From health insurance to patient treatment

supporting the translation of agreements between health insurers and hospitals from yearly numbers to weekly capacity with an IT-tool

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Supporting the translation of agreements between health insurers and hospitals from yearly numbers to weekly capacity with an IT-tool.

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Management summary

In this master thesis, an IT-tool is designed to support the translation of health insurer agreements to a hospital capacity planning. This allows an earlier evaluation of the (mis-)match between health insurer agreements and the actual health care delivery.

Context

Currently, the translation of health insurer agreements to required capacity throughout the year at different departments is limitedly made. By correctly making this translation, hospitals gain insights in whether they are able to deliver the desired care and monitor throughout the year whether they are providing an amount of care that is in line with their budget. Hospitals need support in the translation process and knowledge in order to schedule capacity in line with the expected demand. Moreover, the different hierarchical levels and stakeholders that are involved in the process lack integral and continuous communication. This research addresses the following research question:

"How can the process of translating health insurer agreements to capacity planning be supported with a user-friendly tool and to what requirements must the design of the tool adhere?"

Theoretical background

The relationship under consideration in this research is the organizational relationship between the health insurers and the different hierarchical levels within hospitals. The hospitals are contracted by health insurers, based on negotiations that concern volume, quality and prices. These negotiations are based on individual treatment episodes that are expressed in diagnosis treatment combinations or so-called care products. The contracts and negotiations are agreed upon by the health insurers and the hospital boards. This results in the health insurer agreements that are the base for the remainder of the process investigated in this thesis. Moreover, three main levels of hierarchy in decision-making in hospitals are identified. The strategic level refers to decisions about patient flows and planning of resources at the aggregation level, over a time period of 1 to 5 years. The tactical level concerns planning over a time period of 3 months to a year, using the strategic decisions as guidelines. The operational level looks at the planning over a time period of 3 months to a day and is based on the tactical decisions.

Current process

The results of interviews with four different hospitals are used to identify a common description of the current process of care purchasing and translation to capacity. Two general sub-processes

are identified that are executed simultaneously. The first sub-process is the process of negotiating with the health insurers which results in a lump sum budget of a certain amount of euros. The second sub-process is the process of defining the related production budgets and results in a division of this lump sum over a classification of care products. The hospital must ensure that the lump sum is sufficient for the internal, desired, budget and that the division adds up to the lump sum. This process is followed by the translation of the internal budget to required capacity. No clear structure exists in this process, and the level of translation differs in each hospital.

Desired process

In the desired process, the division over the care products is translated to capacity as well. The capacity managers validate with the relevant department/resource managers whether the budgeted division is feasible within the available capacity. This way, the sales department can use this input in their budget before negotiating a final lump sum budget with the health insurers. The desired process implies that a new way of working must be designed, underlying the tool design.

Tool design

Based on the interviews, several requirements are identified for the tool. The tool must be understandable and usable on different levels, following the end user at each level. Moreover, it must give a good indication of the capacity that is required for the different specifications. The tool must also correctly divide the capacity over the different weeks in a year. Lastly, it must enable the user to interactively change the input to calculate different scenarios, e.g. input from the board of directors. In order to comply with these requirements, a calculation model is made that uses historical capacity profiles to translate an amount of care products to required capacity per resource type. Moreover, three screens are used to visualize the output of the calculation model. The three screens are shown in Figure i.

Implementation

A process model of change is used for the implementation plan. The implementation plan consists of seven core activities that are used to identify issues that the change-leaders must address to achieve the desired outcomes. Given the time, support and type of change, the advised change strategy is a collaborative transformation. Based on the specialists' position in the stakeholder grid, special attention should be given to involving the specialists in the change process and building trust between specialists and the capacity team.

Figure i: Three screens that visualize the calculated results

Discussion

It is concluded that the designed tool is a good start of achieving a more integral manner of managing capacity, supporting the new way of working. Based on the application of the tool on a case study, it is concluded that the tool should be further developed. A first mock-up of this development is already available and indicates the prospects for the results of this thesis.

Preface

Six and a half years of studying are coming to an end as I write this preface. A false start in my bachelor years, because after three years I think I became a different person. The last two and a half years, combining two masters, voluntary projects, work and a social life, have sometimes been a difficult task. Given that happiness does not come from easy work, I can feel an afterglow of satisfaction now that I can mark the end of this difficult task. Before you start reading this thesis, I would like to thank some people that in one way or another helped me with this achievement. First, I want to thank ChipSoft and Yke in particular, for giving me the opportunity to write this thesis at ChipSoft. Being part of the capacity management team, I want to thank them for their support and the de-stressing VrijMiBo's. Moreover, I want to thank Irene, for believing in me and even with a little baby in her belly always making time for discussions and feedback. I think you are a big example for all professors that guide students through their thesis. Then I would like to thank Pascale, for her input and knowledge on the expertise of change management. A big thank you to Papa, Mama and Maaike, for being the best parents and little sister. Thanks to my sweet friends, who did not always like it if I had to cancel another party, but supported me anyway. Needless to say, thank you Daan for your unconditional support and love, always.

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List of abbreviations

Abbreviation	Meaning
DBC	Diagnosis Treatment Combination
EMR	Electronic Medical Record
EHR	Electronic Health Record
OM	Operations Management
OR	Operating Room

List of definitions

Used term	Definition
Care product	A DBC care product includes all activities and operations that must be executed for a certain care trajectory. It includes both the diagnosis and the treatment.
Diagnosis Treatment Combination	The name for a certain treatment in a hospital. It covers all costs of the treatment.
Medical Specialist Company	A cooperation that unites multiple specialists by representing their interests.
Business Units (Dutch: RvE)	Based on specialisms or patient groups, hospitals divide their care delivery in business units. These are responsible for the patients that belong to their specialism or patient group.
Cluster	A cluster is a combination of departments or a combination of specialisms that share the nursing departments in the hospital to gain scale advantages, e.g. number of required beds.

1. Introduction

This chapter starts with a general introduction to the problem investigated in this thesis. The problem identification is extended by describing the relevance and identifying a problem statement. Furthermore, the organizational context of the research is explained. The chapter ends with a reading guide for the remainder of the thesis.

1.1. General introduction

In the last years, several hospitals were forced to refuse patients from specific health insurers (Kuijpens, de Booij, & Nijbroek, 2018). The reason for these refusals was the reaching of the contractual ceiling (Kuijpens et al., 2018). Health insurers and hospitals make yearly agreements on the amount of care that the hospitals are allowed to provide for patients with a specific health insurance. These agreements are based on so-called *diagnose behandel combinaties* which can be freely translated to *diagnosis treatment combinations.* Since an English abbreviation (DTC) could also refer to other meanings and because DBC is a well-known term in the Netherlands, the DBC abbreviation is used throughout the remainder of the thesis. DBCs are used in the Netherlands to indicate the costs of a complete treatment of a specific diagnosis (Wammes, Jeurissen, Westert, & Tanke, n.d.). This covers the outpatient costs, inpatient costs and specialist costs of a treatment and is different per diagnosis (Wammes et al., n.d.).

Health insurers and hospitals agree upon a number of specific care services related to each DBC that the health insurer will pay for. This implies that every patient exceeding this agreed-upon number for a specific DBC, will not be paid for by the health insurer. The amount of care services per DBC is agreed upon contractually for one (or more) future years. Ideally hospitals base their agreements with health insurers on the number of patients that they expect to treat per DBC. By accurately forecasting the number of patients that the hospital expects, the chance of having to refuse patients from specific health insurers is reduced. Moreover, based on this forecast and the agreed-upon numbers the hospital is able to efficiently plan its capacity accordingly.

Currently, the translation of the health insurer agreements to required yearly capacity at different departments is limitedly made. By correctly making this translation, hospitals could gain insights in whether they are able to deliver the desired care and monitor throughout the year whether they are providing the correct amount of care. Moreover, less patients have to be refused and access to health care becomes more equal.

1.2. Relevance

1.2.1. Societal

When hospitals cannot accept patients for specific care services, this results in several consequences. One consequence is that patients that need urgent care have to move to other hospitals, possibly further away and inconvenient to reach as destination. Another consequence is longer waiting times for patients with one health insurer compared with patients with another health insurer. This is in conflict with a universal desire to provide equal access to health care services (Gulliford et al., 2002). Moreover, patients achieve higher health-related quality of life if they have a low waiting time compared to patients with a high waiting time (Tuominenyz et al., 2009). Therefore, the abovementioned consequences are unwanted and preferably prevented.

The agreements between hospitals and health insurers exert pressure on hospital employees. In the current situation, hospitals experience difficulties in monitoring the agreed-upon numbers throughout the year. They have little insights in whether they have treated too little or too much patient volume. Often, their performance in month 1 is known only in month 6 or even later. When too little patient volume has been treated in the first half year, pressure on employees increases in the second half year to catch up with the lacking treatment numbers. When too much patient volume has been treated in the first half year, pressure on employees increases in the second half year to treat patients with less resources. Another consequence of too much patient volume that has been treated in the first half year is a possible underutilization of employees in the second half year. This observation in combination with the current enormous shortage of health care workers cannot be afforded.

The abovementioned problems can be solved by identifying and supporting the process of translating health insurer agreements to hospital capacity. Planning hospital capacity in line with health insurer agreements results in equal access to care and no patients being sent to another hospital. Moreover, hospital employees do not experience high(-er) work pressure or feel underutilized. Therefore, it is societally relevant to further investigate the translation process described earlier.

1.2.2. Academic

Decisions on health care services planning and control are made at different hierarchical levels (Hulshof, Kortbeek, Boucherie, Hans, & Bakker, 2012; J. Vissers & Beech, 2005). In order to optimize utilization rates and reduce waiting time, it is important that the decisions made about

capacity planning balance demand with capacity. The concept capacity management refers to finding a balance between utilization of capacity and accessibility of care. Capacity management can be executed at each hierarchical decision-level, using input from the parent layer. Many researches about capacity management exist, investigating how demand and capacity can be matched. This research often simulates the balance between demand and capacity for departments or units of a hospital (Joustra, Kolfin, van Dijk, Koning, & Bakker, 2012). More research on capacity management focusses on waiting time reduction, describing methods to achieve this at existing hospital units (Nguyen, Sivakumar, & Graves, 2015; Rechel, Wright, Barlow, & McKee, 2010; Vissers, 1998). These researches focus on one hierarchical level, while it is important to oversee all hierarchical levels and their required and generated input.

