formalization must be somewhere in the middle, in order to exploit existing knowledge and to explore and create new knowledge (Raisch et al., 2009). When it comes down to the relation between formalization and information quality, this seems also to be the case. As formalization reduces variety and creates order, one may expect that a reduction in the variety of the relations in a network will also reduce the information need and decreases the chance of errors in information shared. This will result in a less complex information provision, with a higher quality of information shared in those systems. Furthermore, formalization forces employees to share information in a particular way and in a certain format, which makes the information reliable and complete (Teller, Unger, Kock, & Gemünden, 2012). However, it may also be expected that as formalization forces employees to share information in a particular way and in a certain format, the conversion of information to this certain format and the sharing of information in that particular way costs time, which makes the information less actual and therefore, less relevant (Galbraith, 1973). Furthermore, procedures can for instance be outdated, and even when a faster way of information sharing with less people is possible, people still have to hold on to the procedures (Wright et al., 2012).
This increases the number of relations in a network, and thus the amount of information transferred. This will result in an increase in required information needed, resulting in more complex information provision and thus HIT systems, which are more likely to give problems regarding the quality aspects of information (De Sitter et al., 1994).

Referring back to the pre-incision time out checklist example, this formalized protocol forces employees to share the information needed for surgery in a particular format. This results in the whole checklist being checked and that no important points can be missed, and therefore all the information needed for that surgery is shared. Therefore, the information is complete. Furthermore, as all the information is shared in the same format, everyone in the room is talking about the same information, which makes the information more reliable. However, working through the checklist before every surgery takes time, which can make the information that is shared less actual, especially when there is a lot of information that needs to be gathered for that type of surgery. Furthermore, a highly formalized protocol can result in an increase of the number of relations in a network in which this protocol has to be shared, resulting in an increase of information transferred in such a network. This will result in an increase in required information needed, resulting in more complex information provision and thus HIT systems, which are more likely to give problems regarding the quality aspects of information.

This works the other way around too. If there is a very low degree of formalization, this will reduce the number of relations in a network and thus lowers the information need inside that network, resulting in a less complex information provision and thus HIT systems, with a higher quality of information shared in those systems. Furthermore, information can easily be shared, which makes the information more actual. On the same hand, a low degree of formalization will increase the variability of the relations in that network. This will result in an increase in volume of information shared, resulting in a higher probability of errors in the information shared and a higher information need. This will result in a more complex information provision with a lower quality of information shared within these systems, resulting in more complex HIT systems, which are more likely to give problems with one or more of the quality aspects of information (De Sitter et al., 1994). Furthermore, employees are not forced to share information in a particular way and in a certain format, which will make the information less reliable and complete, and therefore, will also affect the relevance of the information (De Sitter et al., 1994).
Referring back to the example of the planning of surgeries, information is only shared inside their own specialism, and not across multiple specialism. This results in shorter lines between less people, which makes the information that they share more actual. On the same hand, the information that is shared from one specialism can be interpreted differently than the information from another specialism. Information that can be interpreted in multiple ways makes it less reliable and complete, and therefore also less relevant. Therefore, it might be expected that either a very high or a very low degree of formalization will result in both an increase in either the amount of information shared or the variability (and thus volume) of information shared, both resulting in a higher information need. This will result in more complex information provision with a lower quality of information shared within these systems, resulting in more complex HIT systems, which are more likely to give problems with one or more of the following quality aspects in terms of the actuality, completeness, reliability and relevance of information shared in those systems (De Sitter et al., 1994; Teller et al., 2012; Wright et al., 2012).

2.3.9.1 Norm value of formalization

Based on the above and the desired relation between formalization and the quality of information shared in HIT systems, that is for formalization to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value can be established: The level of formalization must neither be very low nor very high (so average) so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems.

2.3.10 Summary of HPV on HIT problems

It may be concluded that when it comes down to information quality, the effectiveness of an organisational structure has an important function. To create this effectivity, first the production structure must be adjusted in such a way, that there is both a low need of information and a low probability of errors in the information shared. The control structure must then be designed based on the production structure (or if not, must also be designed in such a way that there is a low information need and a low probability of errors in the information shared), taking in mind the quality aspects of information. The design and working of a structure can be predicted with use of different design parameters.
If there is a HPV structure, this will affect the information provision in two ways. First, due to high functional concentration and a high degree of differentiation and specialization of operation activities, the amount of transferred information and the volume of this transferred information will increase, which increases the information need. Besides that, the probability of errors in the information that is shared in such a structure will increase as well. This will make the information provision more complex, resulting in more complex HIT systems that have a higher probability of problems with one or more of the quality aspects of information as mentioned by De Sitter (1994).

Second, as the control structure is a derivative of the production structure, and as the production structure is designed as mentioned above, the need for extra regulatory capacity like more planning and coordination to deal with these disturbances also increases. To deal with these disturbances, extra information on top of the already needed information on that process is needed. This will make the information need, and therefore the information provision even more complex.

Furthermore, the focus shifts from improving the quality of information that is inside HIT systems to making the HIT systems more complex as there is more need for coordination and planning. These two problems will eventually lead to problems with the HIT systems, which are reflected by the quality aspects of information as stated by De Sitter (1994). It may be expected that if there is a HPV structure, the above two problems will occur which will result in complex HIT systems, where problems with one or more of the following quality aspects are likely to occur: the reliability, actuality, completeness and relevance of information. This can be summarized with use of the following schematic in table 2.2 below.
Now, one may think that instead of changing an organisational structure, it would be easier to just add more HIT systems to cover for a not properly functioning organisational structure. However, HIT systems cannot be seen as a quick fix for a not properly functioning organisational structure. This is because a HIT system can never change information that does not meet the information quality criteria into information that does. This is due to the fact that an HIT system is always an outcome of the production and control structure (De Sitter et al., 1994).

<table>
<thead>
<tr>
<th>Functional concentration</th>
<th>A high value leads to the following problems which affect the quality aspects on the right as follows</th>
<th>Relevance</th>
<th>Reliability</th>
<th>Completeness</th>
<th>Actuality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes variability that increases the volume of transferred information, which causes more errors in the shared information and a higher need of information, which results in a more complex information provision</td>
<td>Indirect Becomes more important as volume of information increases</td>
<td>Indirect Becomes more important as volume of information increases</td>
<td>Indirect Becomes more important as volume of information increases</td>
<td>Direct As volume of information increases, lead time also increases</td>
<td></td>
</tr>
<tr>
<td>A high value leads to the following problems which affect the quality aspects on the right as follows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Table 2.2 - High Parameter Values on quality aspects of HIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A high value leads to the following problems which affect the quality aspects on the right as follows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional concentration</td>
<td>Causes variability that increases the volume of transferred information, which causes more errors in the shared information and a higher need of information, which results in a more complex information provision</td>
<td>Indirect Becomes more important as volume of information increases</td>
<td>Indirect Becomes more important as volume of information increases</td>
<td>Indirect Becomes more important as volume of information increases</td>
<td>Direct As volume of information increases, lead time also increases</td>
</tr>
<tr>
<td>Specialization and differentiation of operational activities</td>
<td>Causes more relations which increases the amount of transferred information, which results in a higher information need, which will result in a more complex information provision</td>
<td>Indirect Becomes more important as amount of information increases</td>
<td>Indirect Becomes more important as amount of information increases</td>
<td>Direct As tasks are more specialized, the distance between tasks get larger</td>
<td></td>
</tr>
<tr>
<td>Separation of operational and regulatory activities</td>
<td>Causes more relations which increases the amount of transferred information, which results in a higher information need, which will result in a more complex information provision</td>
<td>Indirect Due to problems with reliability, completeness and actuality</td>
<td>Direct Due to encoding and decoding, more errors occur</td>
<td>Direct Due to transferring information, causes dead time</td>
<td></td>
</tr>
<tr>
<td>Specialization of regulatory activities</td>
<td>Causes more relations which increases the amount of transferred information, which results in a higher information need, which will result in a more complex information provision</td>
<td>Direct People who make decisions for processes in which they are not involved affects reliability of information</td>
<td>Direct Due to small tasks harder to oversee the whole process and thus information of the whole process, affects completeness of information</td>
<td>Direct Due to small tasks information has to pass a lot of persons, which affects actuality of information</td>
<td></td>
</tr>
<tr>
<td>Formalization</td>
<td>If low variability and thus volume of transferred information increases. If high number of relations and therefore amount of information transferred increases. Either a very low of high value will result in a higher information need, which will result in a more complex information provision</td>
<td>Direct Sharing information through formalized ways costs time and makes information less relevant</td>
<td>Direct Sharing information in a certain format makes information more reliable</td>
<td>Direct Sharing information in a certain format makes information more complete</td>
<td>Direct Sharing information in a certain format costs time</td>
</tr>
</tbody>
</table>
Therefore, when looking at not properly functioning HIT, one should always investigate the underlying organisational structure first to find out if there are information quality problems that come forward of a not properly functioning organisational structure, as the quality of information is not something that can be changed afterwards with changing or adding more HIT systems. Therefore, when looking at not properly functioning HIT, the organisational structure in relation to the not properly functioning HIT must be investigated first.

The objective of this research is to provide insight in (1) which HIT related problems occur at the operating rooms in the Radboudumc (2) and if and how the structure of the operating rooms of the Radboudumc is a cause for the HIT problems that the operating rooms is experiencing. Therefore, this research aims at identifying the desired and actual situation at the Radboudumc, in order to identify the possible gap between these two. The desired situation was described in this chapter. First, the criteria chosen to describe properly working HIT were outlined, and the norm values were identified. After that, the parameters and norm values for defining a proper organisation structure were identified, and the link between how an organisational structure can cause HIT problems was made. Now that is known what the desired situation in the Radboudumc must be and that the theoretical framework is created to analyse the actual situation in the Radboudumc, the actual situation must be investigated by conducting qualitative research. How this research is conducted precisely will be discussed in the next chapter.
Chapter 3 - Methodology

In this thesis, the relation between HIT problems at the operating rooms in the Radboudumc and the organisational structure of this operating rooms at the Radboudumc will be investigated. In the previous chapter, the theoretical framework and the desired situation at the Radboudumc were defined. This chapter deals with the actual situation in the Radboudumc, in order to give answer to both the first and the last sub questions: “Which HIT related problems do occur at the operating rooms of the Radboudumc” and “How is the structure a cause for the HIT problems that occur at the operating rooms of the Radboudumc?”. To do so, at first the choice for a practice-oriented qualitative research is outlined. This is done in section 3.1. In section 3.2, the research design is described. This includes information on the research object, and the set-up of the qualitative part of this research. Section 3.3 will be devoted to the research process. The operationalization will involve section 3.3.1 to 3.3.7. The data analysis will follow in section 3.3.8. At last, in sections 3.3.9 and 3.3.10, the research quality and research ethics of this research design will be outlined.

3.1 Research strategy

3.1.1 Practice-oriented

The aim of this research is to provide knowledge and information on which HIT problems occur at the operating rooms at the Radboudumc, what the organisational structure of the operating rooms at the Radboudumc looks like and how the organisational structure of the operating rooms at the Radboudumc can be a cause for the HIT problems that are in play. According to Verschuren & Doorewaard (2010) this can be identified as a practical problem and to solve this problem, an intervention is needed. In this case, a practice-oriented research suits this research objective best as this type of research is meant to provide knowledge and information that can contribute to a successful intervention in order to change an existing situation (Verschuren & Doorewaard, 2010).

According to Verschuren & Doorewaard (2010), an intervention cycle consists out of five stages: problem analysis, diagnosis, design, intervention and evaluation. As the aim of this research is to provide insight on which HIT problems there are in play at the operating rooms at the Radboudumc and how the organisational structure of the operating rooms at the Radboudumc can be a cause for this, the focus on this research is at the problem analysis and diagnosis of the intervention.
First of all, it must be made clear that there is a problem, why it is a problem and for who this is a problem, to convince all the stakeholders that there is something going wrong. This will happen in the first stage of this intervention during the problem analysis. To do so, the existing situation will be investigated and compared with the desired situation, to point out that there is a gap: the main problem, or in this case the HIT problems (Verschuren & Doorewaard, 2010). After the problem has been identified, the causes for these problems have to be identified. This is the diagnosis stage, which will be used in this research to investigate how the structure can play a role in the HIT problems at the operating rooms at the Radboudumc. Through the use of background analysis, opinion research and a gap analysis, a clear picture can be established on how the structure of the operating rooms at the Radboudumc can be a cause for the HIT problems that are in play (Verschuren & Doorewaard, 2010).

### 3.1.2 Qualitative research

To give answer to the research question, qualitative research was performed. The choice for qualitative research was made based on the explorative character of this research, and to gain more insights in which HIT problems play at the operating rooms in the Radboudumc and how they are connected with the organisational structure of the operating rooms in the Radboudumc. Qualitative research focusses on studying phenomena in their natural habitat to explain how people give purpose to this phenomena within their social environment (Lucassen & Olde Hartman, 2007; Vennix, 2011). Different qualitative research methods like interviews and observations are used to gain different insights of the people involved, enabling the researcher to view the phenomena from different perspectives and to suggest explanations of the phenomena that has been studied (Boeije, 2005). In complex situations like the operating rooms at the Radboudumc, in-depth interviews are preferred because in-depth interviews tend to give purpose to why and how complex relations exist. With use of surveys with a quantitative character, relations can be proven, but the understanding of this relations will not be researched. And as this research will be in the problem analysis and diagnosis phase, the why and how in complex relations are important subjects to give a proper answer to the research question. Therefore, there has been chosen for qualitative research.

With use of in-depth interviews and documents, the complex relation between the organisational structure and the HIT problems can be discussed in-depth to be able to give a rich description of how and why these relations exist, to be able to give a full diagnosis of the problem.
Hence, different qualitative research methods will be central in this research to present a full image about what are exactly the HIT problems that play at the operating rooms of the Radboudumc and how and why they are caused by the organisational structure of the operating rooms of the Radboudumc.

3.2 Research design

3.2.1 Interviews

The most important data source during this research were the semi-structured in-depth interviews. With the use of interviews, the researcher can ask personal questions about someone’s experiences, behaviour and attitudes; items that a researcher won’t be able to ask in surveys (Bleijenbergh, 2013). These interviews were semi-structured: the interview questions were lined up before the interviews to structure the interviews and to get comparable data out of the interviews, but with enough room to diverge from the protocol and get more in-depth with the interviewee (Vennix, 2011; Yin, 2009). For this research, the semi-structured in-depth interviews were needed to explain the connection between the HIT problems and the underlying organisational structure. The semi-structured interviews provided the in-depth information from multiple perspectives, so that a clear picture of the problem could be outlined. Therefore, it was needed that from every department that was involved in one of the processes as identified during the prior focus group session, one or more people were interviewed.

During the interviews, the aim was on identifying two things: identifying the HIT problems that play at the operating rooms of the Radboudumc and identifying the organisational structure of the operating rooms at the Radboudumc. Topics used to identify these two things were the experienced problems regarding the quality of the information stored in HIT systems, functional concentration, specialization and differentiation of operational activities, separation of operational and regulatory activities, specialization of regulatory activities and formalization. Every interview started with a short introduction about the aim of the research and the setting of expectations on time and confidentiality. Furthermore, it was asked to the respondents if they had problems with the interview being recorded, on which all respondents replied that they had no problems with their interview being recorded.
Every interview ended with the open ended question if the respondents would like to add something to the interview that had not been discussed yet. All attendees received appreciation for participating in this research. The complete interview protocol can be found in Appendix A.

As it is hard to make notes during the interviews, every interview has been recorded and transcribed afterwards. One of the advantages of recording and transcribing interviews afterwards is that the focus from the interviewer during the interviews can be on the non-verbal communication, something that would be missed if the interviewer had to focus on taking notes (Boeije, 2005; Vennix, 2011). Furthermore, a recording can be listened multiple times, so that it is sure that nothing is missed (Bleijenbergh, 2013). It was asked to the respondents if they wanted to read back the transcripts for approval and if the respondents wanted to read back the final version of this thesis. If so, respondents received their transcript and/or the final (anonymized) version of this thesis.

As mentioned before, the selection of respondents was based on building a group of respondents that is representative for the processes of the OR of the Radboudumc. From every department that is involved in the processes at the OR of the Radboudumc, one or more respondents were interviewed. This includes the transportation (1 management), CSA (1 operational and 1 management), OR Logistics (1 operational and 1 management) and OR (1 operational, 1 floor manager, 3 management). Dependent on size and involvement of the department more persons were interviewed, to get a full picture of the HIT problems that are in play and what the organisational structure looks like. In this research it was specifically chosen to select candidates on their knowledge and involvement in the processes of the OR of the Radboudumc to make sure that the appropriate insights were gained and that a full picture of the situation of the OR of the Radboudumc could be obtained (Bleijenbergh, 2013). A summary of the respondents, departments and their functions can be found in table 3.1 below.
3.2.2 Documents

The second data source were the use of documents. For qualitative research, documents are mostly used to collaborate and augment evidence from other sources (Yin, 2009, p. 107). The researcher can use documentary evidence to check information from other sources. When the researcher finds contradictory evidence, this information can be used in the interviews to find out why the information gathered out of interviews is contradictory with the information gathered out of documents (Bleijenbergh, 2013; Yin, 2009). The documents used in this research were collected from the Q-Portaal, a system from the Radboudumc in where all the protocols and organisational documents are stored. Furthermore, data was gathered from a focus group that has been conducted prior to this research between the different stakeholders of the OR of the Radboudumc.

The first document provided insight on the organisational structure from the OR (Appendix B). However, this involved only the processes at the OR, and not which processes are connected to the OR. The second document provides a better insight on the overall structure of the Radboudumc, with a description of how the 52 departments operate and are being controlled (Appendix C). These two documents were used to derive a better understanding of the processes at the OR and were used in the interviews to investigate different parts of the process. The last document contains pictures of the outcome of a focus group session held prior to this research (Appendix D).

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Department</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent 1</td>
<td>OR</td>
<td>Floor manager</td>
</tr>
<tr>
<td>Respondent 2</td>
<td>OR</td>
<td>Management</td>
</tr>
<tr>
<td>Respondent 3</td>
<td>OR Logistics</td>
<td>Management</td>
</tr>
<tr>
<td>Respondent 4</td>
<td>CSA</td>
<td>Operational</td>
</tr>
<tr>
<td>Respondent 5</td>
<td>OR Logistics</td>
<td>Operational</td>
</tr>
<tr>
<td>Respondent 6</td>
<td>OR</td>
<td>Management</td>
</tr>
<tr>
<td>Respondent 7</td>
<td>CSA</td>
<td>Management</td>
</tr>
<tr>
<td>Respondent 8</td>
<td>OR</td>
<td>Management</td>
</tr>
<tr>
<td>Respondent 9</td>
<td>OR</td>
<td>Operational</td>
</tr>
<tr>
<td>Respondent 10</td>
<td>Transportation</td>
<td>Management</td>
</tr>
</tbody>
</table>
It was used to identify the different stakeholders involved in processes of the OR and to better understand these processes. An overview of the used documents can be found in table 3.2 below.

### Table 3.2 - Overview of the used documents

<table>
<thead>
<tr>
<th>Type of document</th>
<th>Content of document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisational chart OR</td>
<td>Representation of the organisational structure of the OR</td>
</tr>
<tr>
<td>Description of the organisational chart of the Radboudumc</td>
<td>Description of the representation of the organisational structure of the Radboudumc</td>
</tr>
<tr>
<td>Outcome of focus group</td>
<td>Pictures of the outcome of the focus group held prior to this research</td>
</tr>
</tbody>
</table>

## 3.3 Research process

### 3.3.1 Operationalization

A theoretical framework alone is not enough to measure the concepts of a research (Vennix, 2011). To measure these abstract concepts, an operationalization is needed in which the concepts are linked to non-abstract dimension and indicators. With use of these dimensions and indicators, the concepts can be measured (Bleijenbergh, 2013). The theory as provided in chapter 2 will be operationalized in this section. Furthermore, for each theoretical concept several examples of questions asked during the semi-structured interviews to identify those concepts are given. The full interview protocol is outlined in Appendix A. First, the HIT criteria are further defined into dimensions and indicators, which will only measure if and how problems occur in HIT systems. Second, in contrast to the quality of information, the design parameters used in this research to describe the functioning of a structure will be operationalized for both high and low values with use of the theory as stated by De Sitter and Achterbergh & Vriens (Achterbergh & Vriens, 2019; De Sitter et al., 1994; De Sitter et al., 1997).