The best-known studies on hierarchical decision-making levels in the health care sector, broadly distinguish a strategic level, a tactical level and an operational level (Hulshof et al., 2012; Vissers & Beech, 2005). Each level generating input for the subsequent levels. However, little theory is identified about *how* the input can be used for the subsequent level. In order to meet the growing and changing demand for care in the Netherlands, hospitals must focus on their strategy (Meijerink et al., 2008). Therefore, the strategic level of decision-making, planning and controlling is an important one for hospitals. In order to make the best decisions, on both strategic level and subsequent levels, it is important to correctly use and transform input at each level.

Concluding, two gaps of knowledge are identified that make this research academically relevant. The first gap concerns capacity management on different hierarchical levels. A lack of research and case studies on the cohesion of capacity management at all decision-making levels exists. The second gap concerns the need for research about using and transforming the input that is generated at each hierarchical level.

1.3. Problem identification

Since a literature gap exists on relating health insurer agreements to capacity planning and the lack of this translation has negative consequences for hospitals and patients, this research should be executed. Based on both the societal relevance and academic relevance of investigating the translation process of health insurer agreements to capacity planning, the following problem statement is identified:

"Hospitals have little insights in their care delivery and whether this matches with the agreements made with health insurers due to a lack of integral capacity management. This results in an inequality in access for patients of different health insurers and an increasing working pressure for hospital employees."

1.4. Organizational context

The organization providing the research problem and involved in this research is ChipSoft. ChipSoft is a Dutch software organization that provides smart IT solutions for the health care sector. The organization is market leader in the Netherlands in supplying Electronic Medical Record (EMR)/Electronic Health Record (EHR) software. ChipSoft delivers their IT solutions to over 85 health care organizations, ranging from independent clinics to academic hospitals. ChipSoft is currently operating at the highest level of modern and sophisticated EMR/HER solutions. The main product ChipSoft delivers is called HiX (Healthcare Information eXchange), which is an all-encompassing electronic patient dossier.

Because of the rise of using capacity management concepts in the health care sector and the challenges that their clients are facing, ChipSoft sees opportunities to use the concept of capacity management in their software solutions. By implementing methods from the industrial engineering field, ChipSoft aims to increase efficiency of hospital processes with the support of their solutions. This is in line with literature stating that industrial engineering principles can be used to e.g. reduce waiting times in hospitals (Murray & Berwick, 2003).

1.5. Reading guide

The remainder of this research report elaborates on the problem described above and works towards a solution. This is followed by Chapter 2, explaining the scope, research question and methodology of the research. The research approach is followed by a theoretical framework in Chapter 3. This chapter provides the key concepts and developments related to the problem, identifying the current process according to the literature. Thereafter, the process identified in Chapter 3 is extended in Chapter 4. It describes the analysis and diagnosis of the problem on the basis of conducted interviews, representing the process according the practice in hospitals. Based on the analysis and diagnosis, a solution design is explained in Chapter 5. The solution design is applied to a case study and evaluated in Chapter 6. In Chapter 7 an advise is given about how to implement the designed solution. The research concludes with a discussion of the research, limitations and recommendations for future research in the final chapter.

2. Research approach

In this chapter the research approach is explained, which is based on the problem-solving cycle. First the objective and scope of the research and the relating research question are introduced. For each phase of the cycle the executed steps are explained, as well as the sub-questions that are answered within each phase.

2.1. Research objective

A research objective is formulated, based on the problem analysis and problem definition (see Chapter 1). The solution to the problem should be based on health insurer agreements, or another form of budgeting used in hospitals, and it must be able to monitor the budgeted and actual health care service delivery. Moreover, in order to solve the aforementioned problem, the goal is to design a tool that supports the decision-makers in scheduling capacity. The concluding objective of this research therefore is as follows:

"The objective of the research is to develop a supportive tool for the translation of health insurer agreements to a hospital capacity planning that allows earlier evaluation of the (mis-)match between health insurer agreements and actual health care delivery."

2.2. Research scope

In order to achieve the research objective within the given time period, a scope is defined for the research. Different levels of decision-making are involved with describing the current and desired process of care purchasing and the translation of agreements to capacity. Due to the nature of planning and control decision-making, decisions become more separated as time progresses and more information is available (Zijm, 2000). This results in a taxonomy of decision-making levels, as illustrated in Figure 1. The strategic level is concerned with defining and translating the strategy of the organization over a long planning horizon (Bowen et al., 2010; Hulshof et al., 2012). The tactical level is concerned with operations of the health care delivery process, addressing planning and decision-making for a medium time horizon of months or a year (Hulshof et al., 2012). The operational level designs plans for patients and resources, focusing on allocating resources to individual patients by planning for a short time period of days (Bowen et al., 2010; Hulshof et al., 2012). The operational level planning can be divided into an offline operational planning and an online operational planning (Hulshof et al., 2012). The offline operational planning refers to the planning that was made in advance, whereas the online operational planning focusses on monitoring and reacting to unforeseen events (Hulshof et al., 2012).

Figure 1: Hierarchical planning and decision-making levels

Besides the different planning and decision-making levels, several stakeholders are involved in the process from health insurer agreements to operational planning. Since the focus of this research is on the translation of the agreements to the subsequent planning levels, the process of achieving agreements between all stakeholders is out of scope. In the process of achieving an agreement with the health insurer, stakeholders are iteratively discussing and investigating what the agreement should look like. The research scope therefore begins at the agreements or the budget, which is input for the subsequent level and continuous until the operational planning level. Figure 2 gives an overview of this process, the relating stakeholders and the scope of this research.

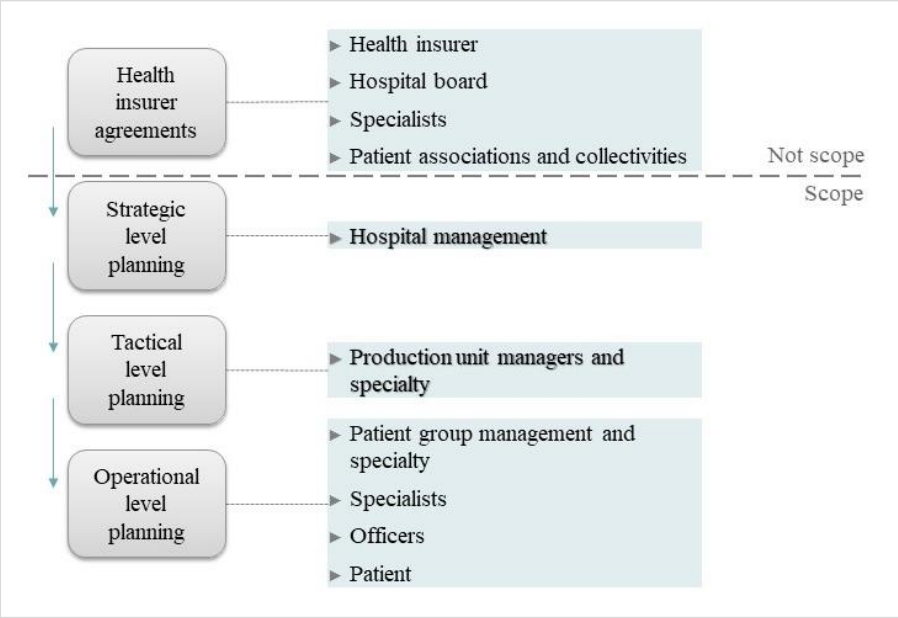

Figure 2: Scope of decision-making levels and stakeholders

2.3. Research question

Based on the problem statement, research objective and the defined scope, the following research question is formulated to be answered with this research:

"How can the process of translating health insurer agreements to capacity planning be supported with a user-friendly tool and to what requirements must the design of this tool adhere?"

2.4. Research methodology

In order to answer the research question, the research follows the problem-solving cycle, also referred to as the regulative cycle. The problem-solving cycle is a framework which helps finding solutions for operational problems and is shown in Figure 3. In each phase of the cycle several sub-questions are answered that will together form the answer to the research question.

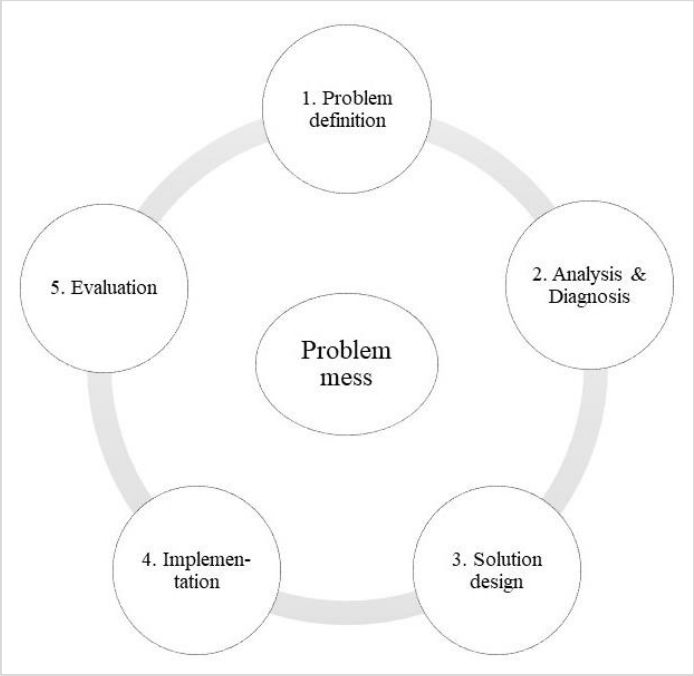

Figure 3: The problem-solving cycle

2.4.1. Phase 1: problem definition

The problem-definition phase is driven by an organization that recognizes a business problem (Aken, Berends, & Bij, 2012). The problem results from a problem mess that consists of multiple related issues (Aken et al., 2012). The problem definition is driven by the organizational context of ChipSoft. Based on the introduction with the described societal and academic relevance, the problem is identified and defined.

2.4.2. Phase 2: analysis and diagnosis

In the analysis and diagnosis phase, specific knowledge on the context and the nature of the problem is gathered (Aken et al., 2012). Therefore, the current process of translating health insurer agreements to capacity planning is mapped. This is done by designing a theoretical framework and by interviewing both the capacity managers and sales managers of several hospitals.

The theoretical framework is based on a separate literature study. The methods that are used in this literature study are less relevant for this research and are therefore added in Appendix A. A summary of the literature study is used as a base for the theoretical framework which is extended as the research is performed. The theoretical framework is described in Chapter 3.

For the interviews, qualitative, semi-structured interviews are held with 4 different hospitals. Specific questions are prepared, regarding the identification of required resources and influencing factors. However, the interviewee will be given space and time to elaborate on his or her thoughts as well. The interviewees are mainly sales managers and capacity managers of several hospitals, because they have a broad overview of the process under consideration. This type of interview is chosen because it is proven to be a useful technique when issues concerning an existing situation must be identified (Blumberg, Cooper, & Schindler, 2011).

Concluding, the results of the theoretical framework that concern the current and desired process are compared with the results of the interviews that concern the current and desired process. Based on this comparison, it can be evaluated what the gap is between the current and the desired process and how a supportive IT tool can support to fill this gap. The interview procedure is explained in Chapter 4, together with the results and the comparison with the theoretical framework. After Chapter 3 and 4, the analysis and diagnosis phase is finalized and the following sub-questions are answered after this phase:

1. *What does the current process from health insurer agreements to capacity planning look like, according to the literature and according to the hospitals?*
2. *What are the current problems and consequences related to the planning of capacity, according to the literature and according to the hospitals?*
3. *What are bottlenecks that are currently counterworking a successful translation process, according to the literature and according to the hospitals?*
4. *What are requirements for the design of an IT-tool, supporting the translation of production agreements to required capacity?*

2.4.3. Phase 3: solution design

During the solution design phase, a potential solution for the identified problem is developed (Aken et al., 2012). The solution consists of a conceptual model and a mathematical model. Based on the gap between the current process and the desired process, steps towards a solution are investigated. Moreover, based on the results of the interview, requirements for the solution design are identified. The conceptual model is then used as a base for the mathematical model. Figure 4 illustrates what input is used by the model, which parameters are set and dynamically used by the model, resulting in specific output. This set-up for a conceptual model is based on a framework used to model the capacity management of nursing staff (Elkhuizen, Bor, Smeenk, Klazinga, & Bakker, 2007). Both the conceptual and mathematical model for the solution design are explained in Chapter 5. After this chapter the following sub-questions are answered:

5. *How can the health insurer agreements at strategic level be translated to a tactical level?*
6. *Which factors influence the yearly required capacity for hospitals?*
7. *What should the solution design look like to achieve a translation between the strategic and tactical level with the design aimed at the end-users?*

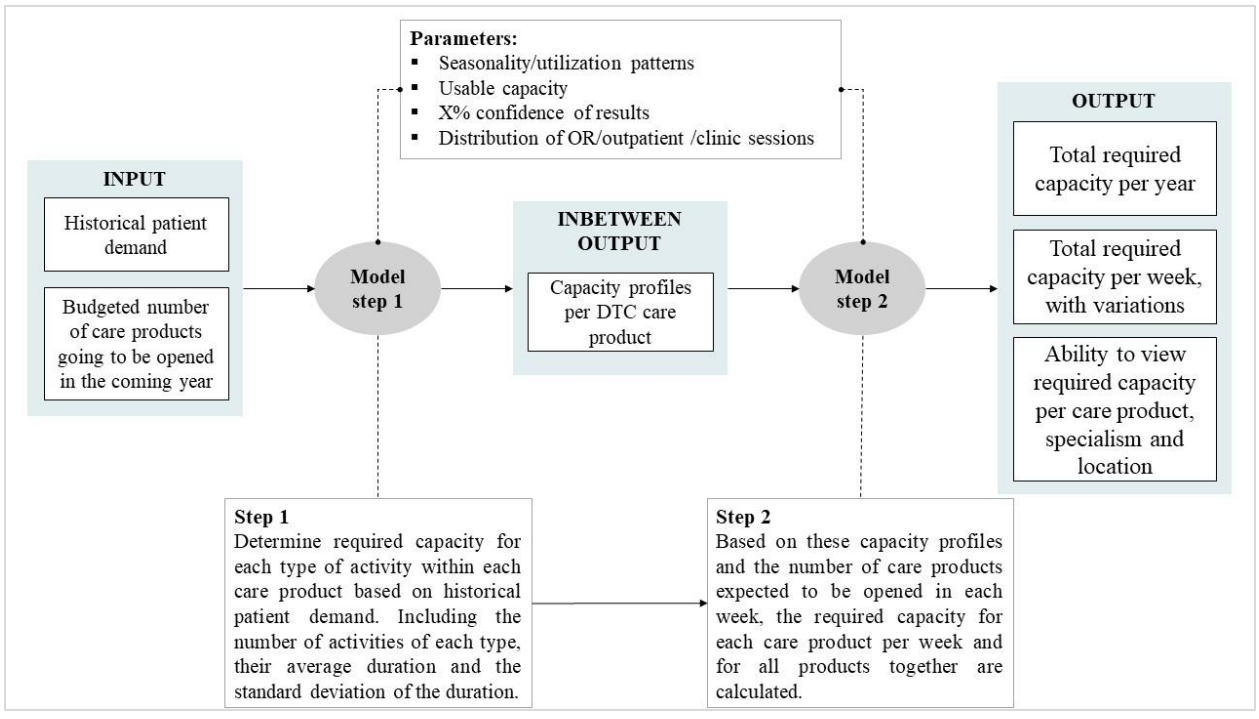

Figure 4: Conceptual framework for solution design model

2.4.4. Phase 4: application

In the evaluation phase it is tested whether the designed solution solves the research problem. The goal of the solution is not only to work with correct calculations, but also to motivate a process towards an integral manner of capacity management. The solution design and the implementation plan described in Chapters 5 and 7 are the first improvements towards this improved integral process. To validate the qualitative side of the model, the model was applied to a case study, which is described in Chapter 6. Throughout the application, it is evaluated whether the model matches the process. This chapter also includes a validation of the calculation model by using the model to determine the required capacity in 2017. The required capacity is then compared with the realized production in 2017 to ensure the quality of the mathematical model. After the evaluation phase the following sub-question is answered:

8. *Does the model follow and support the actual process, based on the case study results?*

2.4.5. Phase 5: implementation plan

Originally, the goal of the implementation phase is to successfully implement the solution design in the context of the research. Within the given time frame of the research it is not possible to implement the solution design. Therefore, the implementation phase will focus on replacing the current process with the process that is required for the solution design. This phase is based on the bottlenecks that are identified in the interviews of Chapter 4 and knowledge about implementation processes and change management. Chapter 7 therefore starts with a small investigation for additional literature, explaining why a structured implementation process is required and identifying steps to be taken in order to achieve this. The goal of this phase is to design a structured implementation process that incorporates the bottlenecks identified in the analysis phase with the aim of successfully implementing the solution design to solve the research problem described. After the implementation phase the following sub-question is answered:

9. *How can the solution be implemented in the current process to ensure a successful solution for the identified problem?*

3. Theoretical framework

This chapter provides a summary of the executed review of literature about health insurer agreements and hospital capacity management (Knoben, 2018). It forms the base for designing the current process from translating health insurer agreements to hospital capacity. First, the heart of the Dutch health care sector is explained, followed by the planning and control hierarchy that is the foundation for the capacity planning process. After reading this chapter, the following sub-questions are (partly) answered:

1. What does the current process from health insurer agreements to capacity planning look like?

2. What are the current problems and consequences related to the planning of capacity?

3. What are bottlenecks that are currently counterworking a successful translation process?

3.1. The Dutch health care sector

The Dutch health care sector is dominated by a tradition of self-regulation, private provision of services and financing via a system of social health insurance (Kroneman et al., 2016). Since the health care sector's reform in 2006, the hearth of the health care system consists of three markets: delivery of care, purchasing of care and insurance of care (Kroneman et al., 2016). In these three markets, different market players operate: health insurers, insured people and health care providers (Kroneman et al., 2016). These different markets and market players are illustrated in Figure 5.

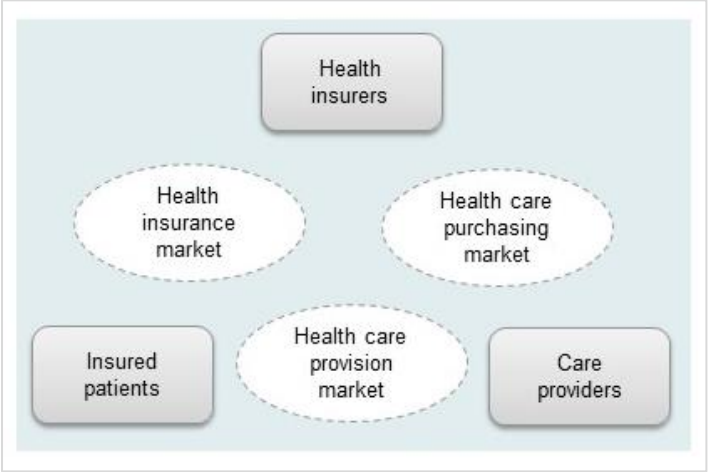

Figure 5: The heart of the health care system

The relationship under consideration in this research is the organizational relationship between the health insurers and the health care providers (Kroneman et al., 2016). Health care providers are contracted by health insurers through negotiating services with providers based on volume, quality and prices (Kroneman et al., 2016). The negotiations for individual treatments are based on individual treatment episodes that are expressed in Diagnosis Treatment Combinations

(DBCs), hereafter referred to as *care products* (Kroneman et al., 2016). The contracts and negotiations are agreed on by health insurers and the hospital boards. This results in the health insurer agreements that are the base for the remainder of the process investigated in this research.

Two evident decision makers in the process of purchasing care are therefore the health insurers and hospital boards (Heida, 2008). Moreover, the specialists must negotiate with hospitals on the prices of the care that the specialists provide (Kroneman et al., 2016). Therefore, the third group of decision makers consists of the specialists that are working in the hospital (Heida, 2008). Currently, patient associations and collectivities are not involved enough in the care purchasing process but are identified as relevant stakeholders for the future (Heida, 2008). This results in the illustration of Figure 6 . The yellow circle implies that in the current process the agreements mainly result from the negotiation between health insurers and care providers.