### 3.3.2 HIT criteria

As described in section 2.1, there are four criteria used in this research to identify a problematic quality of information, which will lead to not properly working HIT systems and of which the cause may lay in the organisational structure. First of all, information must be relevant, in this research defined as “the extent to which the shown information is also the information that one wants to know”.

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Second, information must be reliable, in this research defined as “the extent to when showing information, it is also for sure that the information that is shown is correct and free of errors”.

Third, information must be actual, in this research defined as “the extent to which the age of the data is appropriate for the task at hand”. At last, information must be complete, in this research defined as “the extent to which data are of sufficient breadth, depth, and scope for the task at hand”.

Indicators that point towards information that is not relevant are ‘not all the data shown in HIT systems is relevant for the person that sees this data’ and ‘not all the shown data in HIT systems is also used during operations’. Indicators that point towards information that is not reliable are ‘based on the shown information in HIT systems, a proper decision or action cannot be made’ and ‘the shown information in HIT systems is not free of errors’ and ‘information in HIT systems can be interpret in multiple ways’. Indicators that point towards information that is not actual are ‘information in HIT systems is outdated’ and ‘information that is shared in HIT systems reaches other persons is often too late’ and ‘information in HIT systems is not actual’. At last, indicators that point towards information that is not complete are ‘in HIT systems information that is needed for a decision or action is missing’ and ‘information in HIT systems is incomplete’ and ‘information in HIT systems is stored at the wrong places’. A schematic overview of this operationalization can be found below in table 3.3.
Questions asked during the semi-structured interviews to identify problems regarding the quality the information stored in HIT systems were “Do you experience problems with IT applications?” and “Do you experience missing information during your activities?” and “Do you experience information that reaches you too late during your activities?” and “Do you have the feeling that in systems you see too much information during your activities?” and “Do you experience that in the IT applications too much incorrect information is shown?”

The section above was about the operationalization of HIT problems that may be caused by the organisational structure. However, as mentioned in chapter 2, there are also causes of HIT problems that are not connected to the organisational structure.

Table 3.3 - Operationalization of Information Quality

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Quality</td>
<td>Information that is not relevant</td>
<td>Not all the data shown in HIT systems is relevant</td>
</tr>
<tr>
<td></td>
<td>Information that is not reliable</td>
<td>Not all the shown data in HIT systems is also used during operations</td>
</tr>
<tr>
<td></td>
<td>Information that is not actual</td>
<td>Based on the shown information in HIT systems, a proper decision or action cannot be made</td>
</tr>
<tr>
<td></td>
<td>Information that is not complete</td>
<td>The shown information in HIT systems is not free of errors</td>
</tr>
<tr>
<td></td>
<td>Information that is not complete</td>
<td>Information in HIT systems can be interpreted in multiple ways</td>
</tr>
<tr>
<td></td>
<td>Information that is not actual</td>
<td>Information in HIT systems is outdated</td>
</tr>
<tr>
<td></td>
<td>Information that is not actual</td>
<td>Information that is shared in HIT systems reaches other persons is often too late</td>
</tr>
<tr>
<td></td>
<td>Information that is not actual</td>
<td>Information in HIT systems is not actual</td>
</tr>
<tr>
<td></td>
<td>Information that is not complete</td>
<td>In HIT systems information that is needed for a decision or action is missing</td>
</tr>
<tr>
<td></td>
<td>Information that is not complete</td>
<td>Information in HIT systems is incomplete</td>
</tr>
<tr>
<td></td>
<td>Information that is not complete</td>
<td>Information in HIT systems is stored at the wrong places</td>
</tr>
</tbody>
</table>
To identify also those problems, several questions were asked during the semi-structured interviews. “Do you experience problems regarding the lay-out or user-friendliness of IT systems?” and “Do you experience other problems regarding the IT systems?” are examples of questions to identify problems with HIT systems that are not connected to the organisational structure.

3.3.3 Functional concentration

Functional concentration has been defined as the degree to which operational activities are related to all order types. It can have either a high or low degree, resulting in two dimensions. With a low degree of functional concentration, operational activities are only related to a select amount of order types, better known as the grouping of operational activities based on specific order types. With a high degree of functional concentration, operational activities are related to all order types, better known as the grouping of operational activities based on all order types (Achterbergh & Vriens, 2019; De Sitter et al., 1994).

Both dimensions can be indicated with use of three variables. A ‘low number of order types per operational activity’, a ‘low percentage of order types one comes across in performing operational activities’ and ‘operational activities of a different type being grouped into production flows’ point toward the grouping of operational activities based on specific order types, which implies a low degree of functional concentration. A ‘high number of order types per operational activity’, a ‘high percentage of order types one comes across in performing operational activities’ and ‘operational activities of a similar type being grouped into functional departments’ point towards the grouping of operational activities based on all order types, which implies a high degree of functional concentration (Achterbergh & Vriens, 2019; De Sitter et al., 1994; De Sitter et al., 1997). A schematic overview of this operationalization can be found below in table 3.4.
Questions asked during the semi-structured interviews to identify the degree of functional concentration were “On a weekly basis, with how many different types of surgery (specialisms) do you get in touch during your daily operations?” and with use of two schematics representing the grouping of operational activities based on all order types (left picture) and the grouping of operational activities in production flows (right picture): “Do you classify your operational activities as left or right?” and “Do you feel that the way your operational activities are currently classified lead to problems regarding the exercising of your activities and the sharing of information?”. 

Based on the norm value as stated in section 2.3.4.1, that is that the level of functional concentration must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems, it can now with use of provided operationalization be defined when the level of functional concentration is low. The level of functional concentration is low when operational activities are grouped based on specific order types, which entails that there must be a low number of order types per operational activity, a low percentage of order types one comes across in performing operational activities and that operational activities of a different type are being grouped into production flows.

Table 3.4 - Operationalization of Functional Concentration

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Concentration</td>
<td>Grouping of operational activities based on specific order types</td>
<td>Low number of order types per operational activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low percentage of order types one comes across in performing operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operational activities of a different type being grouped into production flows</td>
</tr>
<tr>
<td></td>
<td>Grouping of operational activities based on all order types</td>
<td>High number of order types per activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High percentage of order types one comes across in performing operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operational activities of a similar type being grouped into functional departments</td>
</tr>
</tbody>
</table>

Table 3.4 - Operationalization of Functional Concentration

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Concentration</td>
<td>Grouping of operational activities based on specific order types</td>
<td>Low number of order types per operational activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low percentage of order types one comes across in performing operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operational activities of a different type being grouped into production flows</td>
</tr>
<tr>
<td></td>
<td>Grouping of operational activities based on all order types</td>
<td>High number of order types per activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High percentage of order types one comes across in performing operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operational activities of a similar type being grouped into functional departments</td>
</tr>
</tbody>
</table>
### 3.3.4 Specialization and differentiation of operational activities

The specialization of operational activities has been defined as the degree to which operational tasks are divided into smaller sub-tasks. One particular way of doing this is the dividing of a task in preparation, production and support, in this research also defined as the differentiation of operational activities. It can either have a high or low degree, resulting in two dimensions. With a low degree of specialization and differentiation of operational activities, operational activities are grouped into larger tasks. If there is a high degree of specialization and differentiation of operational activities, operational activities are split up into short sub-tasks.

Both dimensions can be indicated with use of four variables. A ‘high number of performed operational activities’, a ‘high average cycle time per operational activity’, ‘combining preparation, support and production into a single task’ and a ‘broad scope of performed operational activities’ point towards the grouping of operational activities into larger tasks. A ‘low number of performed operational activities’, a ‘low average cycle time per operational activity’, ‘preparation, support and production are all separated tasks’ and a ‘narrow scope of performed operational activities’ point toward the splitting of operational activities into short sub-tasks (Achterbergh & Vriens, 2019; De Sitter et al., 1994; De Sitter et al., 1997). A schematic overview of this operationalization can be found below in table 3.5.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialization and differentiation of operational activities</td>
<td>Operational activities are grouped into larger tasks</td>
<td>High number of performed operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High average cycle time per operational activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Combining preparation, support and production into a single task</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broad scope of performed operational activities</td>
</tr>
<tr>
<td></td>
<td>Operational activities are split up into short sub-tasks</td>
<td>Low number of performed operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low average cycle time per operational activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preparation, support and production are all separated tasks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Narrow scope of performed operational activities</td>
</tr>
</tbody>
</table>
Questions asked during the semi-structured interview to identify the degree of specialization and differentiation of operational activities were “can you tell how the total process for the OR looks like?”, “in which part of the process are you involved?” and “do you have the feeling that certain tasks are split up into preparation, production and support tasks?”.

Based on the norm value as stated in section 2.3.5.1, that is that the level of specialization and differentiation of operational activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems, it can now with use of the provided operationalization be defined when the level of specialization and differentiation of operational activities is low. The level of specialization and differentiation of operational activities is low when operational activities are grouped into larger tasks, which entails that there must be a high number of performed operational activities, a high average cycle time per operational activity and a broad scope of performed operational activities.

3.3.5 Separation between operational and regulatory activities

The degree of separation between operational and regulatory activities has been defined as the degree to which these two activities are separated from each other and are being assigned to different tasks. It can, again, have a high and a low degree, resulting in two dimensions. With a low degree of separation between operational and regulatory activities, operational and regulatory activities are integrated into tasks. With a high degree of separation between operational and regulatory activities, operational and regulatory activities are separated into different tasks.

Both dimensions can be indicated with use of four variables. ‘Performing both operational and regulatory activities’, the ‘ability to solve problems that occur when performing operational activities’, the ‘ability to change operational activities’ and the ‘ability to make decisions about operational activities’ all point toward operational and regulatory activities that are integrated into the same tasks. ‘Performing only either operational or regulatory activities’, ‘no ability to solve problems that occur when performing operational activities’, ‘no ability to change operational activities’ and ‘no ability to make decisions about operational activities’ all point toward the
separation of operational and regulatory activities into different tasks (Achterbergh & Vriens, 2019; De Sitter et al., 1994; De Sitter et al., 1997).

A schematic overview of this operationalization can be found below in table 3.6.

Table 3.6 - Operationalization of Separation between Operational and Regulatory activities

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation between operational</td>
<td>Operational and regulatory activities are</td>
<td>Performing both operational and regulatory activities</td>
</tr>
<tr>
<td>and regulatory activities</td>
<td>integrated into tasks</td>
<td>Ability to solve problems that occur when performing operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to change operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to make decisions about operational activities</td>
</tr>
<tr>
<td>Operational and regulatory</td>
<td>Operational and regulatory activities are</td>
<td>Performing only either operational or regulatory activities</td>
</tr>
<tr>
<td>activities are separated into</td>
<td>separated into different tasks</td>
<td>No ability to solve problems that occur when performing operational activities</td>
</tr>
<tr>
<td>different tasks</td>
<td></td>
<td>No ability to make decisions about operational activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No ability to make decisions about operational activities</td>
</tr>
</tbody>
</table>

Questions asked during the semi-structured interviews to identify the degree of separation between operational and regulatory activities were “do you notice a distinction between both tasks?”, “can you solve problems that occur when performing operational activities?” and “to what extent can you organize your operational tasks to own view without intervention of a manager?”.

Based on the norm value as stated in section 2.3.7.1, that is that the level of separation of operational and regulatory activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems, it can now with use of the provided operationalization be defined when the level of separation of operational and regulatory activities is low. The level of separation of operational and regulatory activities is low when operational and regulatory activities are integrated into tasks, which entails that one should perform both operational and regulatory activities, one has the ability to solve problems that occur when performing operational activities, one has the ability to change operational activities and one has the ability to make decisions about operational activities.
3.3.6 Specialization of regulatory activities

The degree of specialization of regulatory activities has been defined as the degree to which regulatory tasks are divided into smaller sub-tasks. Again, a high and low value result in two dimensions of this parameter. With a low degree of specialization of regulatory activities, regulatory activities are grouped into larger tasks. If there is a high degree of specialization of regulatory activities, regulatory activities are split up into short sub-tasks.

Both dimensions can be indicated with use of three variables. A ‘high number of performed regulatory activities’, a ‘high average cycle time per regulatory activity’ and a ‘broad scope of performed regulatory activities’ point towards the grouping of regulatory activities into larger tasks. A ‘low number of performed regulatory activities’, a ‘low average cycle time per regulatory activity’ and a ‘narrow scope of performed regulatory activities’ point toward the splitting of regulatory activities into short sub-tasks (Achterbergh & Vriens, 2019; De Sitter et al., 1994; De Sitter et al., 1997). A schematic overview of this operationalization can be found below in table 3.7.

Table 3.7 - Operationalization of Specialization of regulatory activities

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialization of regulatory activities</td>
<td>Regulatory activities are grouped into larger tasks</td>
<td>High number of performed regulatory activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High average cycle time per regulatory activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Broad scope of performed regulatory activities</td>
</tr>
<tr>
<td></td>
<td>Regulatory activities are split up into short sub-tasks</td>
<td>Low number of performed regulatory activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low average cycle time per regulatory activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Narrow scope of performed regulatory activities</td>
</tr>
</tbody>
</table>

Questions asked during the semi-structured interviews to identify the degree of specialization of regulatory activities were “how many different regulatory activities do you perform?” and “when problems occur, how long does it take you to fix them?”.

Based on the norm value as stated in section 2.3.8.1, that is that the level of specialization of regulatory activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality and completeness of the information that is stored, shared and retrieved in HIT systems, it can now with use of the provided operationalization be defined when
the level of specialization of regulatory activities is low. The level of specialization of regulatory activities is low when regulatory activities are grouped into larger tasks, which entails that one should perform a high number of regulatory activities, there is a high average cycle time per regulatory activity and one should have a broad scope of performed regulatory activities.

### 3.3.7 Formalization

The degree of formalization has been defined as the degree to which rules and procedures dictate how tasks should be executed. Also, this last parameter can have a high and low value, resulting in two dimensions. With a low degree of formalization, work processes and decisions are limited restricted by rules and procedures. With a high degree of formalization, work processes and decisions are highly restricted by rules and procedures.

Both dimensions can be indicated with use of two variables. “Work processes that are restricted by rules and procedures to a limited degree” and “decisions are restricted by rules and procedures to a limited degree” point towards a low degree of formalization, in which work processes and decisions are only limited restricted by rules and procedures. “Work processes that are highly restricted by rules and procedures” and “decisions that are highly restricted by rules and procedures” point towards a high degree of formalization in which work processes and decisions are highly restricted by rules and procedures. A schematic overview of this operationalization can be found below in table 3.8.

#### Table 3.8 - Operationalization of Formalization

<table>
<thead>
<tr>
<th>Concept</th>
<th>Dimension</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formalization</td>
<td>Work processes and decisions are limited restricted by rules and procedures</td>
<td>Work processes that are restricted by rules and procedures to a limited degree</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decisions that are restricted by rules and procedures to a limited degree</td>
</tr>
<tr>
<td></td>
<td>Work processes and decisions are highly restricted by rules and procedures</td>
<td>Work processes that are highly restricted by rules and procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decisions that are highly restricted by rules and procedures</td>
</tr>
</tbody>
</table>
Questions asked during the semi-structured interviews to identify the degree of formalization were “to what extent are you free to decide how you will perform your operational activities?” and “Do you have the feeling that rules and procedures obstruct you from taking own decisions?” and “How do you see the balance between following rules and the ability to perform to own insight in case of emergencies?”.

Based on the norm value as stated in section 2.3.9.1, that is that the level of formalization must neither be very low or very high (so average) so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems, it can now with use of the provided operationalization be defined when the level of formalization is average. The level of formalization is average when work processes and decisions are restricted by some rules and procedures, which entails that work processes must be restricted by rules and procedures to some degree that is not highly restricted nor not restricted at all, and that decisions must be restricted by rules and procedures to some degree that is not highly restricted nor not restricted at all.

3.3.8 Data analysis

After the interviews were conducted, the interviews were transcribed and, if the respondent had confirmed, send to the respondents to check and confirm that this transcribed version of their interviews could be used in this research. After confirmation, the interviews were coded and analysed in Atlas.ti.

To do the coding and analysing in Atlas.ti, a deductive research approach was used. A deductive approach tries to reason from the abstract into the more specific (Vennix, 2011). The theoretical concepts and operationalization as stated in section 3.3.1 were used as starting points. Quotations within the transcripts were labeled with codes that corresponds with this operationalization. Quotations within the transcripts that dit not correspond directly with the operationalization but were still useful for this research were assigned with a new label. The coding and analysing existed of two phases. The first phase was the mapping of the different HIT problems in one of the four categories of information quality. If some of the HIT problems could not be labelled onto one of the four categories of information quality, they were provided the label “Other IT” Furthermore, disturbances that arose due to these HIT problems were labelled with disturbances.
The second phase was the coding of the organisational structure with use of the 5 parameters. Also here disturbances that arose due to a problematic parameter value were labelled with disturbances. In the end, 11 different disturbances and 3 different problems with “Other IT” could be distinguished. Among with the 5 parameters and 4 quality information aspects, a total of 11 categories could be distinguished. This coding three can be found in Appendix E.

3.3.9 Research quality

Three factors define the quality of qualitative research: internal validity, external validity and reliability (Bleijenbergh, 2013; Boeije, 2005; Vennix, 2011). It is now explained how this research meets these criteria on internal validity, external validity and reliability.

3.3.9.1 Internal validity

With internal validity is meant that a researcher measures that what he intends to measure (Boeije, 2005). According to Vennix (2011), internal validity can be improved by doing two things: using an operationalization based on theoretical findings and validating the interview protocol by respondents to be sure that what a researcher is measuring is also what he intends to measure. In this research, both criteria are met. The operationalization has been made based upon existing literature and to two respondents, trial interviews have been conducted to make sure that the concepts as measured are also the intended concepts to measure.

3.3.9.2 External validity

External validity, also known as generalizability, refers to the degree to which results from one research are also applicable for other researches in a larger population (Boeije, 2005). This research is a very specific problem identifying and diagnostic research, that is not directly applicable to other situations. However, the theoretical concepts and foundation can still be used in similar situations, for instance when an organisation wants to find out if their organisational structure may be a cause for experienced IT problems. Therefore, this research still is generalizable, but only on theoretical foundation and not on results.
3.3.9.3 Reliability

Reliability is defined as the degree to which other researchers would find the same results if they would perform the exact same research in the future (Bleijenbergh, 2013). To have reliable results, the measurement itself must be independent of the researcher or the research instruments, so that if the measurement is repeated by other researchers or with different instruments, the same results will be found (Vennix, 2011). One way to achieve reliable results is to precisely describe the used method, the data gathering and the steps taken for data analysis (Bleijenbergh, 2013). Furthermore, asking the same questions to multiple respondents or asking respondents multiple questions about the same object also result in more reliable results (Vennix, 2011). This also has been done in this research. Multiple questions have been asked to respondents about the same topic, and every respondent was interviewed according to the same interview protocol. Furthermore, steps taken in this research such as the used method, the data gathering and data analysis have been precisely described, which increases the reliability of this research.

3.3.10 Research ethics

When performing research, the researcher must be aware of that his/her own role can affect the research process, the respondents and the outcome of the research. To take this into account, certain research ethics have been developed, such as informed consent, confidentiality and anonymity (Wiles, Charles, Crow, & Heath, 2006). This section will explain how the researcher has addressed the research ethics for this research.

First of all, all respondents that participated in this research got explained what the research was about, what the implications might be for participating in this research and that participating in this research was on a voluntary basis. It was explained at the beginning of the interviews that respondents could stop during interviews at any time and that they could withdraw from the research at any time. Furthermore, their permission was asked to record the interviews and to read their interview transcripts afterwards and possibly leave sentences out of the transcript. This is called informed consent: the respondents are fully aware of their participation in this research and of the consequences that participating in this research might have (Wiles et al., 2006). Although there was no signing of actual consent forms, the respondents knew that with agreeing on their interview transcripts, they would agree with participating in the research and the possible implications that come with participation.
Second, all the interviews were held under strict confidentiality. Respondents do not know from each other who is being interviewed or where the interviews took place. All the interviews have been held at the cooperating departments and quotations are not traceable back to persons. All of the 10 respondents, which includes the client who gave the admission for this research, receive the anonymized version of this thesis. The non-anonymized version of this thesis is only available for the 1st and 2nd supervisors at the university.