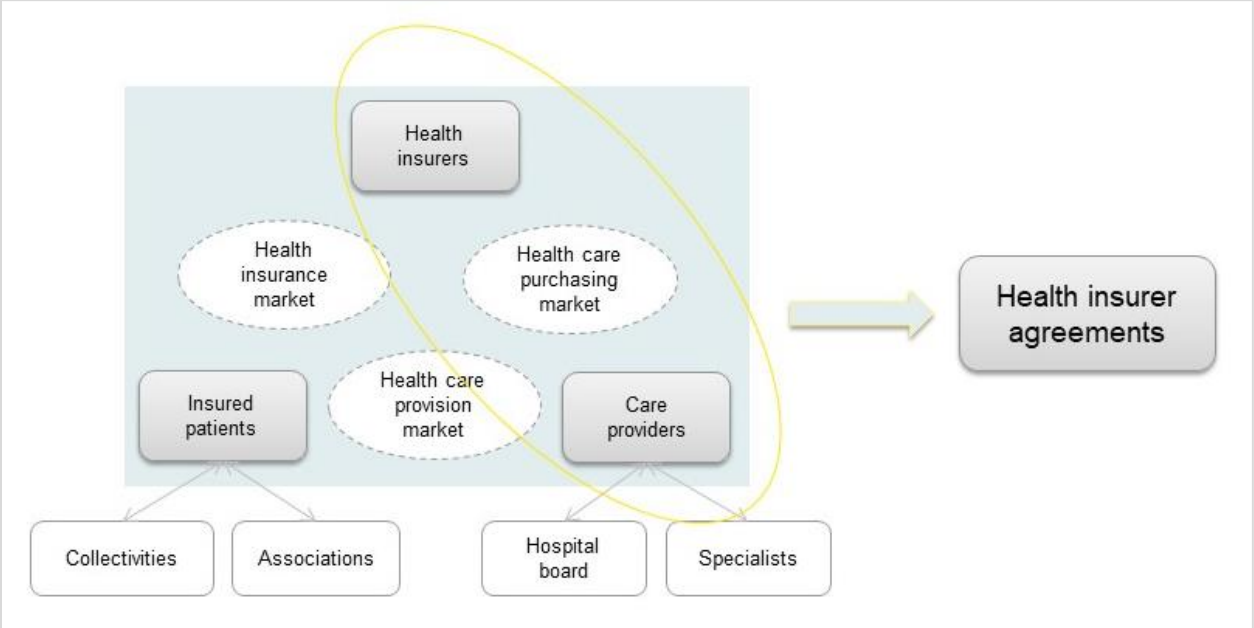

Figure 6: From health care market to agreements

3.2. Planning and control hierarchy

Based on known or forecasted demand, capacity can be planned at different decision-making levels (Hulshof et al., 2012). Due to the nature of planning and control decision-making, these decisions become more separated as time progresses and as more information is available (Zijm, 2000). This results in a decision-making hierarchy that incorporates different levels and relating activities, stakeholders and required input (Hulshof et al., 2012).

3.2.1. The strategic level

The strategic level refers to structural decision-making and planning at the aggregation level of the organization (Hulshof et al., 2012). It is concerned with both the patient flows and resources over a time period of 1 to 5 years. The planning at this level is based on the range of services that the hospital offers, the long-term resource requirements, the shared resources, the (forecasted) patient volumes, the desired service and efficiency levels, the capacity that is annually available per specialty and the regulations about resource use (Vissers & Beech, 2005). The strategic level can be considered as capacity dimensioning which involves decision making over a long planning horizon and based on highly aggregated information (Leeftink, Bikker, Vliegen, & Boucherie, 2018). The strategic decisions that are made are often seen as inputs and assumed to be set in advance (Ahmadi-Javid, Jalali, & Klassen, 2017). The decisions about the strategic planning are made by the hospital management (Vissers & Beech, 2005). They are concerned with defining and translating the strategy of the organization (Hulshof et al., 2012).

3.2.2. The tactical level

Next, the tactical level uses the strategic decisions as guidelines for planning decisions (Hulshof et al., 2012). It refers to planning at an aggregate level with a medium time horizon of 3 months to 1 year (Vissers & Beech, 2005). The tactical plans allocate available resources to different care processes in a way that aims to achieve the objectives of the tactical level (Hulshof et al., 2013). These objectives are to achieve equitable access for patients, to meet production targets and to use resources efficiently (Hulshof et al., 2013). Moreover the selection of patients to be served that are at a particular point in their care process is determined (Hulshof et al., 2013). The decisions about the planning at tactical level are made by the production unit managers and the speciality and the decisions concern how resources are allocated to specialties and patient groups (Hulshof et al., 2013; Vissers, Bertrand, & De Vries, 2001).

3.2.3. The operational level

The operational level then uses the results of the tactical decisions as input for their planning (Hulshof et al., 2012). This level is concerned with patient flows and resources over a time period of 3 months to 1 day (Hulshof et al., 2012). At the operational level, an online and an offline planning level can be distinguished (Hulshof et al., 2012). The online operational planning is concerned with monitoring the process and reacting to unforeseen events (Hulshof et al., 2012). On the other hand, the offline operational planning refers to the planning that was made in advance

(Hulshof et al., 2012). The operational planning is based on service requirements, planning guidelines, schedules of individual patients and regulations of using resources (Hulshof et al., 2012). Decisions that are related with this level concern the specialist-time and treatment moments at patient group or even individual patient level (Hulshof et al., 2012). These decisions are generally made by the patient group management, the specialty, the specialists, the officers and the patient (Hulshof et al., 2013).

3.3. Resources and capacity

The decisions that are made at each level are concerned with, amongst others, resources and capacity. Resources are input for an activity and are used for the transformation into outputs, but are not consumed and can therefore be used again for following activities (Vissers & Beech, 2005). Six different types of health care services can be distinguished, each resulting in specific resource capacity planning and decisions (Hulshof et al., 2012). These are ambulatory care services, emergency care services, surgical care services, inpatient care services, home care services and residential care services (Hulshof et al., 2012). For this research three of these care service types are relevant, since the research focuses on the outpatient clinic (ambulatory care), the inpatient clinic and the operating theatre.

Ambulatory care services provide care to patients without offering a room, a bed and board (Hulshof et al., 2012). For these types of services, common resources are consultation rooms, staff consultation time capacity, equipment and waiting rooms (Hulshof et al., 2012). Surgical care services provide correction, repair and diagnosis by the use of operative procedures (Hulshof et al., 2012). Operating rooms, operating time capacity, pre-surgical rooms, recovery wards, ambulatory surgical wards, equipment and staff are resources that are required for providing surgeries (Hulshof et al., 2012). Inpatient care services are provided to patients who receive treatment or surgery and stay for a minimum of one night (Hulshof et al., 2012). Nowadays, more treatments are given in day-treatment, which implies that inpatient care services are relevant for these patients as well. Resources for inpatient care services consists of beds, equipment and staff (Hulshof et al., 2012).

In almost all health care systems, the throughput is limited or constrained by a so-called bottleneck (Murray & Berwick, 2003). A bottleneck resource determines how much can be produced or how much service can be delivered because it is the most scarce resource (Vissers & Beech, 2005). A common bottleneck resource in hospitals is the time of clinicians, which is almost

always the most scarce resource (Murray & Berwick, 2003). For this research, the specialist time is the leading resource, implying that the other required resources follow and are aligned with the specialist time capacity. For the capacity budget that is going to be determined in this research, the resources that are relevant are as follows. For the outpatient clinic, the specialist time (in hours) is used as resource. The specialist time (in hours) is used as resource as well for the operating theatre. For the inpatient clinic the specialist time is not leading anymore, because at this point in the patient treatment it is most important that a bed is available and manned. Therefore the capacity budget for the inpatient clinic is expressed in number of required beds.

3.4. Literature gap and conclusion

It is concluded from the theoretical framework, that in the current process little translation is made from the health insurer agreements to capacity planning. To (partly) answer the first research question, health insurer agreements are made in the health care market without calculating the consequences for capacity and incorporating the available capacity. Moreover, the capacity planning is currently not based on any production agreements or budgets. It are two stand-alone concepts that have a role in hospitals.

Based on the above explanation of the planning process, it is desirable to have the different hierarchical levels of planning and decision-making and the process of achieving health insurer agreements continuously feeding forward and backward (Vissers & Beech, 2005). To (partly) answer the second research question, it is determined that decisions at each level are separately modelled and investigated (Ahmadi-Javid et al., 2017). This, while the different planning levels highly depend on each other (Ahmadi-Javid et al., 2017). Concluding, it is desired to make a translation between each of the levels aforementioned. This way each level should communicate with one another and working in silo's is replaced by an integral manner of capacity management.

The main answer to the third research question, based on the theoretical framework, is the gap that exists in literature about translating and communicating between each level. This research aims to start filling this gap in literature. In order to design a solution, the next chapter will validate and extend the abovementioned process and hierarchy with knowledge from the work floor at several hospitals in the Netherlands. Figure 7 illustrates that the focus of this research lies with the translation part of the strategic and tactical level and on how to implement this translation back to the work floor. The entire triangle represents the concept of integral capacity management whereas the little strategic triangle represents the translation of strategic agreements to the tactical level.

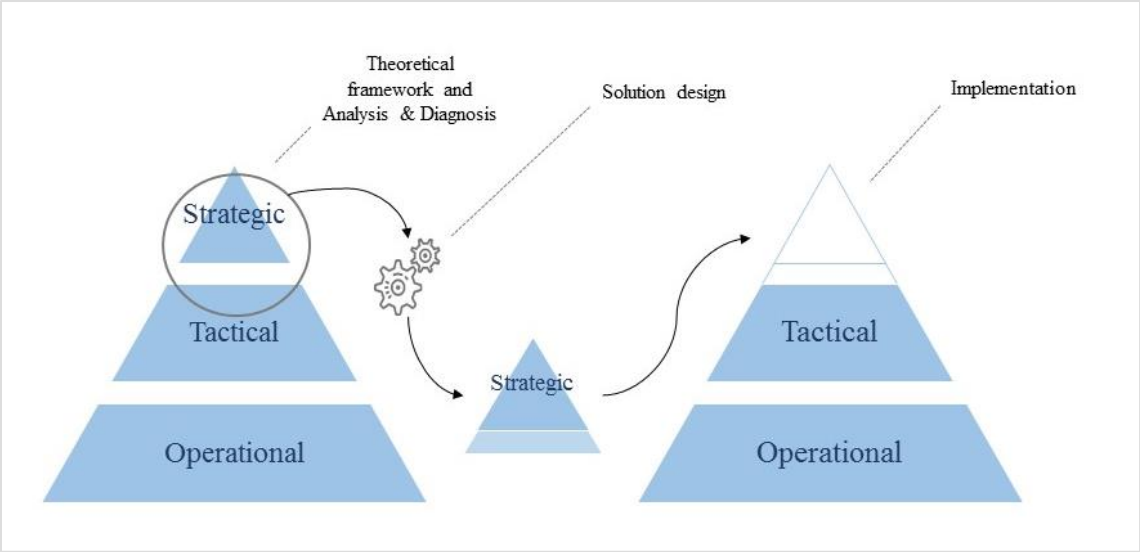

Figure 7: Illustration of literature gap and conclusion

4. Analysis and diagnosis

The goal of the analysis and diagnosis phase is to identify the current process of translating health insurer agreements to capacity planning and to identify (high-level) design requirements for the solution. By investigating relating literature and conducting interviews, a conceptual model is designed that explains what steps are required to improve the current process. The relating literature was explained in Chapter 3, whereas this chapter will focus on the results of the interviews and concludes with similarities and differences with the literature. After reading this chapter, the following sub-questions are (partly) answered:

1. What does the current process from health insurer agreements to capacity planning look like?

2. What are the current problems and consequences related to the planning of capacity?

3. What are bottlenecks that are currently counterworking a successful translation process?

4. What are requirements for the design of an IT-tool, supporting the translation of production agreements to required capacity?