Third, all the interviews were held with strict anonymity. Quotations and sentences out of the interview transcripts are not traceable back to individual names or persons within the organisation. Although quotes are traceable back to departments, functions have been anonymized in such a way that quotes are never traceable back to 1 person. The researcher was aware that some departments hold only 2-3 management functions, which makes quotations traceable back to one of these 3 persons. However, the researcher made this aware to the respondents at the beginning of the interviews and they had no problems with this.

Fourth, the researcher was during the interviews aware of his work history at the Radboudumc. It might happen that people say more or even less during interviews because they have the feeling that the researcher is not independent towards the research. At the beginning of the interviews, the independence of the researcher was clearly stated. Furthermore, the researcher has tried to not steer interviews in a certain direction based on pre-existing knowledge about the situation. The researcher has done everything in his power to be fully independent throughout the whole research.

This chapter was devoted to outlining the research methods used in this research. With use of 10 semi-structured interviews and 4 documents, the data gathering took place. The findings are presented in next chapter.
Chapter 4 - Results

This chapter is dedicated to answering the following sub questions: "Which HIT related problems do occur at the operating rooms of the Radboudumc” and “How is the structure a cause for the HIT problems that occur at the operating rooms of the Radboudumc?”

First, the findings on the different HIT problems are presented for each quality aspect (sections 4.1.1 till 4.1.4) and for the HIT problems that could not be addressed to one of these quality aspects (section 4.1.5). An overview of these findings can be found in section 4.1.6. Second, the findings on the discovered degrees for the different design parameters are presented (sections 4.2.1 till 4.2.5). Based on the norm and discovered values, a difference between both can be established. Section 4.3 is devoted to providing an explanation for how the discovered values on the different design parameters can be a cause for the experienced HIT problems at the OR of the Radboudumc.

4.1 HIT problems

As defined in chapter 2, HIT are systems that are designed to improve the storage, retrieval and sharing of information between different users in a healthcare organisation. When designing this information structure, there are four aspects of information quality that play an important role: the reliability, actuality, completeness and relevance of information. Properly functioning HIT systems can then be defined as the timely delivery of information conform the four quality aspects in the purpose of supporting the underlying processes in a healthcare organisation. One may speak of HIT problems when the measured situation of the OR in the Radboudumc shows a derivation with one or more of the quality aspects of that information that is stored, retrieved and shared with use of HIT systems. In general, there are 3 HIT systems used in the process of the OR in which information is stored, retrieved and shared. EPIC is the EMR and is used by the OR for the storage, retrieval and sharing of patient data. OVMA is the inventory management system, used by OR Logistics, to manage the stock of the products used at the OR in their warehouse. T-Doc is a system used by the CSA for the track&trace of the instruments that are used at the OR. CSA is only using T-Doc, the OR is using T-Doc and EPIC and OR logistics is using all 3 systems. The results for each quality aspect of the information that is stored, retrieved and shared with use of one of these HIT systems will now be discussed in detail.
4.1.1 Relevance of information inside HIT systems

First of all, information must relevant, in this research defined as the extent to which the shown information is also the information that one wants to know. If users of the HIT systems at the Radboudumc is not shown the information they want to know in order to perform their activities or if users see more information that they need to know in order to perform their activities, one may speak of a derivation in the quality of information and thus in problematic HIT systems. This problem becomes visible in the relevance of the information that is stored, retrieved and shared with use of HIT systems.

When respondents were asked about wrong information they had while performing their activities or seeing more information than needed to perform their activities, there were some respondents that did not experience these problems: “No, I don’t experience any problems.” (Respondent 4), “No, I don’t experience it that way. There is only information in there that I can use and there is not really information that bothers me” (Respondent 5) and “No, for me it is about having not enough information and missing information” (Respondent 7).

However, there are respondents confirming that they see more information than they need to know in order to perform their activities, for instance with T-DOC: “The applications of the CSA are not adjusted to the needs of the OR, which results in a lot of un-used data inside those systems” (Respondent 3) and “You have to deal with all kinds of information, because it is all in there, but it is not the exact information that I need” (Respondent 8). Respondent 6 mentions that a cause may lay in the chain of departments between OR - Logistics OR - CSA: “That chain is absolutely not optimally structured, and because of that a lot of information that is shared is not usable for other users”. This sometimes leads to information that is not shared anymore. Even though the other departments need that information, they cannot work with that information: “So if I would send my information in EPIC to the CSA, they wouldn’t be able to work with that information. The information of EPIC does not directly translate to how many instruments are needed” (Respondent 6). Respondent 4 mentions that this is not a big problem: “It is up to each person to decide if that information is important for him/her or not”. However, this does lead to cases in which the wrong information is displayed.
When users of HIT systems at the OR were asked if they were also experiencing examples of irrelevant information shown to them in the HIT systems, again several respondents confirmed: “Not being able to deliver the right information to the other person, that is a big problem. And that is where I can see the failing IT systems” (Respondent 6). Some respondents experienced this problem with T-DOC: “If you have a question about an instrument set, where that set is located at that moment, there is a lot of other information visible but it is not directly visible in the system where that set is located” (Respondent 1). The same problem is also experienced in EPIC: “Often there is only a general description in the surgery request in EPIC. You then have to go in medical reports of the patient and look up what the surgeon agreed on with the patient. So this essential information is not in the right places for the OR. It is accessible but takes a lot of time” (Respondent 2).

To conclude, although there are some respondents that do not experience problems regarding the relevance of information that is shared with use of HIT systems, the majority of the respondents do experience problems regarding the relevance of information that is shared with use of HIT systems. Most of the problems the respondents experience is related to information sharing between different departments, that use different HIT systems for their production processes. Only few of the problems occur when information is shared in the same HIT systems between employees with different functions, responsible for different parts of the production process. A detailed conclusion can be found below in table 4.1 in which the discovered problems related to the relevance of information are mapped to the different systems.

### Table 4.1 - Findings on Relevance of information

<table>
<thead>
<tr>
<th>HIT System</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-Doc</td>
<td>Respondents see more information than they need to know, information is useful for the CSA but not for OR</td>
</tr>
<tr>
<td></td>
<td>Respondents see information that they not need to know, information is useful for the CSA but not for OR</td>
</tr>
<tr>
<td>EPIC</td>
<td>Respondents see more information than they need to know, information is not for all users actionable</td>
</tr>
<tr>
<td></td>
<td>Respondents see information that they not need to know, difficult with the high amount of data to collect the actionable data</td>
</tr>
<tr>
<td>OVMA</td>
<td>No problems found related to the relevance</td>
</tr>
<tr>
<td>Information shared outside HIT systems</td>
<td>No problems found related to the relevance</td>
</tr>
</tbody>
</table>
4.1.2 Reliability of information in HIT systems

Second, information must be reliable, in this research defined as the extent to when information is shown, this information is correct and free of errors. If users of the HIT systems at the Radboudumc cannot make a proper decision or action based on the shown information in HIT systems, or if users are experiencing errors with the information shown in HIT systems or if users can interpret information shown in HIT systems in multiple ways, one may speak of a derivation in the quality of information and thus in problematic HIT systems, reducing the reliability of that information that is stored, retrieved and shared with use of HIT systems.

When asked if respondents can make proper decisions or actions based on the shown information in HIT systems, often heard responses are “No, I think that you cannot” (Respondent 1), and “That is just how the system works. When something is missing in an instrument set, the system sometimes indicates that the set is complete. Nowadays we just don’t react to it anymore, because that is the way it is been going for years” (Respondent 2).

According to respondent 6, information in EPIC changes a lot last-minute: “That is happening at the OR. Information is last-minute changed, which causes a lot of extra last-minute work”. And according to respondent 4, sometimes the wrong names are used: “What I experience is that sometimes instruments end up at the request list, with a name that does not exist. And so my employees are searching for that instrument, which takes them a lot of time.” Information in T-Doc is also often mentioned as information on which you cannot make proper decisions or actions: “Sometimes we are looking for instruments that are not even at the OR complex, even though the system says it is” (Respondent 9) and “Sometimes instruments are just lost. According to the system, they should be here, but they are not, and you cannot find it anymore” (Respondent 2).

Information in OVMA is also not always reliable: “When an employee is so fixed on clearing up disposables, he sometimes forgets to scan the OVMA articles. You then lose this information and according to the system, the article is used.” (Respondent 5)

When asked if users experience errors in information shown in HIT systems, respondents also confirmed: “Yes, we experience a lot of incorrect information” (Respondent 10) and “Errors in information in the system, sometimes that is definitely the case” (Respondent 8). Most of the respondents experienced errors in information in T-Doc: “It can happen that an extra instrument is
added to an instrument set, but that the systems does not indicate that.” (Respondent 1) and “Sometimes it happens that an instrument set is not complete but in the system it says it is” (Respondent 9). Respondents 9 adds to that: “Sometimes you scan an instrument set and the system says it is at a location, but it is not”. According to respondent 7, human mistakes can be a cause for errors in information: “That happens, due to bad scan discipline, people make mistakes and because of that, information in the system is not actionable”. One respondent experiences information errors in EPIC: “Sometimes we are dressed up in protective clothes and then the patient appears to be not contagious” (Respondent 1). And respondent 5 mentions the following about OVMA: “If some of the articles are send to departments outside the OR and they are not scanned properly, we lose them in the system. When they are returned our stock does not match with the stock in the system.”

When asked if users can interpret information in HIT systems in multiple ways, they confirm that this is the case: “There is a difference in information, in the interpretation of that information” (Respondent 3) and “Sometimes different names for the same instruments are used. Sometimes that causes confusion” (Respondent 9). Most of the respondents experienced misinterpretation in T-Doc: “It can happen in T-Doc that multiple sets have the same ID number. If you want to pair an instrument set to a patient for backwards traceability, this is not possible, because with that ID still 10 different sets can be used on that patient.” (Respondent 6) and “Some of the codes that the CSA uses are not clear for us, they can be interpreted in multiple ways” (Respondent 5) and “The system keeps track of the owner of an instrument set, but that does not necessarily mean that the owner is also financially accountable if something happens to the instrument set. And when some instruments need repair, who pays? For instance, when labelled OR Orthopeadics, does the department Orthopeadics or the OR need to pay for the reparation?” (Respondent 8). Respondent 6 adds that this might give problems in the future when the two systems are integrated: “What is essential in digitalization is that multiple systems can communicate with each other. And that when they communicate, users know that in both systems the same information holds the same definition. So that the information in both systems is interpreted in the same way by its users. And that when you have a unique ID, you know for sure that it is that instrument set, and that not 3 other instrument sets hold the same number”
Users are not experiencing misinterpretation in EPIC and OVMA. However, there is misinterpretation between the OR logistics and the OR, happening over the phone: “Yes, using the correct names. OR assistants use different, for us unknown, names for the same instruments that we not know. We then have to call back and that takes time, time in which the surgeon is waiting for his instruments” (Respondent 5). Also the protocols that are used to prepare surgeries for the next day can be a source of misinterpretation: “Sometimes surgeries are prepared wrong. Then I have to call the logistics to bring in the right instruments, because now we have the wrong instruments” (Respondent 9) and “Sometimes the protocols are delivered late, are not printed out in the right way or the wrong protocols are printed. There is no check if what they are asking for is available, sometimes they ask more instruments than we have or that are available. With as consequence that we are searching for instruments that do not exist or are not available.” (Respondent 5).

To conclude, the majority of the respondents experiences problems regarding the reliability of the information that is shared in HIT systems. In all three systems respondents are dealing with information that is not proper enough to make sound decisions. Furthermore, respondents experience the most information errors in T-DOC, while occasionally information in OVMA and EPIC also show errors. In addition, respondents mention that some information in T-DOC can be interpreted in multiple ways. However, respondents are also experiencing misinterpretation of information that is shared without HIT systems. Examples of these cases are information that is shared trough the phone or with the protocols that are used to prepare surgeries for the next day. A detailed conclusion can be found below in table 4.2 in which the discovered problems related to the reliability of information are mapped to the different systems.

Table 4.2 - Findings on Reliability of information

<table>
<thead>
<tr>
<th>Reliability</th>
<th>T-Doc</th>
<th>EPIC</th>
<th>OVMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents cannot act on information, cannot trust information</td>
<td>Respondents report errors in information, information shown in the system appears to be wrong</td>
<td>Respondents report errors in information, information is updated too late</td>
<td>Respondents cannot always act on information, cannot always trust information</td>
</tr>
<tr>
<td>Respondents can interpret information in multiple ways, ID numbers are not unique</td>
<td></td>
<td></td>
<td>Respondents report errors in information, information about stock inventory does not always add up</td>
</tr>
<tr>
<td>Information shared outside HIT systems</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.1.3 Actuality of information in HIT systems

Third, information must be actual, in this research defined as the extent to which the age of the data is appropriate for the task at hand. If users of the HIT systems at the OR of the Radboudumc experience information that is outdated and not actual anymore or information that reaches them too late, one may speak of a derivation in the quality of information and thus in problematic HIT systems, becoming visible in the actuality of that information that is stored, retrieved and shared with use of HIT systems.

When asked if respondents experience information in HIT systems that is outdated and not actual anymore, several respondents confirm: “Yes, I experience problems regarding the actuality of information for sure” (Respondent 4) and “Often the request is not actual” (Respondent 7). Several respondents experienced outdated information in T-Doc: “In T-Doc, a location is noted for each instrument set, that is also put on the instrument set itself. However, when a location changes, we cannot change the location in T-Doc ourselves, we are not authorized. With as consequence that the location in T-Doc does not match the actual location of an instrument set” (Respondent 3) and “Yes, we definitely experience information that is not actual in T-Doc anymore, but that has everything to do with the physical distance between the CSA and OR. That we literally need a transportation department to transfer materials between us” (Respondent 4) and “For instance, in T-Doc, attached to every instrument set is a photo of the content of that instrument set, but almost no instrument sets have a photo attached, and almost no instrument sets have an actual photo attached. So the administration of the instrument sets, that is always behind and never actual” (Respondent 8).

Respondents also experienced information in EPIC that is outdated and not actual anymore: “In Epic I find it unfortunately that when someone is labelled with contact isolation, that information is not updated anymore. We then treat someone according to the contact isolation protocol, but during the briefing and time-out we find out that this person does not have to be treated according to the contact isolation protocol” (Respondent 1) and respondent 5 states: “The information in EPIC is updated by the specialist the night before surgery and then the next day, we plan for that surgery. But at the time we are preparing the OR, information may already have changed in EPIC, of which we do not know.”
Respondent 9 adds: “Sometimes we are lagging behind with information that is not actual. I have even experienced that according to the information in EPIC the surgery should be at the right side of the patient, but actually the surgery had to be performed at the left side of the patient. That is of course unacceptable.”

Furthermore, respondents also experienced information that is shared and outdated outside HIT systems, for instance with sight shipments: “A request is done by the OR that there is a sight shipment and that information will follow. Sometimes information then follows but at the wrong place, so you have to be extra alert and most of the time you then have to call people to get that information. Most of the time, that information is available by someone else, but the request is just not updated to us.” (Respondent 2). Or with backorders: “We receive that there is a backorder, but what then. You have to follow up by yourself about how long it stays in backorder, when it is delivered again by a supplier. The information we have is already outdated.” (Respondent 5) The same holds for the protocols that are used for the preparation of the surgeries: “Using the old surgery reports, I think that is where the outdated instrument names come from. The wrong name for the instruments is used. With as consequence that people are searching for those instruments, while the concerned instrument set may be next to them. But they do not know, because the outdated name is used.” (Respondent 4)

Respondents also experienced information that reaches them too late: “So that is information that reaches you too late, indeed” (Respondent 2), “Yes absolutely, that is information that is delayed” (Respondent 4) Respondent 5 added to that: “Sometimes information has to pass multiple persons, and when you give the information to the first person, by the time it has reached the last person, the information has completely changed. It takes a lot of time, you want to deal with it faster but you cannot.” One respondent experienced information in T-Doc that reached the respondent too late: “That information reaches you too late, it reaches you when you use that instrument set, but then it is already open and too late” (Respondent 2). Respondent 5 stated that this is also the case for information in EPIC: “Information that is last minute changed about surgeries in EPIC reaches us only when the OR’s are starting, which leaves us very little time to bring the right instruments”
Besides, respondents also experienced information that is shared outside HIT systems that reaches them too late. For instance, for borrowed instruments: “If it is for instruments that we have in our warehouse, that is fine. But sometimes an implant or borrowed instruments of another organisation are needed, and that information is communicated too late. No one knows, but we need that information.” (Respondent 5) Or with the protocols used for the preparation of the surgeries: “The current situation is that we receive the protocols too late because they are printed by the OR assistants themselves. A lot of these protocols are changed last minute, while the OR’s are already prepared. We then have to change those OR’s. If we would have had the information earlier, we would have prepared the right protocol.” (Respondent 3). Or if an instrument set is needed in case of emergency: “Yes, if an instrument set is for instance placed on a cart for a certain OR, no one knows on which cart it is placed. Another OR is then calling for these instruments. We then have to search these instruments, while in the end it appears that all the instruments are already in use on different OR’s: we are searching for instruments that are not available.” (Respondent 7).

To conclude, the majority of the respondents experience problems regarding the actuality of the information that is shared with HIT systems. In both T-DOC and EPIC respondents experiences outdated information and information that is not actual anymore. This is also experienced with information that is shared outside the HIT systems, for instance with sight shipments or backorders. Furthermore, in both T-DOC and EPIC respondents are experiencing information that reaches them too late. This also applies to information that is shared outside the HIT systems, for instance with borrowed instruments and the protocols. No problems were mentioned regarding the actuality of information in OVMA. A detailed conclusion can be found below in table 4.3 in which the discovered problems related to the actuality of information are mapped to the different systems.
4.1.4 Completeness of information in HIT systems

At last, information must be complete, in this research defined as the extent to which data are of sufficient breadth, depth, and scope for the task at hand. If users experience the missing of information or information that is incomplete which is needed for a proper decision or action, or information that is stored at the wrong places, one may speak of a derivation in the quality of information and thus in problematic HIT systems, becoming visible in the completeness of that information that is stored, retrieved and shared with use of HIT systems.

When asked if respondents experienced the missing of information or information that is incomplete which is needed for a proper decision or action, several respondents confirm that this is the case: “We are missing information, departments are missing information, information that is crucial.” (Respondent 3), “There is definitely is a shortage on information that is crucial for planning” (Respondent 2), “The problem is mainly the absence of information. Either we don’t have that information, or the information is inadequate. We do not have the correct information.” (Respondent 7) and “The information I am seeing is not enough” (Respondent 8).

Most of the respondents experienced incomplete or missing information in T-Doc: “The information in T-Doc is not complete.” (Respondent 5), “Yes, I think that is the biggest problem, the instrument tracking system” (Respondent 4), “In T-Doc, we cannot see all the information that the CSA can see. For instance, when there is an instrument missing on an instrument set, we cannot see all the information but the CSA can.” (Respondent 2) and “Reparations of the instruments are not being updated the right way. There is a registration of that an instrument is being repaired, but as

<table>
<thead>
<tr>
<th>Table 4.3 - Findings on Actuality of information</th>
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<tbody>
<tr>
<td><strong>Actuality</strong></td>
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<tr>
<td><strong>T-Doc</strong></td>
</tr>
<tr>
<td>Respondents report cases of information that is outdated and not actual anymore, in for instance the location of the instrument sets</td>
</tr>
<tr>
<td>Respondents receive information too late, for instance about missing instruments on an instrument set</td>
</tr>
<tr>
<td><strong>EPIC</strong></td>
</tr>
<tr>
<td>Respondents report cases of information that is outdated and not actual anymore, for instance with information about the type of surgery</td>
</tr>
<tr>
<td>Respondents report information that reaches them too late, for instance about contact isolation</td>
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<tr>
<td><strong>OVMA</strong></td>
</tr>
<tr>
<td>No problems found related to actuality</td>
</tr>
<tr>
<td><strong>Information shared outside HIT systems</strong></td>
</tr>
<tr>
<td>Respondents report cases of information that is outdated and not actual anymore, for instance about sight shipments or backorders</td>
</tr>
<tr>
<td>Respondents report information that reaches them too late, for instance updates about borrowed instruments and protocols</td>
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an instrument set has no unique code, the repaired instrument can for instance be on three different instrument sets.” (Respondent 8). Respondent 6 agrees: “That will be essential with the digitalization. That when you have an unique instrument set, that there is no doubt that there are accidentally 3 more instrument sets with the same number. But that that unique number is linked to a unique instrument set, in which errors are excluded.”