4.1. Interview set-up

Four different hospitals in the Netherlands participated in the interviews. Each interview was attended by the interviewer, the team manager Capacity Management of ChipSoft, a representative of the Sales department of the hospital and a representative of the Capacity Management department of the hospital. As explained in the Methodology description, semi-structured interviews are held, following some prepared questions but giving the interviewee space and time to elaborate on the topics (Blumberg et al., 2011). The indicative question list was reviewed and approved by the Capacity Management team manager of ChipSoft and can be found in Appendix B. Some examples of the interview questions are as follows:

"How does the hospital prepare for making the production agreements?"

"What input is used for a strategic planning?"

"When and how often is the budgeted capacity compared with the realization?"

Moreover, Table 1 gives an indication of the different sizes and types of the interviewed hospitals and the function descriptions of the interviewees. The results of the interview are validated through a light-validation of the process descriptions. This is done by discussing the results with the case study hospital, which is explained in more detail in Chapter 6.

Table 1: Description of the interviewed hospitals and interviewees

Hospital	Type	Size	Interviewees functions
Hospital A	Top clinical	2 locations 300 beds	1: Business controller Sales and Purchasing of Care 2: Head of Department Care Logistics
Hospital B	General	2 locations 500 beds	1: Sales Manager 2: Program Manager 'Operational Excellence'
Hospital C	General	2 locations 1100 beds	1: Manager Care Purchasing and Strategy 2: Manager Care Logistics
Hospital D	General	3 locations 500 beds	1: Manager Care and Purchasing 2:Program Manager Patient Logistics

4.2. The care purchasing process

In order to define a general care purchasing process, the process descriptions of each hospital interview are combined to form one common process description. The process description parts of the interviews can be recognized in Appendix C by the yellow marked text. It is concluded from the interviews that the care purchasing process consists of two sub-processes that are executed simultaneously. The first sub-process is the process of negotiating with the health insurers and results in a lump sum budget of a certain amount of euros. The second sub-process is the process of defining the related production budgets and results in a division of this lump sum over a classification of care products. The lump sum budget is used as input for the division and the division is used as a base for the lump sum agreement. This way the hospital must ensure that the lump sum is sufficient for the internal, desired, budget on one hand. On the other hand the division must add up to the lump sum. Eventually the production of the hospital must not be more or less than the agreed-upon lump sum. In Figure 8, an illustration is shown of the care purchasing process that is defined and based on the interviews with the four different hospitals. The figure shows a combination of their descriptions of the care purchasing process.

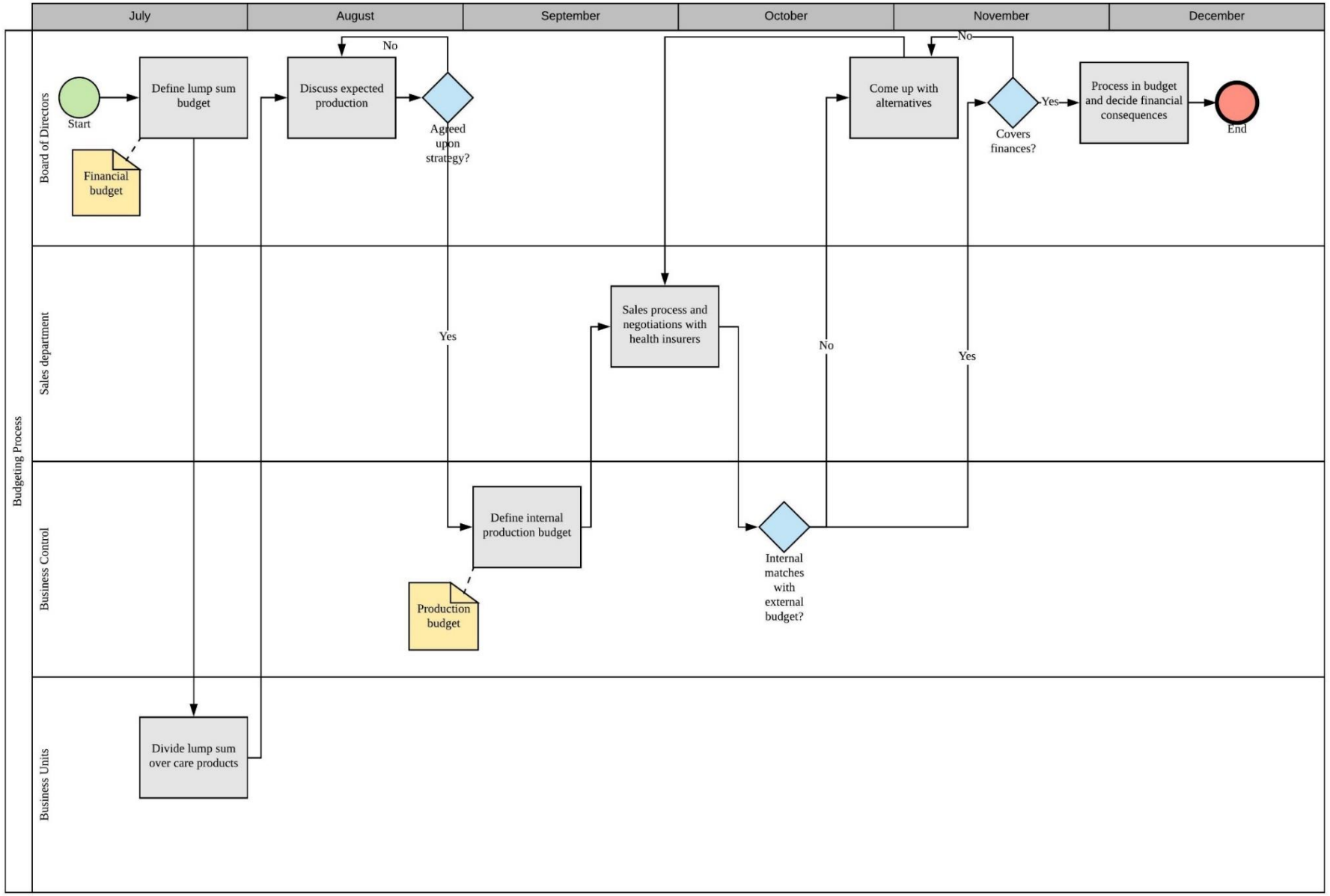

Figure 8: Current care purchasing process based on the interviews

4.2.1. Information flow current situation

The information that is captured in the process model of Figure 8 is transformed throughout the process as well. Figure 9 explains this transformation in further detail. The Board of Directors of the hospital agrees with health insurers upon a financial budget. The financial budget represents the lump sum of money that is going to be available for the care delivery of the hospital. This lump sum of money is allocated to each care product, based on discussions with the different business units and their specialists. Moreover, the Sales department provides the hospital with a cost price for each care product. Combining these three information pieces, results in a budgeted amount of care products per care product code, representing the internal production budget of the hospital. In the desired process, which will be explained in the solution design, the capacity budget is added to the different budgets in the process.

An example is now given to illustrate the information flow. A certain hospital only provides hip and knee replacement surgeries. After long negotiating between the Board of Directors and health insurers, the hospital has been given an amount of €140.000 for the care delivery next year. This is the lump sum that is represented in the financial budget. Based on historical data and knowledge about the required materials, the sales department has estimated that one hip replacement surgery has a cost price of €9.000 and that one knee replacement surgery has a cost price of €10.000. In consultation with both the “hip business unit” and the “knee business unit” the amount of required money is decided. Based on the amount of hip and knee replacement surgeries, the number of nursing days, required materials that were executed previous years and the expected growth of each business unit, the hip business unit expects to need around €90.000 and the knee business unit around €50.000. This implies that in terms of care product care packages, around 10 hip replacement surgeries (90.000/9.000) and 5 knee replacement surgeries (50.000/10.000) are going to be done next year. The required capacity for these surgeries will be added to the desired process and the relating information flow in the next chapter(s).

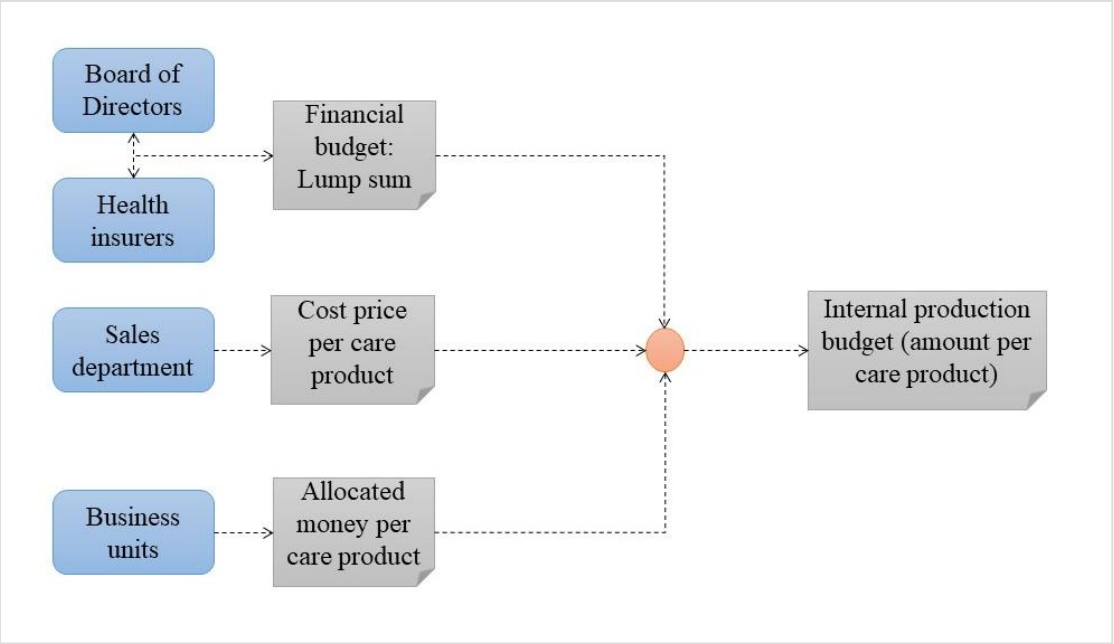

Figure 9: Information flow in the care purchasing process (AS-IS)

4.3. Translation from budget to capacity

In order to know how much capacity is going to be required for the upcoming year, the internal production budget should be translated to required capacity. Many types of resources are involved in the care delivery, the three largest types being the outpatient clinic, the inpatient clinic and the operating theatre. It is noticed in the interviews that a difference exists between the different hospitals in their level of capacity involvement in the care purchasing process.

- Hospital A translates the budget to capacity for the outpatient clinic schedules. They distract how much time at the outpatient clinic is required, based on the desired turnover, at a strategic level. These budgets are translated to a tactical and operational level as well. The operational use of capacity is currently supported and steered upon with a daily consultation. In this consultation the bed occupancy and staff for tomorrow and the day after tomorrow is discussed.
- Hospital B compares their budget with previous years to make a decision about the capacity. If there are no big changes in the budget, it is assumed that there is enough capacity since there was enough in the previous years.
- Hospital C calculates the amount of capacity for the first time this year. An external tool is used that calculates the actual required capacity, based on the financial budget. This tool

shows the required capacity and how it changes under influence of certain changes, at a high-level.

- Hospital D is trying to translate their budget to capacity at a more detailed level. This translation is made in terms of main operations, which can be defined as the main activity that is performed during the visit of a patient. For each main operation hospital D has made an estimation of the average duration and a budgeted amount. By combining both values, an expected value for the required capacity can be calculated. Hospital D currently executes these calculations for the inpatient clinic and the operating theatre, the outpatient clinic is left out of scope. It is a risky calculation since the budget for each main operation is given separately. This implies that when they increase the budget for hip replacement surgeries, the budget for nursing days is not increased simultaneously. As a result, the capacity for the different resource types might not be in line with each other.

4.4. Monitoring realization of capacity

In order to gain insights in the hospital's production compared to the budget, the hospital should monitor their realization. If the realization is exceeding the budget, the hospital can conclude that the agreed upon lump sum is not going to be sufficient. This implies that certain values are at risk, resulting in, for example, patients from specific health insurers that can no longer be treated at the end of this year. If the realization is falling short on the budget, the conclusion is drawn that the objectified turnover is not going to be reached. Both situations are desired to be in sight so the hospital can undertake actions to correct the overage or shortage before the end of the year. From the interviews it is again concluded that each hospital recognizes the need for this monitoring but that each hospital currently is at a different maturity level in this process.

- Hospital A currently makes use of a tactical planning consultation, in which the medical specialist company, the sales department and the care logistics department discuss how the performance was last month. This consultation incorporates the prognoses for coming months, which specialisms are lacking behind or running ahead, the access times, the waiting times and the bed occupancy.
- Hospital B discusses the production objectives (in financial terms) throughout the year, each month within the management team of each specialism.
- Hospital C reviews the budget once per year, looking at the utilization and the waiting list.

- Hospital D currently has no process in place that structurally reviews and monitors the production and realization.

4.5. Stakeholders

In order to design a solution that will gain commitment from the end-users, the stakeholders in the process are identified. Some of the stakeholders are already identified in the literature. The analysis & diagnosis phase is used to confirm or expand this selection of stakeholders and their role in the process. The hospitals that are interviewed generally appoint similar stakeholders, which are marked green in the interviews in Appendix C. The involvement of stakeholders can be divided over the different planning levels that are described in Chapter 2 as well.

4.5.1. Strategic level

At the strategic level the main stakeholder is the *Board of Directors*. They decide what the objectified total budget for next year must be. Moreover they provide input for different scenario's, based on their decisions or proposals, that should be calculated to capacity for next year. In order to process the input of the Board of Directors in the financial budget and health insurer agreements, the *sales department* is involved at the strategic level as well. They use the input in their negotiations with health insurers to make the best agreements. The *business control department* is responsible for making sure that the same input is used and processed in the internal budget of the hospital. Lastly, the interviewed hospitals have a *patient care logistics, capacity management or operational excellence team* in place. This team makes sure that the agreed-upon budget is translated to capacity and checks whether the required capacity is available in the hospital.

4.5.2. Tactical level

At tactical level multiple stakeholders are involved and provide input to give more detail to the lump sum budget. The *medical specialist company* and *department* and *cluster managers* review the results of the strategic level and often represent the Board of Directors in the internal and external negotiations. Besides these stakeholders, the *business units* of each specialism are involved at the tactical level as well. It is their responsibility to ensure that the objectives are in line with the capacity they can deliver (in terms of employees) and the personal objectives and expectations of the specialisms.

4.5.3. Operational level

At the operational level, the *specialists* are an important stakeholder because they are generally required for the production. They give input for what they expect to produce in the next

year. Moreover the monitoring of performance, either financially or capacity-wise, is done in consultation with the specialists. Besides the specialists, often the *planners* are involved at the operational level as well. They are responsible for (parts of) the schedule of the resource types and ensure that their schedule is sufficiently utilized.

4.6. Bottlenecks

In order to successfully design and implement an IT-tool that is going to support the hospitals in this process, the current bottlenecks are identified. This way, both the solution design and the implementation plan can anticipate on the bottlenecks that might stand in the way of success. Multiple bottlenecks were mentioned by the hospitals and can be recognized by the red marked parts of the interviews in Appendix C.

Multiple bottlenecks are concerned with monitoring the realization of the production. Because of the registration and invoicing of each activity, there is a 2-month slack in the usability and reliability of the historical data. This makes it currently difficult to steer and anticipate because the hospitals are looking at the numbers of two months ago. For any decision that is made at this moment, the effects will not be seen until over three months. Moreover, there is currently no or a small link between the financial budget and the capacity. This implies that after adjusting either the budget or the available capacity, the entire process of calculating the capacity has to be executed again. The third difficulty with the realization of the production is the unpredictability of the production. Since the prediction of the production is unreliable, it is not desired to monitor and evaluate multiple times in a year. The chances are high that with each evaluation moment the results have changed in a way that the entire capacity planning must be adjusted every time which is very time consuming.

Besides the registration time, the specialists could show resistance against a more flexible capacity allocation. One of the results of translating the budget to capacity could be that one specialism needs more capacity in one week than in another. Currently their surgery time is saint for the specialists. There is no trust from the specialists in the capacity managers that they will get the capacity they need when they need it. Moreover, it costs the hospital money if the operating theatre is underutilized while it does not matter for the specialists (financially) if they have an empty OR every now and then. In order to base the capacity on the translation of the budget and the related seasonal pattern, the specialists must be willing to handle their surgery time flexibly.

4.7. Requirements for the tool design

The objective of this research is to design an IT-tool that will support the hospitals in the described process. During the interviews the hospital employees were asked what their wishes for such an IT-tool are. The passages that are marked purple in the interviews represent these wishes and are shown in Appendix C.

The most important question that the tool must answer is how much capacity is required for patients with each diagnosis, taking into account the seasonal pattern, achieving the production objectives for that year. In order to achieve this it must be known for each care product what the required capacity is. Moreover the tool must enable the user to tweak and adjust the capacity and the budget in an easy and fast manner.

An important point to keep in mind when designing the tool is the usability and understandability of the tool. The employees are not waiting for very complicated tools. The view of the tool must be simple, and easy to translate to what the employees must do. According to the interviews, interpretation of the results is very important. The end-user must know what to do and understand the cause-consequence relationship of what the user sees.

4.8. Conclusion

In this chapter the theoretical framework is extended with practical and more detailed information. The current process of purchasing care and defining the budget is described on the basis of interviews with several hospitals, answering the first research question with Figure 8. The answers to the second and third research question, investigating the problems and bottlenecks, mainly focus on the difficulty of correctly forecasting the related capacity for each care product. Extending this answer with the difficulty of specialists' resistance to the different way of working and handling flexible capacity allocation. Moreover the desires and requirements for the solution design are investigated, solving the fourth research question. The main desires are requiring an answer to the amount of required capacity and a high level of usability and understandability of the IT-tool. Based on the requirements and the current process, Chapter 5 describes a solution design. The stakeholders that are identified in this chapter are important to keep in mind when implementing the solution design according to Chapter 7.

5. Solution design

The solution design phase is twofold within this research. In order to translate the health insurer agreements to capacity, a calculation model is developed and validated on one hand. On the other hand, the results of this calculation must be logically visualized in the IT-tool. First, a conceptual description is given of the calculation model. The chapter ends with a conceptual design for the visualization of the results, which is the IT-tool that is designed. In this chapter the following sub-questions are answered:

5. How can the health insurer agreements at strategic level be translated to a tactical level?

6. Which factors influence the yearly required capacity hospitals?

7. What should the solution design look like to achieve a translation between the strategic and tactical level with the design aimed at the end-users?