Some of the respondents experienced incomplete or the missing of information in EPIC: “At the WPM I found out that if someone says that a prothesis must be ordered, someone first have to gather all the details about what is needed exactly, because that information is missing at that moment” (Respondent 1) and “Printing out the protocols with EPIC, that is usable but not watertight. Too often things get changed and too often things on the protocols are missing. We then have to call to the concerning specialism to ask for information, which takes time” (Respondent 5).

However, most of the respondents experienced incomplete or missing information that they need for their production process, that is not bounded to a HIT system. It is just not in a HIT system. Missing information about what can be planned in relation to how many instruments and materials there are available at the OR is a frequently heard problem: “There is an information shortage on what can be planned and what we have on instruments and materials” (Respondent 2) and “Information about the OR-planning is missing to make a proper OR-planning.” (Respondent 3). Respondent 4 experienced similar problems: “We are called in case of an emergency, but we are not provided with an overview of for example, tomorrow we are doing 8 hips, be prepared. We currently do not have that information.” Respondent 7 confirms: “Ideally they would give me a list of instruments that they are going to use tomorrow, and then I’ll deliver those instruments before that surgery starts. But right now, that information is not available. That information is not shared with us.” Respondent 6 says that although it takes a lot of time to fix the problems that arise because this information is not available, it hardly leads to surgeries that are cancelled: “It takes a lot of time to fix these things. Patients have to be moved to other time windows, sometimes even to another day. But people are really creative in finding solutions, so when something is not working they will find another way to make it working. So I don’t see very often that surgeries are cancelled.”
Respondent 8 stated that the problems start with the planning: “For instance we have 5 of the same instrument sets. The Orthopeadics are using these 5 instrument sets. However, general surgery also needs one instrument set. Orthopeadics is planning on using all 5 sets, because they are assuming that they can use 5 sets. Then you have a mismatch. That information is not shared nor visible”

Some of the respondents experienced cases of information that is stored at the wrong places: “Sometimes it is that the information is not missing, but kept at the wrong places” (Respondent 8) and “If the surgeon or planner does not add the information in the right place, it is just not visible for OR assistants. They then have to search through the patient files to find that information, which takes a lot of time” (Respondent 1). All the experienced cases are in EPIC: “A nice example is the use of free text fields in EPIC. For instance, when you transfer a patient from the OR to the recovery. You can then put information about which type of care must be provided at the recovery in the text field ‘transfer’ but also in the text field ‘recovery’. There are many of these free text fields in which you can type information. It would be preferred that there is only one such text field, and that people are forced to use that text field.” (Respondent 8) or “For instance a doctor that puts in the patient file that breast protheses are needed, but does not add if it is one-sided or double-sided, or without size. You then have to gather that information by yourself by looking into the reports of the conversation that the doctor and the patient had.” (Respondent 1).

To conclude, the majority of the respondents experience problems regarding the completeness of the information that is shared with HIT systems. Most of the respondents experience problems with incomplete or missing information in T-DOC, some respondents also experience problems with incomplete or missing information in EPIC. No problems about incomplete or missing information are mentioned about OVMA. However, the biggest experienced problem is the missing of information that respondents need for their production process and is currently not shared within a HIT system. Furthermore, in EPIC respondents experience cases of information that is stored at the wrong places. No problems about information that is stored at the wrong places are mentioned about OVMA and T-DOC. A detailed conclusion can be found below in table 4.4 in which the discovered problems related to the completeness of information are mapped to the different systems.
4.1.5 Other causes failing HIT systems

As mentioned earlier, there may be other causes for the failing of HIT systems but are not directly linkable to the organisational structure. These findings will now be outlined. First of all, respondents are missing HIT systems that connect to their processes. For instance, respondent 2, who misses an IT system that shows which instruments are needed for which patient: "You just don’t have an IT system that shows exactly which instruments are needed for which patient". Respondent 3 misses the traceability of instruments: "If such an instrument set is chipped and you have scanners at certain points, then you know which set is where. If you then get an emergency situation and you need a set, you know where that set is located. You work much more efficient, now there is just no system that can do this. There are too much restrictions in the current systems.” Respondent 3 adds to that: “There has to be an integral IT system with which we all work with and with which we can trace instruments.”

Respondent 7 saw problems with T-Doc: “Right now we work with T-Doc, the instrument tracing system, but the problem is that the OR is only granted permission to view, and not to change the system so that it matches their processes. We currently do not have an instrument tracing system that matches the demands of the OR logistics.” Respondent 8 agreed: “T-Doc has been bought as a track-and-trace system, but it is not a track-and-trace system, and with that I mean that it now is a system in which it helps administrating the processes at the CSA. But it is not for track-and-trace of instruments. And certainly not for the OR.” However, Respondent 4 also saw possibilities in T-Doc: “There is a lot of functionality in T-Doc, we are actually working with very few. It would be very useful if I could see in T-Doc how many instruments sets we have of a particular instrument set. That is what I am missing currently.”

<table>
<thead>
<tr>
<th>Completeness</th>
<th>T-Doc</th>
<th>EPIC</th>
<th>OVMA</th>
<th>Information shared outside HIT systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents report incomplete or missing information, about for instance instruments that are in reparation</td>
<td>Respondents report incomplete or missing information, about for instance prothesis that need to be ordered for surgery</td>
<td>Respondents report cases of information that is stored at the wrong places, for instance information about the recovery process that can be stored in multiple places</td>
<td>No problems found related to completeness</td>
<td>Respondents report incomplete or missing information, about for instance about how many patients can be planned with the number of instruments that are available</td>
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Table 4.4 - Findings on Completeness of information
Respondent 6 misses a proper IT system for the planning of patients: “The planning on available materials, that is something that should be a lot easier. Now conflicts are not visible because different specialisms do not communicate with each other, but do use each other’s sets. There currently is no system that makes that visible.” Respondent 6 adds to that: “The problem is that specialisms plan on their own available materials, and that knowledge is nowhere stored. So when one of the specialist is absent, we lose this knowledge and things will go wrong.” Furthermore, respondent 8 sees an overall problem with the different systems, they are not connected: “What I find interesting, what I notice, is that all those applications do not connect with each other. Some have overlapping functions and all together they are also missing certain functions. And why is that? Because no one has ever looked critically to the overall process. All the involved departments have different interests with different demands, the end effect being that every department has its own unique application and we are running around in circles.”

Furthermore, respondent 8 misses a system that predicts certain variables: “I think we should do more with Artificial Intelligence in a way that we can predict certain variables. There are so many variables, and if we would be able to predict some of them, that would give us a lot more control on our processes”. And respondent 1 states that it is not able to work with multiple people in the same patient file: “In the WPM for instance, we all meet and discuss the patients one by one. But I want to know different things than for instance the anaesthetist. I want to know which placings protocol we are going to use, but the anaesthetist wants to know something different. Right now you cannot work in the same record.”

Second, there is the user-friendliness of the existing HIT systems. Working with multiple applications leads to frustration by some respondents: “I find it unfortunate that you have to start up several separated applications. In the morning, you are busy with starting up these applications. It would be nice if there was one in which all these applications were connected” (Respondent 1), “We have a lot of separate applications running, that rely on each other’s data. That is prone to error sensitive.” (Respondent 3) and “I think that the IT systems need to be connected more to each other anyway. Now it is not, partly because the board of directors does not formalize the use of a single application.” (Respondent 2) Respondent 2 adds to that: “Ideally you could go from a patient file in EPIC directly to the instrument tracking system and the inventory management system, to see if all the material that is needed for that surgery is available.”
Respondent 9 agrees: “I think T-Doc is an old-fashioned system. In the last hospital I worked the instruments were linked to the patient in the EMR. Here I have to work from two screens, one with EPIC and one with T-Doc. Why can we not merge those two systems into one?”

Furthermore, T-Doc is regarded as a very difficult system to search in: “Then you get a big number of sets with synonyms for the instruments you are searching for. You then have to find the one based on your own knowledge. Searching is very difficult” (Respondent 5). Furthermore, respondent 5 experienced OVMA as a slow system: “It is usable, you can work with it, but it takes a lot of time to log in and do things. Sometimes you get a notification of which you think what do I have to do with it, and I cannot fix it. It takes a lot of time to perform one action.” This makes the system unreliable when something needs to be fixed ad hoc: “If you need to update some items in OVMA and you have to do that ad hoc in between other processes as well, you need to print out another form, that are all in all a lot of actions. And if someone forgets one because he is really busy, you lose this information, and your inventory does not match OVMA anymore.” (Respondent 5)

About EPIC, respondent 8 mentions: “EPIC is a kind of toolbox, where the whole patient file is stored and a huge amount of the steps and work process are connected. These steps are sequentially connected, for instance the Groene Golf. But if you want to change such a step, that is tremendous complicated. And not even technically spoken, but just how it is arranged in the organisation. We have a complete team that is dedicated to bundle those problems, and bring them to the department that can fix them, Information Management, and then they decide when and if they are going to fix that or not.”. And respondent 1 mentions about EPIC: “Epic is for everyone different. For doctors, anaesthetists, OR assistants, the application is for everyone a bit different. In the beginning, that was difficult for me. If you then had to search for a photo during surgery, you needed the password of a surgeon, otherwise you could not view it. I think there are much more possibilities with EPIC than we currently use.”

Lastly, some of the IT systems are made for certain departments, and therefore do not match other department’s needs: “Right now, the CSA takes only their own processes into account. Based on those processes they designed their system: T-Doc. But T-Doc is not made for the processes at the OR. It is for the OR now not a useful system to use. I won’t say that it cannot become a useful system in the future, but at this moment, it is not.” (Respondent 8).
Respondent 10 confirms: “It does not always run easily. There are a lot of inter relations between departments and for each department a different IT system is used that meets their demands. There are a lot of different IT systems used in the hospital.” Respondent 6 mentions that because each department uses their own IT system, linking two systems together is very difficult: “It takes a lot of time and energy to link those systems together. The systems need to be sealed up before you can start linking them. Those links, we always think they are ease, but in the end it turns out that it is very difficult to do.” Respondent 6 adds to that: “I think that if you want to improve the processes between departments, you need proper information. But right now, that information is not findable. And it must be translated to information that you understand and with which you can work with. Because right now, due to that everyone is working in their own system, people cannot.”

To conclude, several respondents also experience HIT problems that are not related to the quality of information that is stored in HIT systems. First of all, respondents are missing HIT systems regarding the traceability of instruments, the planning of surgeries and a system that predicts certain variables. Second, there is the user-friendliness of all three systems. Working in different applications is overall experienced as frustrating. Searching in T-DOC is experienced as very hard to do, while OVMA is a very slow system in which a lot of actions need to be performed and EPIC is very hard to change if the process changes. And lastly, an integral HIT system that connects the different HIT systems and the demands of different departments is missing. Every department now has its own information need with their own information system build on that, and all those systems are not connected. A system that connects the different information demands is preferred to create with one system actionable information for each department. A detailed conclusion can be found below in table 4.5 in which the discovered problems that do not relate to the quality of information on current HIT systems are mapped.

Table 4.5 - Other findings on HIT systems

<table>
<thead>
<tr>
<th>Experienced problems</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing HIT systems</td>
<td>Traceability of instruments, planning of surgeries, prediction of certain variables</td>
</tr>
<tr>
<td>User-friendliness</td>
<td>Working in different applications is frustrating, searching in T-DOC very hard, OVMA is a very slow system in which a lot of actions need to be performed, EPIC very hard to change when process changes</td>
</tr>
<tr>
<td>Integral HIT system</td>
<td>A system that connects the different information demands and thus different HIT systems of other departments to create actionable information for each department</td>
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</table>
4.1.6 Conclusion on HIT problems

To conclude, three different HIT systems can be distinguished. Furthermore, there is also the possibility that information is shared outside HIT systems. Overall, all four quality aspects seem to be problematic, although the system that is used by only 1 department (OVMA) seem to give less problems regarding the quality aspects than the systems that are used by multiple departments (EPIC & T-DOC). Table 4.6 on the next page represents the findings of the above experienced HIT problems at the OR of the Radboudumc.
| Table 4.6 - Overview of findings found on quality aspects of information |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| **Relevance** | **Reliability** | **Actuality** | **Completeness** |
| **T-Doc** | Respondents see more information than they need to know, information is useful for the CSA but not for OR | Respondents cannot act on information, cannot trust information | Respondents report cases of information that is outdated and not actual anymore, in for instance the location of the instrument sets | Respondents report incomplete or missing information, about for instance instruments that are in reparation |
| | Respondents see information that they not need to know, information is useful for the CSA but not for OR | Respondents experiences errors in information, information shown in the system appears to be wrong | Respondents receive information too late, for instance about missing instruments on an instrument set |
| **EPIC** | Respondents see more information than they need to know, information is not for all users actionable | Respondents cannot always act on information, information changes a lot last minute | Respondents report cases of information that is outdated and not actual anymore, for instance with information about the type of surgery | Respondents report incomplete or missing information, about for instance prothesis that need to be ordered for surgery |
| | Respondents see information that they not need to know, difficult with the high amount of data to collect the actionable data | Respondents report errors in information, information is updated too late | Respondents report information that reaches them too late, for instance about contact isolation |
| **OVMA** | No problems found related to the relevance | Respondents cannot always act on information, cannot always trust information | No problems found related to actuality | No problems found related to completeness |
| **Information shared outside HIT systems** | No problems found related to the relevance | Respondents can interpret information that is shared by phone or by protocol in multiple ways | Respondents report cases of information that is outdated and not actual anymore, for instance about sight shipments or backorders | Respondents report incomplete or missing information, about for instance about how many patients can be planned with the number of instruments that are available |
Furthermore, several respondents experience HIT problems that are not related to the quality of information that is stored in HIT systems. Table 4.7 below represents those items.

**Table 4.7 - Overview of other findings found on HIT systems**

<table>
<thead>
<tr>
<th>Experienced problems</th>
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<tbody>
<tr>
<td>Missing IT systems</td>
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<tr>
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</table>

**4.2 Organisational Structure**

The problems regarding the four quality aspects of information found in the HIT systems of the OR of the Radboudumc can be caused by the organisational structure as outlined in section 2.3. The actual situation at the OR of the Radboudumc situation will be discussed below. For each parameter, the actual situation will be discussed. Combined with the norm value as stated in section 3.3, a parameter value that may be problematic can be discovered. Furthermore, based on section 2.3, an expectation will be given in which certain problematic parameter values can be linked to the experienced HIT problems as outlined above.

As the organisational structure of the OR of the Radboudumc is complicated and therefore may be experienced differently by different persons, at the beginning of the interviews were showed an schematic overview of the organisational structure of the OR of the Radboudumc, and asked if they agreed with the schematic overview. To create this schematic overview of the organisational structure of the OR of the Radboudumc, the documents in Appendix B and C were used as a starting point. The outcome of the focus group session held prior to this research was used to identify the different stakeholders involved in the processes of the OR of the Radboudumc (Appendix D). Conversations with M. Janssen and B. Meij led to some adjustments and to the final version of the schematic that was showed to the respondents (B. Meij & M. Janssen, personal communication, 19 February 2020). This schematic overview is presented below in figure 4.1 and can be found in Dutch in the interview protocol in appendix A.
Apart from one respondent that does not agree at all: “Well no, I do not agree. I think you must see the CSA completely separate from the Logistics and the OR. The logistics are a customer of the CSA.” (Respondent 4), all respondents do in general agree with the schematic overview: “I do agree with this” (respondent 5) and “Yes I agree with this” (Respondent 1). Only minor changes to the planning phase had to be made: “The planning is outside the OR’s. ... But there is a little part, the WPM, that is been done by the OR’s. So that bigger block must be separated.” (Respondent 2) and the responsibility of the transportation of patients lays at the department that holds the patient: “You then call the department to bring that patient for surgery. And not the department that is responsible for transportation itself.” (respondent 6). Also the chain of OR logistics, supply chain (that is also called transport) and CSA is involved at an earlier stage: “I think that chain is involved at a too late stage now in this schematic overview. It must be known at the preparation if certain instruments are available or not, so I think that that chain is already involved in the preparation.” (respondent 7). The final schematic overview is presented below in figure 4.2. This overview is also used to help determine the value of the parameters, as their value can differ per step in the process.
4.2.1 Value of Functional concentration

Functional concentration has been defined as the degree to which operational activities are related to all order types. Combined with the desired relation between functional concentration and the quality of information shared in HIT systems, that is for functional concentration to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value for functional concentration has been established: The level of functional concentration must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems. The level of functional concentration is low when operational activities are grouped based on specific order types, which entails that there must be a low number of order types per operational activity, a low percentage of order types one comes across in performing operational activities and that operational activities of a different type are being grouped into production flows.

To discover the value of functional concentration, it was explained to the respondents that theoretically, two extreme values are possible. With a high level of functional concentration, activities are grouped based on all order types.

Figure 4.2 - Final schematic overview structure OR of the Radboudumc
To the respondents this was explained as that certain departments in the hospital are responsible for all the tasks that involve that type of activity. For instance, the CSA that is responsible for the cleaning of all instruments. To help explain this, the schematic in figure 4.3 below on the left was shown to the respondents. With a low level of functional concentration, activities are grouped into production flows. To the respondents this was explained as that certain tasks, for instance the planning of each specialism in the hospital, are grouped into production flows. Every specialism has its own planning tasks, instead of one big planning department that does the planning for all specialisms. To help explain this, the schematic in figure 4.4 below on the right was shown to the respondents. In the interviews, it is also referred to as the left and right schematic, which are respectively the grouping of activities based on all order types and the grouping of activities into production flows. It was also explained to the respondents that it is unlikely that the whole organisation is grouped based on the left or right model, but that it is likely that this differs per activity and that in reality, the value of functional concentration is somewhere in the middle. To help explain the level of functional concentration at the OR of the Radboudumc, the schematic in figure 4.2 was used to explain the functional concentration for the different activities that are performed at or are connected to the OR of the Radboudumc.
4.2.1.1 Measured value of functional concentration

During the interviews, it became clear that although the activities were in the past set up according to the right schematic, the OR has, and still is being transitioned into the left schematic: “The left, right is the old situation. Left is how we work now, right is how we were used to work” (respondent 5), “The left one.” (Respondent 7) and “We used to work according to the right schematic, but there were too many cons connected to that way of working. It was not efficiently enough, and therefore not maintainable. So we are working towards the left schematic.” (Respondent 8). Respondent 8 explains the choice: “For example, in the past it was very usual that departments bought their own instruments, ending up with a lot of duplicate instruments. Now the OR owns those instruments, and they are being used by the different departments.”

Zooming in on the different activities, it became clear that the planning is set up according to the right schematic. Every specialism has its own planning: “The planning is now not centrally organized.” (Respondent 3). Respondent 6 states that this should not lead to problems if specialisms do not borrow instruments from each other: “If you, as specialism, have all your instruments complete for surgery, you are not dependent on the rest of the OR and that is no problem. But right now, materials are limited, and that leads to problems.” Respondent 3 confirms this: “Right now that leads to problems, so we are investigating the possibility to organize the planning centrally.” Respondent 1 adds to this that in the current situation, people are also not learning from each other, and that therefore some specialisms plan a lot better than others: “I sometimes ask myself, why do planners not look at each other’s departments. Some processes perform much better than others, why not learn from each other’s processes.”

The WPM is also set up according to the right schematic: “The WPM’s, where the planning of patients is discussed, are also separated. Logistics is not involved in here” (Respondent 3). Respondent 2 confirms: “The WPM’s are now also not compared with each other, as a final check.” According to respondent 8, this leads to mistakes when specialisms are borrowing instruments from each other: “So imagine that Neurology wants to use a certain material. They discuss that in the WPM, it is available, so they can plan the patient. But trauma surgery is much less flexible in planning these patients upfront. They discuss these patients a day before surgery in their WPM, and then the instruments are not available anymore. Who is then getting the permission to perform
surgery? Or even worse, that there is no communication and they find out right before they both want to perform surgery?”

The preparation that is done by the chain OR Logistics - Transport - CSA is all set up according to the left model: “We have 1 central sterilization department, they sterilize all the instruments that are used on the OR’s. Although people have certain areas of expertise, but when it comes down to sterilizing instruments, they should be able to sterilize every instrument that comes to the CSA.” (Respondent 2). For the OR logistics, this is the same: “On a weekly basis, you come in touch with all specialisms. I think that even on a daily basis, you come across all specialisms. And you need to know about every specialism.” (Respondent 5). Respondent 3 confirms: “12 specialisms, so basically everything.” Respondent 2 adds to this: “Also with OR logistics, employees have certain areas of expertise. But in essence, they need to know everything.” For transport, this is no different: “We drive everything from and to the OR’s. We have definitely not set up our activities into production flows” (Respondent 10).