5.1. Desired process

Based on the interviews that are held with four hospitals and experiences in the case study hospital, the desired budgeting process is designed. The desired budgeting process incorporates a capacity swim-lane in the process model, incorporating the translation from health insurer agreements to capacity requirements. This process description is validated by the case study hospital and is used as a base for the remainder of the solution design. The renewed business process model is shown in Figure 10 and is based on the following steps:

1. The Board of Directors of the hospital defines the financial budget. Based on objectives and history, the available lump sum for next year is decided.
2. The financial budget is used to divide the money over all care products. This is done in consultation with the different business units. Based on their experiences, an amount of the lump sum is allocated to each care product.
3. This is discussed with the Board of Directors to decide whether the expected production, indicated by the business units, is in line with the hospital's objectives. If the strategy is agreed upon by the board of directors, the lump sum and the care product division is translated to the internal production budget by the business control department.
4. In the desired process, the internal production budget is translated to required capacity as well. The required capacity could then be compared with the available capacity for the specific resource types. This way it can be decided whether the internal production budget is feasible.
5. If the capacity matches with the availability and the results of the negotiations with health insurers are in line with the internal budget, the financial consequences can be decided

and the hospital can prepare for the consequences of the capacity division. When the aforementioned is not the case, alternatives have to be identified and the consequences of these alternatives are calculated in terms of capacity. An alternative is chosen that meets all the requirements.

Once the decisions are made and the care purchasing process is finalized, the budgeted capacity for each resource type is divided over the different specialisms and locations of the hospital. In consult with the department managers of each resource type these results are discussed and evaluated. For example, based on the required amount of capacity it is concluded that the Orthopedics need X hours of surgery time. Currently the master surgery schedule allocates Y hours of surgery time to the Orthopedics. Together with the department managers it is discussed what this difference implies and how the hospital is going to act upon this knowledge. In order to make such decisions, it is necessary that the hospital knows at what point in time approximately how much capacity is required. This forms the base for the division of the resources' capacity.

Moreover, the production year will start in January. Throughout the year, the hospital must be able to monitor their realized production and compare it with the predicted production. On a weekly basis, this comparison must be made per specialism, with the ability to zoom in for certain details like consultation type and emergency classification. This step is undertaken by the different business unit managers, evaluating the differences they see and anticipating and reacting to these differences. For example, if there were 6 total hip replacement surgeries expected in a specific week, and in the realization production only 1 total hip replacement surgery took place, the Orthopedics team manager should look into this difference. If there is a specific reason for this difference it could be that these surgeries have to take place in other weeks, adding to the surgeries that are already scheduled or predicted for these weeks. A reaction of the team manager could by to ask for some extra surgery time to cope with this difference.

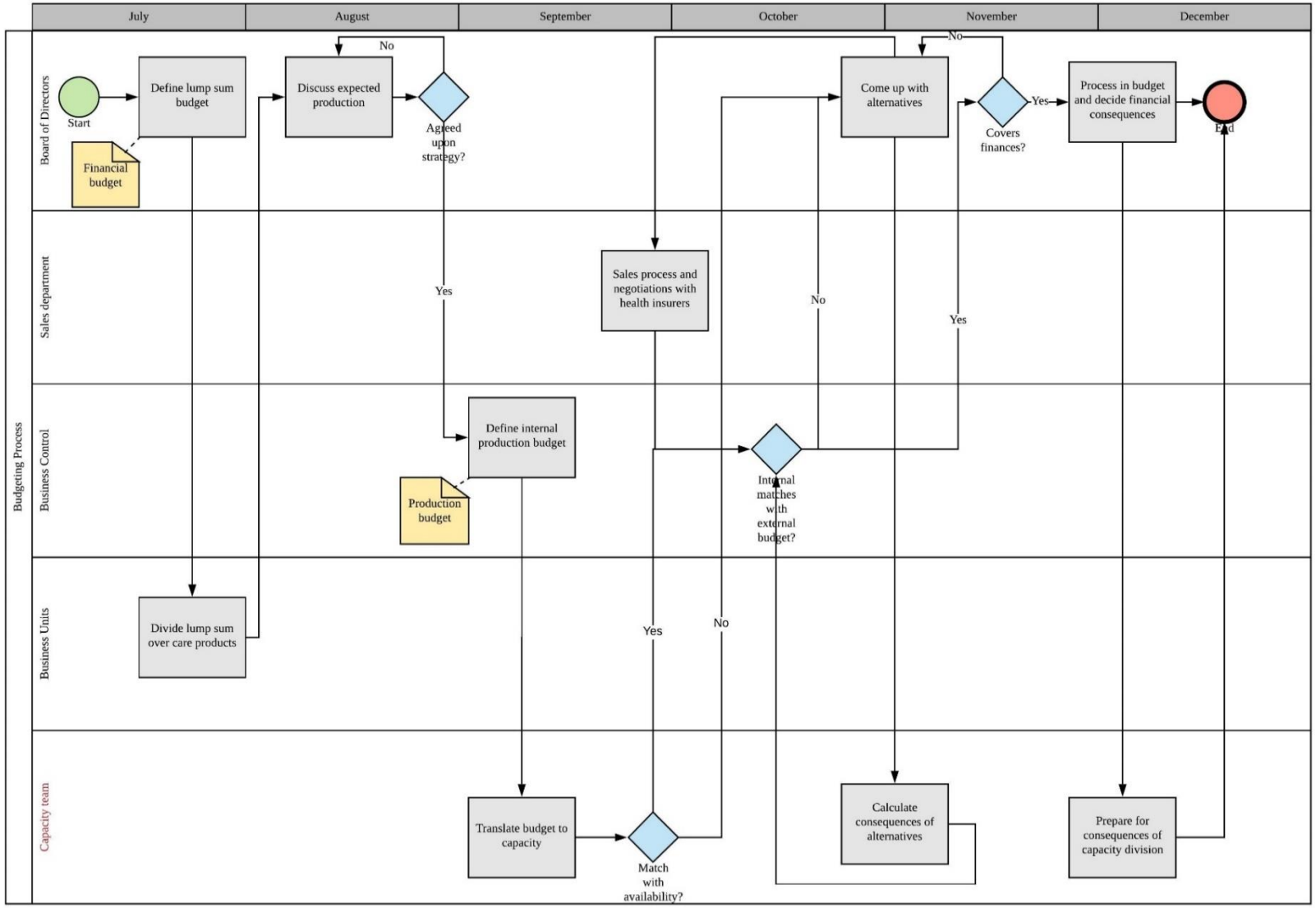

Figure 10: Desired care purchasing process, incorporating translation to capacity

5.1.1. Information flow in desired process

Figure 11 illustrates the change in information flow that is made in the desired process. The main difference is the addition of the capacity team. As part of the calculation model it is calculated how much capacity is required for each care product. Combining this with the internal amount of expected care products, it is predicted how much capacity each resource type needs next year. Picking up on the information flow example given in section 4.2.1., the internal production budget consisted of 6 hip replacement surgeries and 8 knee replacement surgeries. For both care products, a capacity profile is determined based on historical data. A hip replacement surgery requires on average 90 operating minutes, 40 inpatient clinic hours, and 40 outpatient clinic minutes. A knee replacement surgery requires on average 70 operating minutes, 30 inpatient clinic hours, and 30 outpatient clinic minutes. This implies that for the next year, this fictive hospital is going to need 1.100 (6*90+8*70) operating minutes, 480 (40*6+30*8) inpatient clinic hours, and 480 (40*6+30*8) outpatient clinic minutes. A more detailed explanation of the calculation model is given in the next section.

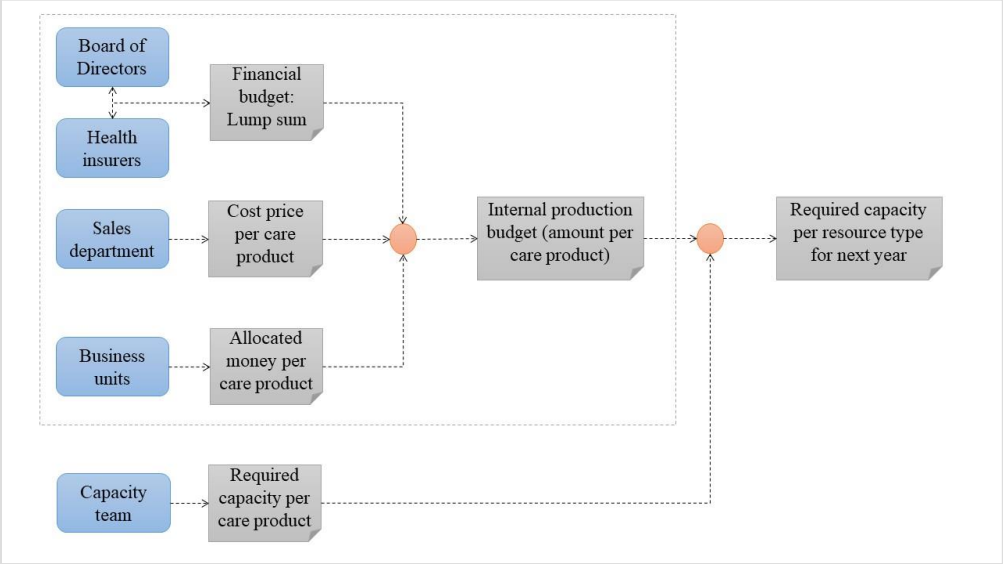

Figure 11: Information flow in the desired process

5.2. Conceptual description of calculation model

Based on the desired process, it is desirable that the calculation model is able to translate the production budgets to required capacity. For the calculation model, four types of input are required that are transformed to different types of output which are required for the visualization part of the solution design. A proposal for the calculation model was already described in Figure 4

of the method description in Chapter 2. The steps that are taken are illustrated by the final conceptual calculation model, shown in Figure 12, explaining how the different data tables result in the output.