For the surgery of a patient, the degree of functional concentration depends on the type of function that a person has: “I think that heavily depends on which level of the OR you look at. If you look at the level of the surgeon, it is the right schematic. The left schematic is more on the level of the operational managers and floor managers, where all the same activities are bundled to functions.” (Respondent 6). Respondent 2 confirms: “An operational manager has 3 specialisms, and basically 5 days a week a sub-specialism of that specialism. There are all kind of different specialisms, so that are a lot of different types of surgeries.” Respondent 1 confirms the same for floor managers: “That depends, it can variate from 80 patients a day to a lower amount if there are a lot of big surgeries. But in essence all specialisms.” Respondent 6 adds: “As a surgeon you only come in contact with your own patients. But as OR assistant you are in a number of teams, for instance Urology/Gynaecology. As a member of that team you then come in contact with all surgeries that are being done by the surgeons that are covered by those two specialisms. So as a surgeon you only see 1 or 2 patients, but as a OR assistant, you see the program for the whole week. So much less in detail, but much more patients. And as an operational manager, you supervise 3 of those specialisms. And as a floor manager, you see every patient that is at the OR that day, but again, which much less detail as a OR assistant.”
To make it even more complicated, OR assistants that belong in a team during a normal work week, have to cover a lot more specialisms during the evening/night/weekend shifts: “If I have a normal day shift, I’m only involved in the Neurology and Plastic surgery. But during the evening, night and weekend shifts I am not only responsible for those two specialisms, but also involved in all kind of surgeries, so then I’m more in the left schematic. It depends on how my workweek looks like.” (Respondent 9). The schematic in Appendix B more or less confirms this, were every specialism has its own dedicated team. But when it comes down to anaesthesia employees, it turns out that they come across all types of surgery.

The recovery of a patient is set up to the schematic on the right; respondent 7 confirms that all patients that come from the OR’s pass this activity that is centrally organized. The transportation of the patient to their own ward is being done by the individual wards that hold these patients, and is thus set up to the right schematic: “You then call to the ward to pick up a patient, and not to transportation.” (Respondent 6) and “You then call for instance the ward C5 with Piet can come down. And afterwards you call the same ward to tell them they can pick up the patient.” (Respondent 6).

4.2.1.2 Disturbances that occur due to the level of functional concentration

Respondents that perform the activities outlined above which have a high functional concentration, encounter several problems during their production process. Especially at the CSA and the OR logistics, where employees come across all the different instruments on a daily basis, that are used at the OR, employees need to have a high level of knowledge: “For instance each instrument need to be treated differently, it has an own way of processing. It can be that one scissor can just be put in the washing machine, while the other scissor must be sterilized with ultrasound. That is for each instrument differently.” (Respondent 4). Respondent 7 agrees: “The problem with the left model is that you get all the instruments randomly, and therefore as an employee, you need to know a lot.”

For the Logistics, this is no different: “You experience that among employees. In the past, employees only had to know 1 or 2 specialisms. Now they need to know every specialism, which makes the work a lot harder.” (Respondent 5).
Another disturbance that respondents experience is that the WPM’s are separated, but specialisms do borrow each other’s instruments without checking if it is available: “That is also a disturbance that we experience here, in the WPM you try to filter that out, but sometimes more patients are planned than we have instruments for. If we can do 5 hips but they want to do 6. The plan bureaus can then plan 5, but if at the same time there is an emergency OR that also need those instruments, then we have a problem. And nowadays we plan with the specialisms, and not OR wide. That goes wrong if multiple specialisms have shared instruments, and they want to use those at the same time.” (Respondent 2) Respondent 2 continues: “There is now no communication between plan bureaus. Plan bureaus do not receive a notification if instruments cannot be used or are not available and that therefore a certain surgery cannot be planned. Now there is no communication about that. That would be very desirable.” Respondent 3 confirms: “A lot of surgeries are now planned without checking if the materials are there. There is a certain overlay on instruments that multiple specialisms use. And if you have a certain surgery planning for the next week and you communicate that with your own specialisms, but you also use instruments from other specialisms and do not communicate that, you get into trouble.”

Respondents have the feeling that the combination of both disturbances leads to a high need of information. When asked if they have the feeling that they need to know and share a lot of knowledge in the current situation, they confirm: “I think so, that is something that could be improved.” and “Yes I think so.” (Respondent 6). Respondent 8 also confirms and blames it directly on how the processes are set up now: “I have the feeling that with the way we have set up the processes at the OR now, the need for information is very high.” Respondent 8 continues: “Imagine, in the old OR complex, the CSA was just inside the OR complex. So if you needed an instrument to be sterilized with high urgency, that was just within reach. At a moment we agreed to not use those autoclaves anymore, but to organize it all centrally in the CSA. But the processes that we had in the old situation, with the CSA inside the OR, have never changed. We just left them for how they are, and if there are problems due to those processes, we create work arounds. That happens continuously, throughout all these years. And at some moment, these processes became unmanageable, it does not fit what it is supposed to do. So once in a while, we need to look critically at our processes and update them, and that is exactly what we need right now.” Respondent 9 agrees: “I think a lot of the processes we have now could use some updating.”
4.2.1.3 Difference between actual and norm value of functional concentration

Based on the actual and norm value of functional concentration as described above, a difference can be established. First, the pre-operative research and planning departments are organized in production flows, and do not differ from the norm value. However, due to that other steps in the process are organized in functional departments, also in the planning departments problems due to functional concentration are experienced. This is because specialisms are using each other instruments. Therefore, it can happen that in the planning departments of the specialisms, surgeries are planned that could have been performed if they were the only ones using those instruments, but because other specialisms are using those instruments as well, there are not enough instruments to perform all those surgeries. There is also no communication and information sharing between the different planning departments and between the planning departments and the OR. The OR has to compare the different planning to figure out if the demand of instruments is higher than the available number of instruments. This takes a lot of time and frustration, and to do this, a lot of information is needed.

Second, the chain OR Logistics - Transportation - CSA is organized into functional departments, which differ from the norm value. It may be no surprise that employees that operate in one of these departments experience problems regarding the information that they need to know in order to perform their operational tasks. Respondents need to know information about all instruments and come in touch with all instruments. To perform their operational tasks, a lot of information is needed. Appendix C confirms this functional structure, where each department (52 in total) are all separated and have their own function. Furthermore, appendix B shows that although the OR seems to have a more production flow oriented structure, the department itself is functionally structured as well. All surgeries happen in here, were everyone uses each other’s instruments. The results of the focus group session held prior to this research confirm this as well. As can be seen in the pictures, the processes of the departments (yellow notes) are highly separated and a lot of disturbances (blue notes) occur when these departments have to work together.

Therefore, it may be concluded that because of the degree of functional concentration, that is in some of the steps of the processes of the OR of the Radboudumc too high, this has resulted in a high volume of information that is transferred between departments, specialisms and persons.
This then has resulted in a more complex information provision and in more errors in the information shared in such a structure, which has both resulted in more complex HIT systems and a higher probability of errors in the information that is shared inside such HIT systems. This will probably lead to a problematic quality of information in terms of the reliability, actuality, completeness and relevance of information shared in those systems. This becomes directly visible in the departments of the CSA and the OR Logistics, where everyone comes across all kind of order types. Respondents find this hard to work with, as they need to have a lot of knowledge. HIT systems have been developed to support them in their work processes. However, as there is so much information in the systems, the systems have become very complex, with as a result, no one knows which information in the system is correct and which is not. And when information stored in those systems has to be used by different departments, it becomes even more complicated, which results in errors in information.

4.2.2 Value of specialization and differentiation of operational activities

The specialization of operational activities has been defined as the degree to which operational activities are divided into smaller sub-tasks. One particular way of doing this is the dividing of a task in preparation, production and support, in this research also defined as the differentiation of operational activities. Combined with the desired relation between specialization and differentiation of operational activities and the quality of information shared in HIT systems, that is for the specialization and differentiation of operational activities to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value has been established: The level of specialization and differentiation of operational activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems. The level of specialization and differentiation of operational activities is low when operational activities are grouped into larger tasks, which entails that there must be a high number of performed operational activities, a high average cycle time per operational activity and a broad scope of performed operational activities.
To discover the value of specialization and differentiation of operational activities, it was explained to respondents that this parameter could, again, have two extreme values. With a high degree of specialization of operational activities, activities such as the planning for a surgery, the sterilization of instruments needed for that surgery, the collection of all the instruments for that surgery and the performed surgery itself are all separated into different activities, that are performed by different persons. With a low degree of specialization and differentiation, all these activities are combined in larger tasks, which are performed by the same person. To help explaining this, figure 4.5 below was showed to the respondents. The small blocks represent the specialization and differentiation of tasks, which with a high degree, are all performed by other persons.

![Figure 4.5 - Specialization and differentiation of operational tasks](image)

4.2.2.1 Measured value of specialization and differentiation of operational activities

When asked if respondents have a broad scope of performed operational activities, all 10 respondents denied and replied that they have a narrow scope of performed operational activities: “It is all separated” (Respondent 5), “I have no idea.” (Respondent 10) and “No, we do not have an idea of what is happening in other departments. In outlines we know what is happening at each other’s departments but we have no idea of the processes that play in those departments.” (Respondent 7). Overall, tasks throughout the whole process are very separated: “Tasks are very separated.” (Respondent 2) and “In principle, all the tasks in your schematic are all very separated and specialized. So it are all different people that perform those different tasks.” (Respondent 8). Respondent 9 confirms: “I am not involved in the other parts of the process.”

No respondent has a clear overview of what is happening in the whole process as described in figure 4.2. The OR seems to have no clear scope of what is happening at the CSA: “The CSA is totally outside the OR, we have no view on that.” (Respondent 1).
Respondent 1 adds to that: “The only thing I know is that there is a dirty side and a clean side. So the instruments that are used go to their dirty side, through a washing machine and from there to their clean side, and from there transported back to OR, to the warehouse of the OR logistics.” Respondent 6 confirms: “If it would be possible to improve the preparation process, in which it is for the CSA clearer on what is needed at the OR on which time and it is for the OR more clear on that you know for sure that when you need certain instruments, those instruments are also available, and that you do not need to communicate constantly about that with each other, that would make a huge difference in time and annoyance.”

This works the other way around too. Respondent 4 confirms that the CSA also has no clear overview of what is been done at the OR: “I am not involved in other processes at the OR, we only sterilize the instruments.” Respondent 2 confirms: “There is a lot of extra communication needed. Ideally you would have a system in which the CSA has an insight in, for instance in two weeks, on Monday, a lot of instruments are being used. You could then deploy more people to sterilize all those instruments. And the other way around too, if there are not very many instruments used, the CSA could react on that as well. Now it is for the CSA a surprise what they have to do on that day.” Respondent 3 agrees: “We are not integrated with the planning, just as the CSA. You notice that in the execution: we just do not belong to the OR. While we are all in the same chain. We are the odd man out, and so is the CSA.” Respondent 4 notices that in the planning: “We cannot see the planning. We do not know when the OR has for instance an activity and that there will be no instruments to sterilize. We are just not looped in.”

For the OR logistics this is no different: “Transportation patients is not inside our scope, the preparation also not. We do have contact with the planning, but only the planning that is delivered to us. We are here to prepare the OR’s, that is our job.” (Respondent 5). Respondent 3 confirms: “We do not have an overview of the other processes. The core business of the OR logistics is the preparation of the instruments for the planned surgeries. Of course, besides that, we have several other tasks like the preparation of emergency OR’s, but that is added to our core business. The OR’s that we have to prepare are planned by the planning departments, where we are no part of. There is little to no reckon with the OR logistics, or the availability of instruments. Our problems start there.” Respondent 3 adds: “We just do not know from each other what we are doing exactly. We are all separated little islands, that fall under separated columns of the hospital.”
The OR has also no clear view on what is happening in the planning departments: “The planning of the patient is not inside the scope of the OR. The plan bureaus decide if a patient must be done at that moment in time. The indication for surgery is with the planning department, not with the OR.” (Respondent 2). Respondent 3 confirms: “That is the whole problem here, the planning is separated from the production and the CSA is separated from the whole OR department. That makes it very complex.” People in the planning departments have on their turn also no insight on the processes at the OR, with as a consequence that there are more surgeries planned than that the OR has materials for: “Then you have the problem that there are too many surgeries planned. I now have made a list for the planners of the Urology that states how many surgeries they can schedule of a certain surgery type. So they now know how many instruments and materials we have and that they have to make a planning that sticks to that. But they were not used to, they just did not know.” (Respondent 1)

For people performing the surgeries the scope is also narrow: “Actually our scope is from the briefing till the de-briefing on OR.” (Respondent 6). Respondent 9 confirms: “I am not further involved in the other parts of the process. We only deliver the planning to the OR logistics and they make sure that the instruments are ready to go for the next day.” Respondent 6 mentions that as a surgeon, you have no insight on if your instruments are ready or available: “No, as a surgeon you have no insight on that.” Furthermore, respondent 6 mentions that this may cause difficulties: “Sometimes you find yourself in situations, where there are a lot of changes, and that it is very difficult to fix that last moment with the CSA, or to get the right implants from the OR logistics. As a surgeon, you are not aware of the difficulties that come with last minute changes that you make.”

For transportation, this is no different: “I barely have an idea of what is happening at the CSA or the OR.” (Respondent 10). Respondent 10 states that he does not need that insight, because of very tight agreements: “We just say: for this amount we drive this often for your department. We are just a service provider, and when certain processes need to be changed, the OR or the CSA needs to come to us and we give them our conditions. There is not very much to change about that process.” Although it is a very simple process, also here problems are experienced: “We have a very simple framed assignment, and if a condition is not met, then we cannot work. Sometimes this causes incomprehension at the CSA and the OR, because we cannot find the items that we have to transfer from and to the CSA or the OR, so we cannot bring those items while the CSA and the OR are
waiting for those items. If only 1 item is missing in our assignment, we cannot fulfil our assignment.” (Respondent 10).

When asked if respondents experience the differentiation of activities into support, preparation and production, several respondents confirm: “I think that they are separated for sure.” (Respondent 5), “Yes, that is separated.” (Respondent 9) and “Yes, that is just the way we work.” (Respondent 10).

In general, departments are differentiated into support, preparation and production departments: “The planning is just a separated process, also the preparation and transportation of the process, that are all different departments” (Respondent 3). But also activities in those departments are differentiated into support, preparation and production, for instance at the OR: “For the OR assistants, the ones that prepare the planning for the surgeries for next day, that need to be processed by the OR logistics, it is likely that that person does the preparation for tomorrow, but has a day off tomorrow. So that piece of preparation is being done by someone of your team, but that doesn’t mean that that person is also involved in that surgery tomorrow.” (Respondent 2). This also holds for the OR logistics: “We have a day planning. We have two floors with OR’s, that need to be serviced by us if they need instruments. Then we have someone in reserve for when it gets busy. Then we have people that tidy up the materials that have been ordered. And we have one employee that does all back orders. So it is very differentiated.” (Respondent 3).

### 4.2.2.2 Disturbances

There are several disturbances experienced due to the narrow scope of performed operational activities. This is mostly due to that people do not know that their actions or processes have consequences for other persons in a further stage of the process. For instance, respondent 1 who misses preliminary work and because of that, extra work is needed: “I sometimes miss a bit of preliminary work, and that because of that, other persons are busy with those tasks that actually do not belong in their primary process.” Respondent 5 experiences the same problems with the preparation of the surgeries: “A lot of the time we are busy with tidying up disposables afterwards, because a protocol that has been delivered by the OR assistants to us, has not been read through good enough. It is easy for them to just deliver the protocol, while it is costing us a lot of time because we are delivering the wrong stuff.”
And surgeons also seem to have no idea that an incorrect application can have big consequences for other persons in the process: “Actually how it works now is that, the surgeon does a global request for the instruments that he needs during surgery, and then the surgery assistant needs to ask the surgeon which instruments he needs exactly. There is a high error margin in that process. And also that the surgeon sometimes at the morning of the surgery comes with a new request for other instruments that he wants to use. We could work way more precise in that, so that it is for everybody more clear which type of surgery will be performed.” (Respondent 2) Respondent 1 agrees: “I think that will save a lot of extra work. If the doctor just notes the right information, that saves a lot of communication and rework at the last moment.”

Respondent 8 has the feeling that because of the high degree of specialization of operational tasks, it will be hard to make proper future improvements and process changes that improve not only a small part of the process, but the whole process: “So actually, we do not have that information because no one has ever asked for that information or no one has ever thought that that information may be useful. And that is because no one has ever looked at the total process as the process itself. So for instance the connection between the digital preparation protocols to the rest of the process, from the planning to the discharge of a patient. No one looks at the process in that way, with multiple stakeholders, multiple IT systems. With as a consequence that if a surgery is prepared now, that is done digitally through Oracle (OVMA), but the OR assistants do not work with OVMA, so how can they see if an OR is already prepared or not? No one thinks about the process in that way. And that is because we think all from out of our own processes.”

Respondent 9 sees problems that occur due to the differentiation of operational tasks and due to that the different departments have a very narrow scope of performed operational activities: “We are not properly involved with the processes at the CSA, and because of that, problems occur. For instance, a while ago, we brought our used instruments to the CSA on Friday at the end of the day. But the CSA cannot sterilize all those instruments before the weekend. Those instruments were needed on Monday, with as a result that those instruments were not clean on Monday morning. This is due to the fact that you there is no involvement with the processes at the CSA.”
Furthermore, the information sharing between the OR - OR logistics - CSA - planning seems to suffer under the high level of specialization: “We have different departments now, and each department needs other types of information, and it is for nobody clear which information is needed by which department and which agreements there are made. For instance, with the CSA, we cannot always see what is missing on an instrument set, or why a reparation takes so long, or when an instrument set will be available again. We do not receive a notification about that. And we only get updated once a month.” (Respondent 2). Respondent 3 recognizes this: “The information that is needed in the production process, where your work is based on, there is a lot of noise in that information. And nobody uses the same system” This also holds for the communication between the planning and the OR: “Sometimes certain instrument sets are in reparation. But the planning departments receive no information about that, so they plan too many surgeries for a day, while we do not have that many instruments. There is no communication or link between the planning and the OR about that information right now.” (Respondent 2). Respondent 5 experiences the same problems: “Sometimes an OR assistant is not informed properly, for instance they are not always told to keep the packaging of a product, with as a consequence that we end up with an inventory difference. And the OR assistants just do not see the problem because they are not involved.”

4.2.2.3 Difference between actual and norm value of specialization and differentiation of operational activities

Based on the actual and norm value of specialization and differentiation of operational activities as described above, a difference can be established. First of all, there is a narrow scope of performed operational activities. Respondents have no clear idea of what is happening in other departments. Furthermore, they have also no clear idea of what their actions can have as a consequence further in the process. This causes a lot of rework and frustration. Second, tasks throughout the process are very specialized, even within departments. Third, departments are differentiated into support, preparation and production. This holds not only for departments, but also for activities that are performed in departments. This was also an outcome of the focus group held prior to this research. As can be seen in appendix D, processes are highly specialized (each yellow note represents a step in the process) and employees who participated in the focus group session all concluded that they did not knew what the processes of other departments looked like. It can therefore be stated that there is a high degree of specialization of operational tasks in the whole process as schematically showed in figure 4.2.
It therefore may be concluded that the degree of specialization and differentiation, that is in the case of the OR of the Radboudumc too high, has resulted in a higher need of information, which has resulted in a more complex information provision and thus HIT systems, which enlarges the chance of errors in information in those HIT systems. It may be expected that this becomes visible in one or more of the quality aspects of information that are problematic: the reliability, actuality, completeness and relevance of information. One of the many examples in which this is directly visible is with the information sharing between OR - OR Logistics - CSA - planning. Because they all perform only a tiny part of the process, no one has the complete view over the total process. This has resulted in an own information need for each department, on which their information provision is build. This has resulted in many different HIT systems, in which a lot of errors in information are experienced and of many of the respondents state that they cannot trust each other’s information.

4.2.3 Value of separation of operational and regulatory activities

The degree of separation between operational and regulatory activities has been defined as the degree to which these two activities are separated from each other and are being assigned to different tasks. Combined with the desired relation between the separation of operational and regulatory activities and the quality of information shared in HIT systems, that is for the separation of operational and regulatory activities to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value has been established: The level of separation of operational and regulatory activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems. The level of separation of operational and regulatory activities is low when operational and regulatory activities are integrated into tasks, which entails that one should perform both operational and regulatory activities, one has the ability to solve problems that occur when performing operational activities, one has the ability to change operational activities and one has the ability to make decisions about operational activities.

To discover the value of separation of operational and regulatory activities, it was explained to respondents that this parameter could have, again, two extreme values. A high degree of separation of operational and regulatory activities was explained with an example of a surgeon that needed extra instruments during the surgery.
The surgeon then gives the order to the OR assistant to call the OR logistics to bring those extra instruments. The regulatory activities, the ordering of the extra instruments, are separated from the operational activities, the bringing of the extra instruments. With a low degree of separation of operational and regulatory activities, these two activities are integrated into the same task. The schematic in figure 4.6 was showed to the respondents to help explaining the separation of operational and regulatory activities.

![Figure 4.6 - Separation of operational and regulatory activities](image)

### 4.2.3.1 Measured value of separation of operational and regulatory activities

When asked if respondents perform both operational and regulatory activities, several respondents confirm: “I am not performing operational tasks. That is a very informed decision.” (Respondent 3), “I am not working on the operating floor, so if you describe that as an operational task, I have none. I'm always regulating.” (Respondent 2), “I only occasionally do some operational tasks.” (Respondent 5) and “Actually my only task is regulating the whole day. But that is what makes it challenging.” (Respondent 1). However, the separation of operational and regulatory activities seems to be not for all respondents that clear.

When the same question was asked to respondents who perform operational tasks, they mentioned that they are able to solve problems that occur when performing operational activities. For instance, OR assistants who are involved with the surgery, also have regulating tasks in the WPM: “Some of the OR assistants have regulating tasks. They are involved in the WPM, or they arrange for the borrowed instruments that come from different firms, or they are involved in trainings. So there is and there is not a separation at the same time.” (Respondent 2). Respondent 6 confirms: “Sometimes a regulating task can be performed on low operational level. For instance, if an OR assistant can walk to the sterile warehouse to get a new instrument, then that problem is solved. But sometimes it is a little bit more complicated, and then the operational manager or floor manager has to arrange those things.”.
Respondent 9 has the same vision: “It depends on the size of the problem. For instance, when your Doppler is broken and a new one has to be ordered, then your operational manager has to approve that request because it is a financial matter. Is a display broken at your OR, then you fix that yourself with the IT department, so it depends on the problem if you can fix that problem yourself or that you need someone else to fix that problem.”

Employees of the OR Logistics are also able to solve problems that occur when performing operational activities: “If you have a preparation protocol for a planned surgery, during that surgery all kind of complications can occur. That is not planned but we have people who arrange for that kind of complications.” (Respondent 3). Respondent 5 confirms: “They can always try, up to a certain amount, to fix problems that occur during their operational tasks themselves. There are some things, where it is for instance about certain amounts or approvals, which they have to communicate about, but they can fix a lot of problems that occur themselves.”

Employees at the CSA are less able to solve problems that occur when performing operational activities. However, depending on their function and experience, some people are able to solve problems that occur when performing operational activities: “I think that depends on who you speak at this moment. My students are 100% focussed on operational tasks, and when problems occur during their tasks, they do not have to fix those problems themselves. But as international point of contact here, I think that I’m for 80% busy with arranging things for other persons.” (Respondent 4). Respondent 7 confirms: “In principle employees have to fix their own problems.” Respondent 7 adds to that: “Within the borders, you have to let people fix their own problems.” Respondent 4 adds to that: “We have a few dedicated persons that do only activities related to T-Doc. And there is one colleague responsible for the instrument management. So we have a few full-timers that are dedicated to only regulating tasks.”

Employees at the transportation department are not able to solve problems that occur when performing operational activities: “We have different drivers within one reporting post, with different tasks. And we have one dedicated person that is only doing the ad hoc tasks. And we have one centralist that manages that. He knows which driver is at which department at that moment in time. And if he is called with that a package needs pick up, he decides who is going to get that package. But not the driver himself.” (Respondent 10).
Respondents who perform operational activities seem to have only little ability to make decisions about operational activities: “There are some problems that you as individual cannot directly fix. Those problems need to be transferred to other persons inside the OR who can solve those problems. For instance, when someone needs roentgen, but another OR needs the roentgen at the same time. As an individual participating in one of those OR’s, you won’t solve that problem. That is not a decision to make at the level of an OR assistant, or even a surgeon, but more for a floor manager. You then have to make it work in that way that both OR’s can proceed.” (Respondent 6) Respondent 1 confirms: “We as floor managers have a better insight in if it fits or not. People can think with us and bring solutions to us, but we make the call.”

Furthermore, respondents who perform operational activities also seem to have no ability to change operational activities. When asked if respondents that perform operational activities can decide how they divide these tasks on own insight, respondent 3 states: “They cannot.”. Respondent 2 states that although they, most of the time, can solve the problems, someone else needs to change the process to prevent it from happening: “Most of the time it is fixed for that day, but then I am going to look on the backside of the problem with how it could happen and how we can prevent it from happening in the future.”

Furthermore, the activities to create the conditions for the primary process seem to be separated from the primary process itself: “I’m creating the conditions for the people so that they can perform their activities. You are responsible for things as the occupation and education and that kind of stuff.” (Respondent 3). Respondent 7 confirms: “You arrange that people receive education. That they apply to certain quality aspects and that they get time to apply to those protocols. So facilitating your team, that there are enough people, and that those people have the right materials.” At the level of the surgery, this seems also to be the case: “An operational manager is involved in the specialisms themselves and they take care of their own personnel and do the planning and that kind of stuff. Or if new equipment must be ordered, they have to approve and pay that. So they create the conditions for the surgery process.” (Respondent 9).
4.2.3.2 Disturbances

Some of the respondents experienced problems due to the degree of separation of operational and regulatory activities. For instance, respondent 8 who has the feeling that because of the way in which it is separated now, problems that play cross-departmental are not being handled: “I see that people working on the OR, people from the CSA, people working at the logistics. They are just not able to see the problems because they are too much involved in the daily activities, and the managers are standing too far from the process, so they also do not see the problems.” Furthermore, some respondents have the feeling that there is a lot of information transfer needed to fix some of the problems that are brought to them: “I have the feeling that there is a lot of information sharing between operational and regulatory tasks.” (Respondent 3). Respondent 5 adds to that: “I have the feeling that I need a lot of extra information in order to fix some of the problems that I have to fix.” Respondent 2 encounters problems here, as the information that is available for them is often not enough to fix the problems that are brought to them: “I then have the availability of the same information as that the person has that brought the problem to me. But most of the time this is not enough information to fix the problem.” (Respondent 2).

4.2.3.3 Difference between actual and norm value of separation of operational and regulatory activities

Based on the actual and norm value of separation of operational and regulatory activities as described above, a difference can be established. Although people have the ability to solve problems that occur during their operational activities, there still seem to be a separation between the operational and regulatory activities. First of all, respondents have only little ability to make decisions about operational activities. Second, respondents have no ability to change operational activities. And third, the activities that create the conditions for the primary process are separated from the primary process itself. These tasks are solely performed by people who have dedicated jobs that perform these tasks. It can therefore be stated that there is a limited degree of separation of operational and regulatory activities throughout the whole process as schematically showed in figure 4.2.
It may therefore be concluded that the limited degree of separation between operational and regulatory activities contributes to a higher information need and therefore a more complex information provision and thus HIT systems, in which it is likely that problems are experienced in terms of the reliability, actuality, completeness and relevance of that information that is stored with use of such HIT systems.

**4.2.4 Value of specialization of regulatory activities**

The degree of specialization of regulatory activities has been defined as the degree to which regulatory tasks are divided into smaller sub-tasks. Combined with the desired relation between the specialization of regulatory activities and the quality of information shared in HIT systems, that is for the specialization of regulatory activities to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value has been established: The level of specialization of regulatory activities must be as low as possible so that it does not lead to problems regarding the quality as in the reliability, actuality and completeness of the information that is stored, shared and retrieved in HIT systems. The level of specialization of regulatory activities is low when regulatory activities are grouped into larger tasks, which entails that one should perform a high number of regulatory activities, there is a high average cycle time per regulatory activity and one should have a broad scope of performed regulatory activities.

To discover the value of specialization of regulatory activities, it was explained to respondents that this parameter could have, again, two extreme values. With a high level of specialization of regulatory activities, activities are split up, like for instance the specialization of regulatory tasks of the CSA, OR and OR logistics, who all have their own operational manager. With a low level of specialization of regulatory activities, one person is responsible for multiple departments. To help explain this, the schematic in figure 4.7 was showed to the respondents.

![Figure 4.7 - Specialization of regulatory tasks](image)

**Figure 4.7 - Specialization of regulatory tasks**
4.2.4.1 Measured value of specialization of regulatory activities

When asked to respondents who perform the regulatory activities if they also perform regulatory activities within other departments, all respondents deny: “As a floor manager, I’m not involved with the CSA. If there are problems at the CSA, I think it is up to an operational manager to fix that, not the floor managers.” (Respondent 1), “No, I only regulate the logistics part.” (Respondent 3) and “If we cannot find the items that we have to transfer to the other department, we just call the department. We are not able to fix that. We are just the messenger.” (Respondent 10).

Within the OR Logistics, there also seems to be a specialization of regulatory activities that only belong to the OR Logistics: “I arrange the tasks on the floor and the operational manager arranges the tasks off the floor. That is more administrative, not inside my scope. I am busy with arranging the activities on the floor, outside the scope of the operational manager.” (Respondent 5).

Respondent 5 adds to that: “It is fixed in that way that every member of the team has ownership on a specific topic that belongs to the team. One person arranges that in the warehouse everything is taken care off and that all the locations on the instrument sets match up with the actual locations inside the warehouse. One person is responsible for the preparation protocols and communicates with the OR assistants if something about them is wrong. One person does the barcodes, if one is lost this person has to order a new one. And so on.”

This holds for the CSA too: “I’m responsible for the CSA, so I take care that the people that work at the CSA can do their job. The right support and education and that kind of stuff. I’m more in the regulating side that is outside the job.” (Respondent 7). Respondent 4 adds to that that the regulating activities on the floor are also divided: “Someone is responsible for instrument management, that person is full-time responsible for the ordering of new instruments. T-Doc maintenance, two full-time colleagues are doing only T-Doc maintenance. And we have borrowed instruments, I think 5 persons are responsible for that. Every day someone has that responsibility.”

Within the OR this also seems to be the case: “We have divided these tasks among the operational managers that we have. For instance, one person is busy with the planning, one is busy with education, one is busy with the formation.” (Respondent 2). However, respondent 2 adds to that: “Although we have divided some of the tasks among the operational managers, these tasks are broader than the specialism I regulate for.”
And there are also respondents that have a high number of performed regulatory activities: “I arrange everything that involves technology. So that is a bit of support. I make sure that appointments for the maintenance of equipment have been made, that the maintenance is on time. But also when certain maintenance has not been done or forgotten, I arrange on the spot that it is been done at that moment. Or if some equipment is broken and that it is getting fixed. And that when in that process things are not running smoothly, track down where the issues come from. And also for other parts in the process, for instance the cleaning, or the bed sheets or the OR suits.” (Respondent 8). And respondent 1: “Looking at the day planning, looking at if the personnel planning matches the OR planning. If the knowledge is representative among the personnel that is involved at a certain OR. And if not, shift those people. Or employees that are pregnant, that they are not planned to help with surgeries in which roentgen is involved. Or that not always the same people have to do tasks that require heavy lifting, and in that way relieve people. Or if an OR is finished early, to shift people, that kind of stuff.”

4.2.4.2 Disturbances

Respondent 6 noticed that too many problems are now just thrown to other persons because it is not their problem: “I have the idea that problems are all the time thrown to each other. Your problem, you fix it. I need those instruments now, you just arrange that I get those instruments. And we are not thinking along with each other with this is the problem and how are we going to fix that in the future. I am very unhappy with the almost three separate divisions that we have created now. That should have been much more hand in hand, that one person has leverage in the whole chain and see the problems that occur in there. But right now, I cannot change anything at the CSA, I cannot change anything at the OR Logistics, because it is not mine to regulate.” Respondent 3 agrees: “If you have a process that is so important for the success of the OR, but it has 4 different owners that can all order their own process, that is just weird. That cannot be the case, if you work like that, things go wrong.”

Although the degree of specialization of regulatory tasks is not very high, the respondents experience that they are regulating a lot, and that this frustrates. For instance, respondent 5, who notices the effects of regulating in his production process: “That becomes visible in the process preparation for the next day: the programs come too late, are not written in detail enough, there is no instrument check with as a consequence that the demand is a lot higher than what we can offer
in instruments. It all takes a lot of regulating to correct those things.” Respondent 6 confirms: “People have no problems with preparing the OR’s for the next day. But if you run continuously into problems, and the regulating becomes a heavy lift, then people get frustrated.”

The creating of work arounds is an often mentioned concept among respondents: “It is how we are used to work with a lot of work arounds. We are used to having a lot of instrument sets available, right next to the OR. So that if the surgeon needs extra instruments, they are immediately available. People are very innovative too, that if a certain instrument is not available anymore, they make a combination of 4-5 sets to in the end have the same instruments. But that takes a lot of time, gives a lot of unrest.” (Respondent 2). Respondent 3 agrees: “We do fix it in the end, but it should not happen in this way. I expected an academic hospital to be better.” Respondent 6 agrees as well: “The advantage is that people are very creative in coming up with work arounds, so if something is not working, they get very creative to work around the problem. But you only find out right before the surgery. And that takes a lot of time and irritation to fix that. And if you could improve those processes.” Respondent 7 also agrees: “In the Radboudumc we are good at fixing things for each other. So if something does not go right, you can call me and then I am going to fix it for you. So I don’t think that a lot of OR’s are postponed. But to prevent that from happening, a lot of departments and people are fixing all kind of things, which gives frustration.”

4.2.4.3 Difference between actual and norm value of specialization of regulatory activities

Based on the actual and norm value of specialization of regulatory activities as described above, a difference can be established. Although the actual value of specialization of regulatory activities is not very high within departments, it is clear that the specialization is based on the primary process as stated in figure 4.2. Within departments the specialization of regulatory activities is relatively low, but in between departments, as the specialization of regulatory activities is based on the mapping of operational activities, the specialization of regulatory activities is high. This makes that respondents still perform a small number of regulatory tasks and have a narrow scope of performed regulatory tasks. Furthermore, the operational process is error sensitive, which causes that there is a lot of time wasted on regulatory activities. Although it is unlikely that OR’s are postponed due to a lot of work-arounds, it takes respondents a lot of time to fix these problems, which frustrates as well.
It may therefore be concluded that the limited degree of specialization of regulatory activities contributes to a higher information need and therefore a more complex information provision and thus HIT systems, in which it is likely that problems are experienced in terms of the reliability, actuality, completeness and relevance of that information that is stored with use of such HIT systems.

### 4.2.5 Value of formalization

The degree of formalization has been defined as the degree to which rules and procedures dictate how tasks should be executed. Combined with the desired relation between formalization and the quality of information shared in HIT systems, that is for formalization to not be a cause for experienced problems regarding the quality aspects of the information that is stored, shared and retrieved with use of HIT systems, the norm value has been established: The level of formalization must neither be very low nor very high (so average) so that it does not lead to problems regarding the quality as in the reliability, actuality, completeness and relevance of the information that is stored, shared and retrieved in HIT systems. The level of formalization is average when work processes and decisions are restricted by some rules and procedures, which entails that work processes must be restricted by rules and procedures to some degree that is not highly restricted nor not restricted at all, and that decisions must be restricted by rules and procedures to some degree that is not highly restricted nor not restricted at all.

#### 4.2.5.1 Measured value of formalization

When asked to respondents if they are highly restricted to rules in their work processes, some respondents confirm: “Everything is restricted by protocols. Everything. Has to do with the certifications that we have.” (Respondent 4) and “In the surgery process people are highly restricted in what they have to do and what is needed for that. There are rules that apply for those processes.” (Respondent 9). However, almost no respondents seem to have problems with a high degree of formalization: “That is done consciously because people have to do the same things. It is alright if people think how the outcome of a task can be improved, but in some tasks, that freedom to act on own insight is not there. You just don’t want that. You then get disruptions.” (Respondent 3), “Because you are forced to share information in for instance a briefing, in the end the rules and protocols improve the information that is shared.” (Respondent 6), “I think that the rules clarify the information that is transferred. In EPIC we all note in the same way which type of health is needed
during recovery.” (Respondent 8) and “I think it is good to have a strict regime. Because of that less mistakes are made. For instance, to draw an arrow on the patient’s leg that needs surgery is of key importance.” (Respondent 9)

The respondents do seem to have problems with the degree of restriction between the different departments as in figure 4.2. Multiple respondents think that the work processes that connect the different departments need more restriction: “A lot of the agreements are not clear between departments. Just recently we had a conversation with the CSA about how the process for instrument reparation has been set up. The OR does not know better than that the CSA does all the reparation of instruments, but what is the case? They do not repair all the instruments and they also do not do the maintenance of instruments. So there is also an information issue and a lack of agreements. We just do not have them on paper.” (Respondent 2). Respondent 2 adds to that: “Look, OR assistants know exactly what they have to do during an OR. But that cooperation between departments... And how are our processes defined? We just don’t have that on paper.”

Not only between the CSA and the OR restrictions are missing: “You just notice that there are a lot of sub-departments that do not communicate with each other. So for instance when we agree with the CSA that the sterilization of particular instruments must happen as soon as possible, the CSA is going to do everything in their power to sterilize the instruments as quickly as possible. But for instance, after the sterilization is done we forget to agree upon who notifies the transportation that these instruments have to be brought as soon as possible to the OR department. Those agreements between all departments with for instance instruments that have to be sterilized with urgency are missing.” (Respondent 2). This also holds for agreements made with the transportation itself: “Sometimes the transportation takes a break while they are transferring products from the OR to the CSA. In the system we can see that they are on the way, but it takes them already half an hour. But can you blame them for not knowing?” (Respondent 4).

The respondents are not only experiencing problems within departments regarding the missing of restrictions, also agreements with suppliers seem unknown throughout the organisation: “There also seems to be no understanding of agreements with suppliers. If you make an agreement with a company that a product is delivered within 5 days, then you know that if you plan that patient for Thursday, that you have to order that before Monday, or you cannot have surgery on Thursday. It cannot be that hard to make agreements. Now we have to call the firms all the time to let those
products come with urgency, and that are all calls that could have been prevented.” (Respondent 1). Respondent 3 mentions that also within the purchase department there is no clear understanding of when the OR Logistics have to know when a product is not available anymore: “We are a large organisation and the purchase is making hard agreements about the terms with suppliers. But if suppliers cannot deliver there is no communication from out of the purchase department. Look I don’t have to know if a product cannot be delivered from a supplier for 2 weeks and we have an inventory for 3 weeks. But noticing that and the notification of that observation is just missing. There are no agreements about that.”

There also seem to be no clear definition of the so called ‘spoedlijst’, on which instruments are put that need quick sterilization because they are needed for the next day: “No, we are putting too much instruments on the spoedlijst. We do not have a clear definition of urgency. What is urgency?” (Respondent 7). Respondent 3 agrees: “We have a spoedlijst of 5 pages. Urgency can never be urgency if we have a list of 5 pages with instruments that are all urgency. This list then loses its urgency. What if we call to the CSA and we do have something that is needed right away? The CSA just adds it to the list because they don’t know better.” Respondent 7 adds that this way, the list loses its actuality: “If we have doubts on what can be put on the list and what not, what is then urgency? And are the items on the list still urgency?”

4.2.5.2 Disturbances

Some respondents experience disturbances due to a high degree of formalization: “Sometimes information has to pass multiple persons and by the time that you have passed on your information and that information reaches its goal, that information is not actual anymore. It takes a lot of time, and you would act faster, but you are restricted.” (Respondent 5) and “I think that due to the way we have restricted our processes now a lot of information is needed.” (Respondent 6).

However, most of the respondents experience disturbances due to a low degree of formalization between departments: “It comes down to the collaboration between departments. However, we now have systems that are unclear or systems in which information cannot be found. And every department needs its own information, and it is now not clear what the agreements for that information are. And because of that information is not or not properly shared.” (Respondent 2).
Respondent 8 confirms: “It is very difficult to share information with other departments in the process. Right now, systems are not connected and the processes on which those systems are based are not taught out good enough. Right now, there is not 1 person who is responsible and no clear agreements, and that makes it very hard.” (Respondent 8)

4.2.5.3 Difference between actual and norm value of formalization

Based on the actual and norm value of formalization as described above, a difference can be established. The degree of formalization within the different departments is experienced as high, but not too high. Respondents experiences that they have to perform their operational activities with high restrictions, but that at the same time these restrictions also improve their operational activities. However, respondents experience a degree of formalization between different departments that is too low. First of all, some agreements made by other departments are not clear. Second, some agreements about processes between departments seem to be missing. Both result in information that is not shared or that does not exist.

It may therefore be concluded that the degree of formalization, that is too low in between the different departments, has resulted in an increase in the variability (and thus volume) of the information that is shared, resulting in a higher information need. This has resulted in a more complex information provision with a lower quality of information shared within these systems, resulting in more complex HIT systems, which are more likely to give problems with one or more of the following quality aspects in terms of the actuality, completeness, reliability and relevance of information shared in those systems.
This research was about investigating the following conceptual model:

Figure 1.1 - conceptual model

First of all, the experienced HIT problems have been investigated. Three different HIT systems can be distinguished. Furthermore, there is the possibility that information is shared outside HIT systems. In all four ways of information sharing, problems that relate to the quality of information can be established. However, the number of reported problems regarding the quality of information varies depending on by how many departments the system is used (OVMA is used by only 1 department while T-Doc and EPIC are used by multiple departments). Table 4.6 on the next page represents the findings of the experienced HIT problems at the OR of the Radboudumc as outlined in section 4.1.6.
<table>
<thead>
<tr>
<th></th>
<th>Relevance</th>
<th>Reliability</th>
<th>Actuality</th>
<th>Completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T-Doc</strong></td>
<td>Respondents see more information than they need to know, information is useful for the CSA but not for OR</td>
<td>Respondents cannot act on information, cannot trust information</td>
<td>Respondents report cases of information that is outdated and not actual anymore, in for instance the location of the instrument sets</td>
<td>Respondents report incomplete or missing information, about for instance instruments that are in reparation</td>
</tr>
<tr>
<td></td>
<td>Respondents see information that they not need to know, information is useful for the CSA but not for OR</td>
<td>Respondents experiences errors in information, information shown in the system appears to be wrong</td>
<td>Respondents receive information too late, for instance about missing instruments on an instrument set</td>
<td></td>
</tr>
<tr>
<td><strong>EPIC</strong></td>
<td>Respondents see more information than they need to know, information is not for all users actionable</td>
<td>Respondents cannot always act on information, information changes a lot last minute</td>
<td>Respondents report cases of information that is outdated and not actual anymore, for instance with information about the type of surgery</td>
<td>Respondents report incomplete or missing information, about for instance prothesis that need to be ordered for surgery</td>
</tr>
<tr>
<td></td>
<td>Respondents see information that they not need to know, difficult with the high amount of data to collect the actionable data</td>
<td>Respondents report errors in information, information is updated too late</td>
<td>Respondents report information that reaches them too late, for instance about contact isolation</td>
<td>Respondents report cases of information that is stored at the wrong places, for instance information about the recovery process that can be stored in multiple places</td>
</tr>
<tr>
<td><strong>OVMA</strong></td>
<td>No problems found related to the relevance</td>
<td>Respondents cannot always act on information, cannot always trust information</td>
<td>No problems found related to actuality</td>
<td>No problems found related to completeness</td>
</tr>
<tr>
<td><strong>Information shared outside HIT systems</strong></td>
<td>No problems found related to the relevance</td>
<td>Respondents can interpret information that is shared by phone or by protocol in multiple ways</td>
<td>Respondents report cases of information that is outdated and not actual anymore, for instance about sight shipments or backorders</td>
<td>Respondents report incomplete or missing information, about for instance about how many patients can be planned with the number of instruments that are available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Respondents experiences errors in information, information about stock inventory does not always add up</td>
<td>Respondents report information that reaches them too late, for instance updates about borrowed instruments and protocols</td>
<td></td>
</tr>
</tbody>
</table>
Besides, several respondents report HIT problems that are not related to the quality of information that is stored in HIT systems. Table 4.7 below represents those items.

Table 4.7 - Overview of other findings found on HIT systems (from section 4.1.6)

<table>
<thead>
<tr>
<th>Experienced problems</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing HIT systems</td>
<td>Traceability of instruments, planning of surgeries, prediction of certain variables</td>
</tr>
<tr>
<td>User-friendliness</td>
<td>Working in different applications is frustrating, searching in T-DOC very hard, OVMA is a very slow system in which a lot of actions need to be performed, EPIC very hard to change when process changes</td>
</tr>
<tr>
<td>Integral HIT system</td>
<td>A system that connects the different information demands and thus different HIT systems of other departments to create actionable information for each department</td>
</tr>
</tbody>
</table>

Second, the organisational structure has been investigated. With the use of norm values as described in chapter 2 and the operationalization as described in chapter 3, the actual values of the different parameters have been captured. These findings are outlined in section 4.2.1 to 4.2.5. Based on these findings, the following conclusions for the processes as stated in figure 4.2 can be drawn. First of all, it appears that several parameters show too high values in comparison with their norm values. Especially the degree of functional concentration and specialization and differentiation of operational activities show large differences in comparison with their norm values, forming a production structure that probably will be problematic. Examples are the grouping of the same type of operational activities into functional departments such as the OR, OR Logistics and CSA, and the specialization and differentiation of operational activities throughout the whole process. Although the control structure parameters show not very large differences in comparison with their norm values, it appears that the control structure is indeed designed based on the production structure, becoming visible in the degree of specialization of regulatory activities and formalization, that show no difference in comparison with their norm values when looking at these parameters within departments, but do show large differences in comparison with their norm values when looking at these parameters between departments. Table 4.8 on the next page represents the findings on each parameter.
Third, the relation between the organisational structure and the experienced HIT problems has been investigated. As described in section 2.3, from a theoretical perspective, a HPV structure will affect the information provision in two ways. First, due to high functional concentration and a high degree of differentiation and specialization of operation tasks, the amount of transferred information and the volume of this transferred information will increase, which increases the information need. Besides that, the probability of errors in the information that is shared in such a structure will increase as well. This will make the information provision more complex, resulting in more complex HIT systems that have a higher probability of problems with one or more of the quality aspects of information as mentioned by De Sitter (1994). Second, as the control structure is a derivative of the production structure, and as the production structure is designed as mentioned above, the need for extra regulatory capacity like more planning and coordination to deal with these disturbances also increases. To deal with these disturbances, extra information on top of the already necessary information of that process is needed. This will make the information need, and therefore the information provision, even more complex. Furthermore, the focus shifts from improving the quality of information that is inside HIT systems to making the HIT systems more complex as there

Table 4.8 - Overview of found established differences between norm and actual values of structure parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Actual value relative to norm value</th>
<th>Specification</th>
</tr>
</thead>
</table>
| **Functional concentration**                        | Too high in some of the departments                      | - The departments OR Logistics - Transportation - CSA are organized into functional departments  
- The other departments not but due experiences problems of the departments that are organized into functional departments |
| **Specialization and differentiation of operational activities** | Too high in all departments | - Respondents have a narrow scope of performed operational activities.  
- Tasks throughout the process are very specialized, even within departments.  
- Departments are differentiated into support, preparation and production. |
| **Separation of operational and regulatory activities** | Limited in all departments | - Respondents have only little ability to make decisions about operational activities.  
- Respondents have no ability to change operational activities.  
- Activities that create the conditions for the primary process are separated from the primary process itself. |
| **Specialization of regulatory activities**          | No difference within departments but too high in between departments | - Within the departments not very high, but process is based on the specialization and differentiation of operational tasks, and therefore in between departments still high. This makes that respondents still perform a small number of regulatory tasks and have a narrow scope of performed regulatory tasks.  
- Due to error sensitive production process a lot of regulating needed |
| **Formalization**                                   | No difference within departments but too low in between departments | - Respondents experiences high restrictions of processes within departments, but does not lead to problems  
- Respondents experiences little restrictions and agreements in between departments, does lead to problems |
is more need for coordination and planning. These 2 problems will eventually lead to problems with the HIT systems, which are reflected by the quality aspects of information as stated by De Sitter (1994). One may expect that if there is a HPV structure, the above named problems will occur which will result in complex HIT systems, where problems with one or more of the following quality aspects are likely to occur: the reliability, actuality, completeness and relevance of information. The schematic of section 2.3 (repeated on the next page) summarizes the theoretical effects of the parameters on the quality aspects of information. But does this also translate one on one to the situation at the OR’s of the Radboudumc?
It has been shown that the parameters to describe the actual situation of the OR’s of the Radboudumc have too high values, which indicate that the organisational structure of the OR’s of the Radboudumc may be problematic and thus may be a cause for HIT problems. Furthermore, it has been shown that multiple respondents are indeed experiencing HIT problems, which become visible in one or more of the quality aspects of information. But in this context, can the cause for the experienced HIT problems directly be found in the problematic organisational structure? Based on the interviews and the experienced HIT problems among respondents, it can in two ways.

<table>
<thead>
<tr>
<th>Table 2.2 - High Parameter Values on quality aspects of HIT (from section 2.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A high value leads to the following problems which affect the quality aspects on the right as follows</strong></td>
</tr>
<tr>
<td><strong>Relevance</strong></td>
</tr>
<tr>
<td>Functional concentration</td>
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<tr>
<td>Specialization and differentiation of operational activities</td>
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<tr>
<td>Separation of operational and regulatory activities</td>
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<tr>
<td>Specialization of regulatory activities</td>
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<td>Formalization</td>
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Niek Roos  
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shown that due to a problematic production and control structure, the need for information increases, resulting in a more complex information provision and thus more complex HIT systems which have a higher probability of problems with one or more of the quality aspects of information. Second, it is for two of the parameters specifically shown why these parameters lead towards a higher need for information, resulting in a more complex information provision and thus more complex HIT systems which have a higher probability of problems with one or more of the quality aspects of information.

First of all, when looking to the overall parameter values, the effects of all parameter values on the information need and thus complexity of HIT systems inside the organisation becomes visible. First, due to the production parameter values of functional concentration and specialization and differentiation of operational activities that is for both too high, respondents are experiencing high amounts of information that need to be transferred and high volumes of information that are transferred, which has led to a high information need among respondents. This has made the information provision more complex, resulting in more complex HIT systems that have a higher probability of problems with one or more of the quality aspects of information. This is also reported by the respondents, who encounter problems regarding all four quality aspects with information that is shared both in and outside HIT systems. Although the parameter values of separation of operational and regulatory activities, specialization of regulatory activities and formalization show not that much difference with the norm values, the control structure appears to be a derivative of the production structure. This becomes visible in the degree of specialization of regulatory activities and formalization, that is low within departments (intradepartmental), but, interdepartmental, in between departments (and thus based on the production structure) too high. To deal with the disturbances that exist due to the production structure, respondents need extra regulatory capacity for which they need extra information on top of the already available information, which increases their information need. This makes the information provision more complex, resulting in more complex HIT systems that have a higher probability of problems with one or more of the quality aspects of information. This is also experienced among respondents, who encounter problems regarding all four quality aspects with information that is shared both in and outside HIT systems. It may therefore be assumed that due to the overall problematic HPV structure, the information provision has become more complex, which has resulted in more complex HIT systems in which respondents are experiencing problems concerning all of the four quality aspects of information.
Second, when looking closer into two parameters that have a problematic degree, the direct effects of these parameters on the information need and thus complexity of HIT systems becomes visible. The degree of functional concentration and specialization and differentiation of operational activities show large derivatives with their norm values, having their effects directly on the complexity of the HIT systems and indirectly on the quality of the information that is stored, retrieved and shared with use of these HIT systems. The high degree of functional concentration in the departments OR, OR Logistics and CSA has led to a department-based information need, on which the information provision and thus HIT systems are build. This is no problem when information in such systems is shared only within the department (OVMA), but does lead to problems when this information must be shared with other departments (EPIC & T-DOC). Information stored in those two systems does not match other departments information needs, which as result that these systems need to be expanded in such a way that it does match other departments information needs. This increases the volume of information that is shared, which directly leads to a more complex information provision and thus HIT systems, in which more problems are experienced concerning all four quality aspects of information. The same holds for the high degree of specialization and differentiation of operational activities. Due to a highly specialized process in which also a clear differentiation between preparation, support and production has been made, respondents have to communicate with a lot of different departments and individuals. This increases the amount of information that is transferred, which increases the information need, which directly leads to a more complex information provision and thus HIT systems, in which more problems are experienced concerning all four quality aspects of information. This leads to the following modifications on table 2.2, which are outlined in table 4.9 on the next page.
### Table 4.9 - High Parameter Values on quality aspects of HIT as captured in the Radboudumc

<table>
<thead>
<tr>
<th>Functional concentration</th>
<th>Relevance</th>
<th>Reliability</th>
<th>Completeness</th>
<th>Actuality</th>
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<tbody>
<tr>
<td>Causes variability that increases the volume of transferred information, which causes more errors in the shared information and a higher need of information, which results in a more complex information provision</td>
<td>Indirect Leads to higher information need and thus higher complexity of HIT systems, in which problems with the relevance of information stored in such HIT systems are experienced</td>
<td>Indirect Leads to higher information need and thus higher complexity of HIT systems, in which problems with the reliability of information stored in such HIT systems are experienced</td>
<td>Indirect Leads to higher information need and thus higher complexity of HIT systems, in which problems with the completeness of information stored in such HIT systems are experienced</td>
<td>Indirect Leads to higher information need and thus higher complexity of HIT systems, in which problems with the actuality of information stored in such HIT systems are experienced</td>
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</table>

<table>
<thead>
<tr>
<th>Specialization and differentiation of operational activities</th>
<th>Relevance</th>
<th>Reliability</th>
<th>Completeness</th>
<th>Actuality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes more relations which increases the amount of transferred information, which results in a higher information need, which will result in a more complex information provision</td>
<td>Indirect Leads to higher information need and thus higher complexity of HIT systems, in which problems with the relevance of information stored in such HIT systems are experienced</td>
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<td>Indirect Leads to higher information need and thus higher complexity of HIT systems, in which problems with the actuality of information stored in such HIT systems are experienced</td>
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<table>
<thead>
<tr>
<th>Separation of operational and regulatory activities</th>
<th>Relevance</th>
<th>Reliability</th>
<th>Completeness</th>
<th>Actuality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes more relations which increases the amount of transferred information, which results in a higher information need, which will result in a more complex information provision</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the relevance of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the reliability of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the completeness of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the actuality of information may be experienced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specialization of regulatory activities</th>
<th>Relevance</th>
<th>Reliability</th>
<th>Completeness</th>
<th>Actuality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes more relations which increases the amount of transferred information, which results in a higher information need, which will result in a more complex information provision</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the relevance of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the reliability of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the completeness of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the actuality of information may be experienced</td>
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<table>
<thead>
<tr>
<th>Formalization</th>
<th>Relevance</th>
<th>Reliability</th>
<th>Completeness</th>
<th>Actuality</th>
</tr>
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<tbody>
<tr>
<td>If low variability and thus volume of transferred information increases. If high number of relations and therefore amount of information transferred increases. Either a very low of high value will result in a higher information need, which will result in a more complex information provision.</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the relevance of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the reliability of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the completeness of information may be experienced</td>
<td>Due to overall parameter values, information need and thus complexity of HIT systems increases, in which problems regarding the actuality of information may be experienced</td>
</tr>
</tbody>
</table>

This table is an empirical specification of the theory as stated in table 2.2. For functional concentration and specialization and differentiation of operational activities, direct relations for increasing complexity of HIT systems have been found. For the other parameters, it seems probable that they also might contribute to complexity of HIT systems, but a direct correlation could not be proven in this study.
To conclude, there is indeed for the processes at the OR of the Radboudumc as shown in figure 4.2 case of a high parameter value structure that seems to lead to multiple HIT problems. For two parameters, the functional concentration and specialization and differentiation of operational activities, it is clearly visible that the degree of these two parameters lead to a more complex information provision and thus more complex HIT systems, in which it is likely that the problems that respondents are experiencing concerning all four quality aspects of information stored in these HIT systems is due to the complexity of these systems. It may therefore be expected that the experienced HIT problems at the OR of the Radboudumc are an indirect effect of the complexity of the HIT systems themselves, caused by the higher information need due to the organisational structure. For the other three parameters, further in depth research is needed into the direct relation between these three parameters and the experienced HIT problems is investigated. Furthermore, respondents also experience HIT problems that are not directly linkable to one of the quality aspects of information, but may be caused by the organisational structure as well. To find out, further research also is also needed. The schematic in figure 4.8 on the next page captures the findings of this research.
Figure 4.8 - Schematic overview of findings
Chapter 5 - Conclusion and Discussion

5.1 Conclusion

This research was to provide an answer to the following research question: “Which HIT problems do occur at the operating rooms of the Radboudumc and how are these problems related to the underlying structure and processes of the operating rooms of the Radboudumc?” The conclusion below will answer this question.

Several HIT problems have been identified at the operating rooms of the Radboudumc. Overall, three different systems could be distinguished, in which systems that are used by multiple departments exhibit more problems regarding the information quality of that information that stored, retrieved and shared in those systems than systems that are used by only single departments.

Furthermore, several differences between the norm and actual value of the structure parameters have been identified. The largest differences can be found in the functional concentration and the specialization and differentiation of operational activities. Limited differences can be found in the separation of operational and regulatory activities. For the specialization of regulatory activities and formalization no differences can be established in comparison with their norm values when looking within departments, but large differences can be established in comparison with their norm values when looking in between departments, suggesting that the control structure is indeed a derivative of the production structure, that might be problematic.

Based on the experienced HIT problems and the measured values of the structure parameters that have become manifest in the interviews of respondents, the following conclusion can be drawn. First of all, due to an overall problematic production and control structure, the need for information has increased, which has resulted in a more complex information provision and thus more complex HIT systems. Second, the degree of functional concentration and specialization and differentiation of operational activities leads directly to a higher information need, resulting in a more complex information provision and thus more complex HIT systems. And complex HIT systems consequently result in that they have a higher probability of problems with one or more of the quality aspects of that information that is stored, retrieved and shared in such HIT systems.
It may therefore be expected that the experienced HIT problems at the OR of the Radboudumc are an indirect effect of the complexity of the HIT systems themselves, caused by the higher information need due to the organisational structure.

In general, it can be concluded that ideally, one would design organisational processes based on self-provisioning production flows with teams assigned to these flows who perform all tasks within a production flow. Ideally, these teams also have regulatory capacity to deal with disturbances that occur during the execution of their tasks, which makes them self-provisioned. As the information structure is based on these flows, e.g. the production and control structure, IT systems will also cover the whole production and control structure. However, if deviated from this design principle, as in the case of the OR of the Radboudumc where the structure is functionally designed with use of compartments, the information structure and thus (H)IT systems will follow this design. As the structure is split up into different parts (in this case departments), IT systems will also be designed and optimized for these different parts. This forms no problem when information is only shared within each department, but problems arise when information needs to be shared between departments. And that is exactly what has been established and has become visible in the case of the OR of the Radboudumc.

**5.2 Discussion and implications**

The objective of this research was to explore whether the organisational structure of the OR of the Radboudumc could be the cause for the experienced HIT problems. More specifically, this research aimed at two things: 1) identifying HIT problems of the OR of the Radboudumc and 2) identifying the gap between a theoretical desired organisational structure in which an organisational structure cannot act as a cause for HIT problems and the actual situation of the OR of the Radboudumc.

The next section will elaborate on the practical implications of this research. Furthermore, section 5.2.2 will outline the theoretical implications of this research. At last, section 5.2.3 will outline the limitations of this research and recommendations for future research.
5.2.1 Practical implications

Several gaps have been identified between the actual and desired situation of the OR of the Radboudumc. The first gap is with regard to both the functional concentration, and specialization and differentiation of operational activities. Both parameters have a value that is too high and therefore result in a higher information need than strictly necessary. This leads to a more complex information provision, and therefore more complex HIT systems. Furthermore, the OR of the Radboudumc is confronted with information quality issues in HIT systems that are based on processes that have higher values on both parameters. One can conclude that an unnecessarily high functional concentration, and specialization and differentiation of operational activities has resulted in more complex HIT systems of which more quality problems regarding the information stored in those systems are reported. It would therefore be beneficial for the OR of the Radboudumc to decrease the level of functional concentration, specialization and differentiation of operational activities for processes in which both parameters are high. This will decrease the information need, resulting in less complex HIT systems, resulting in less quality issues with the information stored in those systems.

Second, when looking at the separation of operational and regulatory activities, specialization of regulatory activities and formalization, an overall gap is identified. The overall value of these parameters is too high, resulting again in a higher information need, and thus more complex information provision, and thus more complex HIT systems in which it is likely that more problems regarding the quality of information stored in those systems are experienced. Furthermore, although HIT problems are not directly linkable to one of these parameters, it may be expected that the experienced HIT problems are caused by the overall complexity of the HIT systems. Therefore, it would be advised for the Radboudumc to lower the overall value of all parameters in all processes, resulting in less complex processes with a lower information need and thus reducing the complexity of the HIT systems, with fewer problems experienced with regard to the quality of information stored in those systems.

Third, respondents are also reporting HIT related problems other than the information quality. Some of these problems may also be caused by the organisational structure, such as the missing of certain HIT systems or the missing of an overall HIT system that connects multiple systems. This can be caused by the lack of a joint information need due to a functional or specialized organisational structure.
Other problems relate to the user-friendliness of HIT systems, which are not primarily caused by the organisational structure, but can have serious implications for maintaining the quality of information stored in such systems. After optimising the organisational design, it would be advised for the Radboudumc to also take a closer look to both 1) HIT problems other than the quality of information that occur due to the organisational structure and 2) HIT problems other than the quality of information that do not occur due to the organisational structure but may have impact on the quality of information stored in HIT systems.

5.2.2 Theoretical implications

Although this research was mostly conducted from a practical perspective, still some theoretical implications can be made. First of all, De Sitter (1994) mentions that the parameters that define the control structure are directly linkable towards the information quality. Furthermore, De Sitter (1994) states that the control structure should be a derivative of the production structure. However, this research points out that, as there is indeed a HPV production structure and a control structure that seems to be designed based on the production structure, it is very hard to link individual control parameters to individual information quality aspects. The current HPV production structure in use already drastically increases the information need and thus the complexity of HIT systems, of which it might be expected that more problems are experienced related to the quality of information stored in those systems. This makes it hard to point out individual parameters as a direct cause for problems regarding the reliability, relevance, actuality and completeness of information. A more general approach as provided by Achterbergh & Vriens (2019) who state that high parameter values lead towards an overall higher information need, with as a consequence more complex IT systems in which it might be expected that more problems are experienced regarding the quality of information stored in those systems seems more appropriate.

Furthermore, the theory of De Sitter dates from 1994. Back then, IT systems were solely used to support the production and control structures of organisations. Nowadays, IT systems take a more prominent role in which they can do far more than solely support the production and control structure. For instance, IT systems can be used to perform data analysis and data prediction. As a consequence, the information structure of organisations has a different and more prominent role than previously described by De Sitter in 1994.
Of course, the information structure and all the IT systems that this structure entails should still connect to and support the production and control structure, but it is likely that information need becoming more and more important in the future, and thus obtain a more central role in the design of organisations. However, De Sitter (1994) does claim that the organisational structure can serve as a cause for experienced IT problems. This research confirms those findings. This research confirms that high production parameter values indeed lead towards a higher information need, and thus an increasing information complexity. Although the outcomes of this research are not directly linkable to individual parameters nor individual quality aspects of information, this research confirms the underlying idea of high parameter values leading towards an increased information need and thus a more complex information provision, with a higher chance of a problematic quality of information stored in those systems.

5.2.3 Limitations and recommendations

Several limitations apply to this research. Some of them relate to how this research was performed; other limitations relate to the characteristics of this research. Furthermore, recommendations for future research are given. First of all, this research is mainly based on semi-structured interviews with respondents. Although semi-structured interviews can be a solid data source within a research, the researcher’s presence can also influence the respondent in the answers given (Bleijenbergh, 2013). This is of great importance of this research, where the researcher has worked as an employee in one of the departments that is investigated in this research. Therefore, employees might feel social pressure to give socially desirable answers. Although the researcher acknowledges this fact and did everything in his power to present himself as a neutral investigator, this remains a limitation that should be considered.

Second, is the researcher’s paradigm in this research. As mentioned above, the researcher has worked for six years at the OR of the Radboudumc, and therefore may be influenced in his thinking and/or jumping to conclusions during this research. Again, the researcher did everything to obtain and maintain a neutral position. For instance, during interviews to not steer in certain directions and to repeat and confirm answers of the respondents. Still, the researcher is aware that some could see this as a potential biased research.
Third, the researcher tried to interview as many respondents as possible. However, due to the Covid-19 pandemic, this was not always possible. The researcher tried to interview at least two individuals from every involved department (one operational employee and one manager). Only for the transportation department this was not possible. However, as the outcome of this research shows, the transportation department is only limited involved in the processes of the OR of the Radboudumc. Therefore, it may be assumed that also with only one interview with the transportation department, the overall picture has been captured. Furthermore, the researcher managed to do all interviews face-to-face, so that both verbal and non-verbal communication has been captured.

Fourth, is the generalizability of this research. As this research was performed as a explorative qualitative study, the generalizability of this research is limited (Yin, 2009). However, the research design of this thesis can still be used in other organisations and sectors. To find out if the model as proposed in this research gives the same outcomes in other organisations and sectors, future research is needed.

To conclude, this research was conducted to explore whether the organisational structure of the OR of the Radboudumc could act as a cause for the experienced HIT problems. The findings of this research confirms the underlying theory of general HPV structures as a cause for HIT problems but leaves room for future research in linking individual parameters as a cause for problems regarding individual quality aspects of information.
References


Appendixes

Appendix A - Interview protocol

Beste …,

Bedankt dat u tijd vrij kan maken voor mijn interview. Ik ben Niek Roos, masterstudent Information Sciences aan de Radboudumc Universiteit. Ik doe onderzoek naar hoe de huidige organisatiestructuur van de operatiekamers van het Radboudumc een oorzaak kan zijn voor de informatie problemen die spelen rondom de operatiekamers van het Radboudumc. Met dit onderzoek ga ik eerst in op welke informatie problemen er rondom de operatiekamers spelen en hoe deze naar voren komen in de IT systemen. Vervolgens zal ik de huidige organisatie structuur van de operatiekamers in beeld brengen. Daarna zal ik proberen in kaart te brengen hoe de huidige organisatie structuur tot informatie problemen kan lijden. De hoofdvraag van dit onderzoek is als volgt: “Welke informatie technologie problemen spelen er rondom de operatiekamers van het Radboudumc en hoe zijn deze problemen te relateren aan de onderliggende structuren en processen van de operatiekamers in het Radboudumc?”

Iedereen die geïnterviewd wordt werkt voor een afdeling die betrokken is bij de operatiekamers van het Radboudumc / dan wel onderdeel is van de operatiekamers van het Radboudumc. Door alle betrokkenen te interviewen tracht ik een volledig en correct beeld te schetsen van de huidige situatie omtrent de operatiekamers van het Radboudumc. Deze interviews zijn volledig anoniem en uitspraken die gedaan worden tijdens deze interviews zullen op geen enkele manier te herleiden zijn naar respondenten. Als u wilt stoppen tijdens het interview kunt u dit gewoon aangeven. Graag zou ik dit interview opnemen. Gaat u daarmee akkoord?

Dan zal ik nu beginnen met het interview.

Introductie

- Kunt u kort vertellen wat uw functie is, hoelang u al werkzaam bent in deze functie en welke werkzaamheden u uitvoert rondom de operatie kamers van het Radboudumc?
**HIT problemen**

Ik zal u nu vragen stellen over de huidige IT systemen en mogelijke problemen die hiermee spelen.

- Ervaart u problemen met de huidige IT applicaties? Op welke manier uit zich dat?
- Ervaart u dat er informatie ontbreekt tijdens uw werkzaamheden? In welke applicaties uit zich dat? Kunt u daardoor uw werkzaamheden niet of gedeeltelijk niet uitvoeren?
- Ervaart u problemen met informatie die u te laat bereikt? Bent u daardoor niet of gedeeltelijk niet in staat om uw werkzaamheden uit te voeren? In welke applicaties uit zich dat?
- Heeft u het gevoel dat u veel meer informatie te zien krijgt dan u nodig heeft voor het uitvoeren van uw werkzaamheden? In hoeverre zorgt dat ervoor dat u uw werkzaamheden niet of gedeeltelijk niet uit kunt voeren? In welke applicaties uit zich dat?
- Ervaart u problemen met onjuiste informatie of heeft u het gevoel dat u niet uit kan gaan van de informatie die u getoond wordt? In welke applicaties uit zich dat?
- Ervaart u verder problemen met hoe de applicaties zijn ingericht? Bijvoorbeeld mbt de bruikbaarheid van IT systemen, hoe de IT systemen nu zijn ingericht, de begrijpbaarheid van IT systemen en de beknoptheid van de IT systemen?
- Spelen er nog andere problemen mbt de informatievoorziening rondom de operatiekamers in het Radboudumc, die hierboven niet genoemd zijn?

**Organisatiestructuur**

![Diagram](image-url)
Dan zal ik nu verder ingaan op de organisatie structuur van de operatiekamers in het Radboudumc. In dit onderzoek zien we de operatiekamers als een op zichzelf staand bedrijf, met hieraan verbonden afdelingen, zoals de centrale sterilisatie van instrumenten. Hieronder zijn schematisch de processen op en rondom OK globaal in kaart gebracht.

- Kunt u zich hierin vinden?

De structuur kan gemeten worden in een vijftal categorieën. We zullen nu de eerste behandelen: de functionele concentratie.

**Functionele concentratie**

Dit is de mate waarin verschillende order types gekoppeld zijn aan 1 taak. Om u dit beter uit te kunnen leggen zal ik dit nu schetsen. Het vierkant is de afdeling operatiekamers van het Radboudumc, de pijltjes zijn de verschillende types operaties die op de operatie kamers uitgevoerd worden.

- Met hoeveel verschillende types operaties komt u wekelijks in aanraking tijdens uw werkzaamheden? U kunt hierbij denken aan de verschillende specialismen die operaties uitvoeren, zoals Orthopedie, Neurologie, Heelkunde etc.

Daarnaast wordt vaak ook dezelfde soort werkzaamheden ondergebracht in dezelfde afdelingen. Dan is er bijvoorbeeld 1 afdeling verantwoordelijk voor de spullen die bij alle types operaties gebruikt worden die op de operatiekamers uitgevoerd worden. Een voorbeeld hiervan is de centrale sterilisatie van instrumentarium. Hieronder treft u links een grafische weergave waarbij dezelfde soort werkzaamheden zijn ondergebracht in daarvoor bestemde afdelingen, ten opzichte van rechts waarbij dezelfde soorten werkzaamheden zijn ondergebracht in productie-flows.
- Hoe zien uw werkzaamheden eruit? Zijn die meer ingedeeld zoals links of rechts? En in welk beeld herkent u zich met betrekking tot de operatiekamers in het algemeen?
- Leidt volgens u de huidige indeling zoals hierboven besproken tot problemen met het uitvoeren van uw werkzaamheden?
- Leidt volgens u de huidige indeling zoals hierboven besproken tot problemen met betrekking tot het delen van informatie of de kwaliteit van de gedeelde informatie?

**Specialisatie van operationele taken**

Dan gaan we nu verder op de specialisatie van operationele taken. Dit zijn taken die je uit moet voeren om je werk te kunnen doen. Dit in tegenstelling tot regeltaken, die ervoor dienen om problemen op te lossen die in het operationeel proces worden ervaren. Bij operationele taken kunt u bijvoorbeeld denken aan het uitvoeren van een operatie, en alles wat hierbij komt kijken. Dus ook het plannen van patiënten, steriliseren van instrumenten, etc. Het proces voor de operatiekamers loopt vanaf het moment dat bekend wordt dat iemand geopereerd moet worden tot het moment dat de patiënt de OK verlaat. Een voorbeeld van het specialiseren van operationele taken zijn bijvoorbeeld het splitsen van de planning, de sterilisatie van sets, het verzamelen van instrumenten voor een OK en het uitvoeren van een OK. Wanneer dit allemaal door verschillende mensen gebeurd spreken we van specialisatie van operationele taken.

Kunt u vertellen hoe het hele proces voor OK eruit ziet?
- Welk deel van het proces voert u uit? Kunt u dit in bovenstaande afbeelding arceren?
- In hoeverre voert u taken uit in verschillende onderdelen van het proces dat u hierboven beschreven heeft? Het draait hierbij om taken die wezenlijk verschillen van elkaar.
- Hoe lang bent u gemiddeld bezig met 1 taak?
- Heeft u het gevoel dat verschillende typen activiteiten gescheiden worden? Zoals support, voorbereiding en uitvoering van een taak?
- In hoeverre heeft u het idee dat het makkelijk is om informatie omtrent uw taak met andere betrokkenen in het proces te delen? Gebeurd dit door middel van systemen?
- In hoeverre is deze informatie voor u van voldoende kwaliteit? Kunt u op deze informatie vertrouwen?
Heeft u het gevoel dat u veel informatie nodig heeft om uw taken te kunnen voltooien? En zo ja, beïnvloedt dit de informatie die gedeeld wordt? Hoe uit zich dat?

**Specialisatie van regeltaken**

Dan gaan we nu verder in op de specialisatie van regelgevende taken. Dit zijn taken die verbonden zijn aan operationele taken, waarbij deze problemen op kunnen lossen die in operationele taken worden ervaren. Denk bijvoorbeeld aan het tonen van foutieve informatie, het uitvallen van een systeem of het wegvallen van een patiënt. Mochten er problemen optreden terwijl u bezig bent met het uitvoeren van een operationele taak, dan stelt een regeltaak u in de gelegenheid deze problemen op te lossen of het werk op een andere manier in goede banen te leiden. Een voorbeeld van de specialisatie van deze taken is het ondervinden van de regel taken voor operationele taken (die we eerder hebben behandeld) in verschillende afdelingen. Denk bijvoorbeeld aan de operationeel managers van OK, CSA en transport. Deze mensen regelen alleen hun eigen taken en hebben vaak niet het overzicht over het hele proces. Hieronder is dat grafisch weergegeven.

- Waar liggen uw regelgevende taken ten opzichte van uw operationele taken? Kunt u hiervoor een verhouding geven?
- Hoeveel verschillende regelende taken voert u uit? Wat voor een type taken zijn dit? En voert u hiervan ook de operationele taak uit?
- Zijn veelal de mensen die verantwoordelijk zijn voor de regeltaken ook operationeel betrokken bij het proces?
- Als er problemen optreden, hoe lang bent u dan gemiddeld bezig met het oplossen van deze problemen?
- In hoeverre heeft u het idee dat het makkelijk is om informatie omtrent wat u moet regelen met andere betrokkenen in het proces te delen? Gebeurd dit door middel van systemen?
- In hoeverre is deze informatie voor u van voldoende kwaliteit? Kunt u op deze informatie vertrouwen?
- Heeft u het gevoel dat u veel informatie nodig heeft om te kunnen regelen? En zo ja, beïnvloedt dit de informatie die gedeeld wordt? Hoe uit zich dat?
**Splitsen van operationele en regel taken**

Dan gaan we nu verder met de splitsing van operationele en regel taken. Dit houdt in dat taken in het primaire proces zoals eerder geschetst, gescheiden zijn van de regel taken die problemen moeten oplossen voor dit primaire proces. Een voorbeeld van het splitsen van operationele en regel taken zou kunnen zijn het proces waarbij een chirurg om extra instrumenten vraagt tijdens een OK. De chirurg geeft dit door aan de operatie assistent, die vervolgens de logistiek belt om deze instrumenten te laten brengen. Het regelen gebeurd in dit voorbeeld door de chirurg en de operatie assistent, de logistiek medewerker voert het operationele proces uit. Dit kan grafisch als volgt worden weergeven:

- Merkt u een onderscheid tussen deze twee? Zo ja, worden deze taken naar uw mening vaak door andere personen uitgevoerd?
- Wat gebeurd er als er in uw operationele taken problemen optreden? Kunt u dit dan zelf oplossen of gaat dit via iemand anders?
- In hoeverre mag u zelf problemen oplossen die tijdens uw operationele taken ontstaan?
- In hoeverre kan u uw operationele taken naar eigen inzicht indelen zonder tussenkomst van een leidinggevende?
- In hoeverre zijn de mensen die verantwoordelijk zijn voor de regeltaken ook betrokken bij het primaire proces waarover ze regelen?
- Heeft u het gevoel dat er veel informatie gedeeld moet worden tussen operationele en regel taken? En zo ja, beïnvloedt dit de informatie die gedeeld wordt? Hoe uit zich dat?
- In hoeverre heeft u het idee dat het makkelijk is om informatie tussen operationele en regel taken met andere betrokkenen in het proces te delen? Gebeurd dit door middel van systemen?
- In hoeverre is deze informatie voor u van voldoende kwaliteit? Kunt u op deze informatie vertrouwen?

**Formalisatie**

Tot slot de laatste parameter: formalisatie. Dit is de mate waarin regels en procedures voorschrijven wat er in taken moet gebeuren.

- In hoeverre wordt u vrij gelaten om uw werkzaamheden op uw manier uit te voeren?
- Heeft u het gevoel dat regels en instructies u belemmeren om op eigen inzicht beslissingen te nemen in uw werkzaamheden?
- Hoe ziet u de verhouding tussen het enerzijds volgen van de regels en het anderzijds ad hoc kunnen handelen? Is dit in balans?
- Heeft u het gevoel dat door regels en procedures de informatie die wordt gedeeld verbeterd? Hoe uit zich dat?
- Heeft u het gevoel dat u meer informatie moet delen doordat u regels en procedures moet volgen in uw werkzaamheden? Hoe uit zich dat?

**Structuur als een oorzaak voor HIT problemen**

Dan tot slot nog wat algemene vragen over hoe de huidige organisatie structuur een oorzaak zou kunnen zijn voor informatie problemen die er spelen.

- Heeft u het gevoel dat door de huidige indeling van processen zoals in dit interview naar voren is gekomen er meer informatie moet worden gedeeld om deze processen te kunnen uitvoeren?
- Heeft u het gevoel dat de manier waarop uw taken zijn ingedeeld, dit de kwaliteit van informatie die gedeeld wordt beïnvloedt? U kunt hierbij denken aan informatie die gedeeld wordt die niet relevant of betrouwbaar is, of informatie die incompleet of niet meer actueel is.

Dit was het interview. Zijn er verder nog zaken die u met mij wilt bespreken of zijn er zaken die naar uw inziens nog niet zijn behandeld? Wilt u nog een toevoeging doen?

Dan dank ik uw hartelijk voor uw tijd en moeite. Ik ga dit interview uitwerken. Wilt u het interview dan nog teruglezen en goedkeuren voordat ik het analyseer? Ik benadruk nogmaals dat dit interview anoniem zal zijn en uitspraken die in dit interview gedaan zijn niet terug te herleiden zijn naar u of uw functie. Wenst u mijn hele onderzoek te ontvangen?

Bedankt!
8.2  Structuur van het concern

Het Radboudumc is samen met de Radboud Universiteit onderdeel van de Stichting Katholieke Universiteit (SKU). Het bestuur van de SKU fungeert als toezichthoudend orgaan (Raad van Toezicht) voor het Radboudumc en benoemt de leden van de Raad van Bestuur.

8.2.1  Afdelingen en centra

Het Radboudumc heeft circa vijftig afdelingen die zich richten op de kerntaken patiëntenzorg, onderwijs en onderzoek. De Raad van Bestuur stuurt alle afdelingen rechtstreeks aan en stelt de organisatorische, beleidsmatige en bedrijfseconomische kaders vast. Aan het hoofd van een afdeling staat een afdelingshoofd. Elk afdelingshoofd heeft voor operationele taken een bedrijfsleider aan zijn zijde. Het afdelingshoofd is verantwoordelijk voor het reilen en zeilen van de afdeling wat betreft de kerntaken patiëntenzorg, onderwijs en onderzoek en legt daarover verantwoording af aan de Raad van Bestuur. Iedere vier maanden overlegt de Raad van Bestuur met de afzonderlijke afdelingshoofden.

Naast afdelingen organiseren we ons steeds meer in centra. Het Radboudumc Amalia kinderziekenhuis staat inmiddels als resultaatverantwoordelijke eenheid per 1 januari 2019 en ook het Radboudumc Centrum voor Oncologie, het Radboudumc Hart & Vaatcentrum en het Radboudumc Centrum voor Infectieziekten zijn zich aan het ontwikkelen naar een volgende fase.
CSA

OR Logistics

OR

Transport

Tip:normal eye?
Wear a Spine cap?
CSA

OR
Logistics

OR

Transport

transport

Logistics

CSA

transport

Logistics

CSA

Transport
Appendix E - Codebook

The codebook is visible in a separate document due to anonymity reasons.