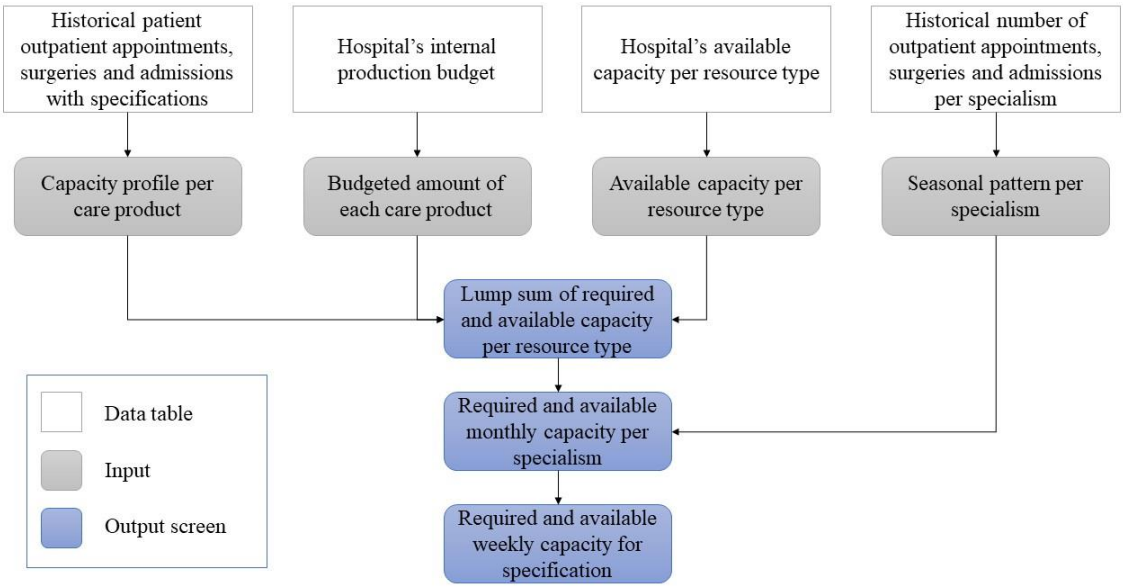

Figure 12: Conceptual description of calculation model

Based on the historical patient data that includes the outpatient appointments, surgeries and admissions, capacity profiles are defined for each care product. Within this capacity profile several specifications are taken into account, like the location, date and emergency classification of each activity. The capacity profiles capture the chance that a newly opened care product results in one of the specified activities.

Each hospital has agreed upon a lump sum (financial) budget for which they are going to deliver care. This financial amount is divided over the different care products that the hospital expects to deliver in the coming year. Based on the cost price per care product, this division is translated to a number of care products. This budgeted amount per care product is the hospital's internal production budget, which is the output of the information flow illustrated in Figure 11. The internal production budget is used as input for the calculation model.

In order to compare the required and the available capacity for each resource type, the available capacity per resource type is included. Since it concerns available capacity for next year, this data cannot be extracted from the hospital information system. Therefore, it is manual input from the hospital that is required for the calculation model.

The three sub-parts described above are used to calculate for each resource type what the lump sum of required and available capacity is. This is done by multiplying the budget per care product with each chance of a specific activity and the related duration of the activity. This results in a number of hours that are required at the outpatient clinic, the operating theatre and the inpatient clinic. The hours for the inpatient clinic are translated to a number of required beds, because that is the unit of capacity that hospitals use for the inpatient clinic.

In order to divide the required capacity over the year, a seasonal pattern is required. The seasonal pattern is identified per specialism, based on the historical number of outpatient appointments, surgeries and admissions per specialism.

5.3. Conceptual description of visualisation

The visualisation of the results is based on the desired process flow and resulted in three different screens. First, conceptual designs are made for the screen(s). Then, Excel is used to design the conceptual screens in a prototype with fictive data, showing the results of the calculation model. Finally, the calculation model and visualization of results are programmed in the HiX software by a HiX programmer. Figure 13 illustrates the first screen, that is used to gain insights on the expectations for the year and whether each resource type is going to be able to live up to those expectations.

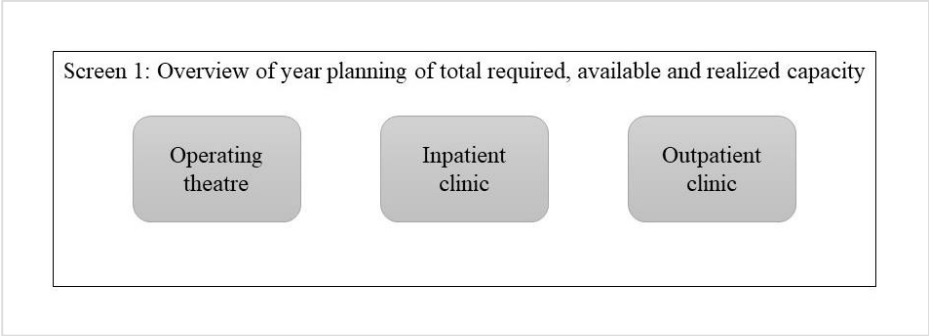

Figure 13: Conceptual visualization screen 1, year planning overview

The next step in the process is to divide the capacity over the year and looking at the results with more detail. Therefore the second screen, shown in Figure 14, illustrates the required and available capacity per month in a graph. To add more detail, three filtering options are added to the screen that enable the user to specify the results for a specific location, specialism and (department-)cluster. Since the three resource types cannot be compared with each other (e.g. beds compared to minutes), this screen always shows the results for one of the three resource types chosen in screen 1. Based on this screen, the user is able to make decisions about the chosen

resource type and the division of capacity for that resource type. Both the first and the second screen support the first step in the capacity swimlane in Figure 10.

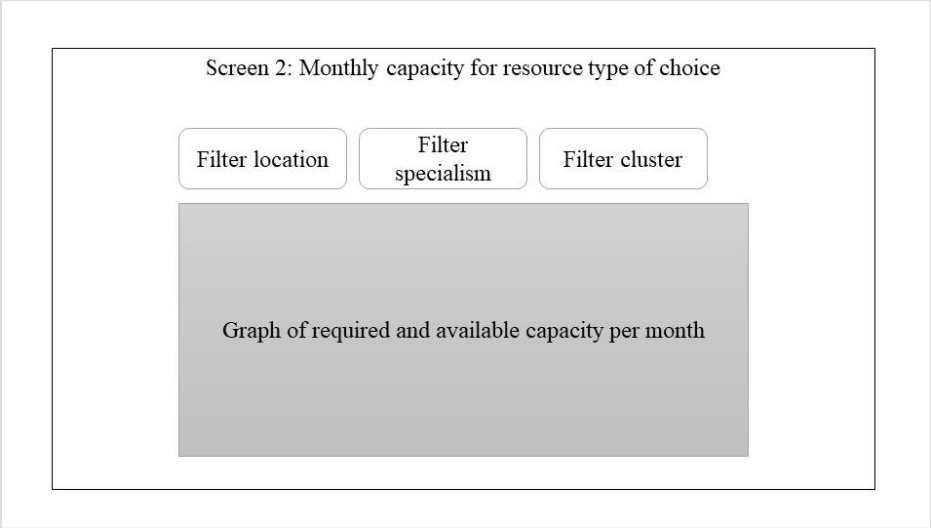

Figure 14: Conceptual visualization screen 2, monthly capacity

The third screen is focusing on the use throughout the year. It shows even more detail than screen 2 and can be used by the department managers to weekly monitor their capacity use. The graph shows besides the required and available capacity, the realized capacity as well for each week. This way the user gains insight in whether they are performing in line with the expectations. If not, they can investigate what is causing the difference between expectation and realization and act upon it. More filters are added to the third screen, which are shown in Figure 15. The results can be more specified by filtering the sub-type (e.g. day admission or clinical admission) and whether it is emergency, semi-elective or elective. The third screen is used throughout the year, after the care-purchasing process is finalized.

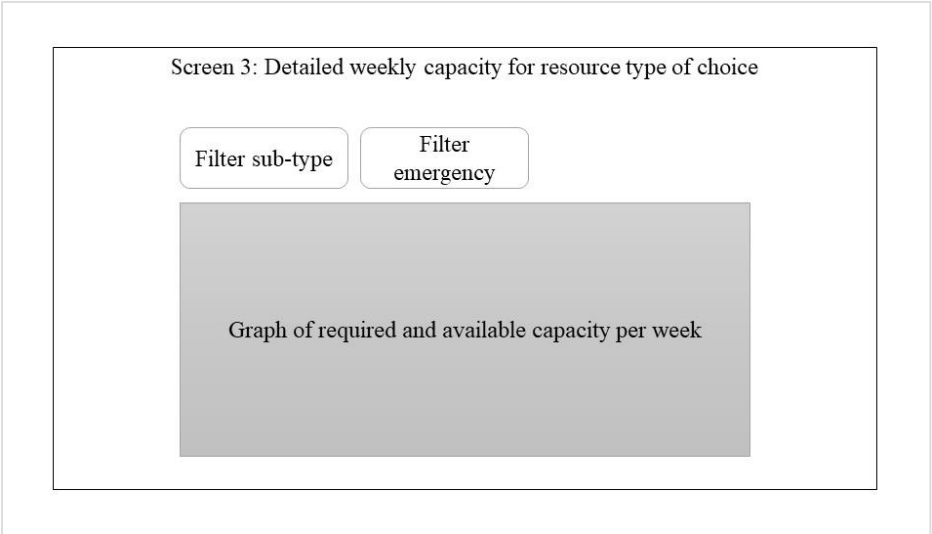

Figure 15: Conceptual visualization screen 3, weekly details

6. Application

In order to evaluate whether the solution design is in line with the organization of activities in hospitals, the model is applied to a case study. This chapter describes the case study and the application of its data to the calculation model. After this chapter, the following sub-question is answered:

8. Does the model follow and support the actual process, based on the case study results?

6.1. Case study description

As indicated in the previous section, the model is applied to a case study setting. In order to create a context for the model and gain knowledge for the solution design, the research follows the budgeting process of a Dutch hospital. The case hospital is the same hospital as hospital D that was interviewed in the Analysis & Diagnosis chapter. The case study hospital is used to validate the solution design and the process description throughout this research as well.

Hospital D is trying to translate the financial budget to capacity as well, for the first time, with a self-built model. Moreover, their model is based on separate main operations, instead of care products. This implies that when, for example, the number of hip replacement surgeries increases, hospital D's model does not incorporate this change in the required capacity for the inpatient clinic. The model designed in this research does take this cohesion in capacity into account, because all activities are incorporated in the capacity profiles. This implies that when the budget for a specific care product increases, both the surgery capacity and the outpatient clinic capacity increase simultaneously. The hospital recognized that it would be very helpful if these calculations could be done for them in the future and therefore they are willing to cooperate in this research.

6.2. Data preparation

Since hospital D is the case study hospital that is cooperating in this research, the data from this hospital is used. The hospital uses the HiX software delivered by ChipSoft, which is a complete hospital information system in which all data is registered. The data is anonymized by scrambling the data, which irreversibly removes sensitive data. It concerns all data that is registered in the database since the hospital started registering. Based on this data, a table is made with the historical patient outpatient appointments, surgeries and admissions with specifications, hereafter referred to as the *profile data*. Another table is made with the historical number of outpatient appointments, surgeries and admissions per specialism, hereafter referred to as the *pattern data*. The profile data contains the information per record that is shown in Table 2.

Table 2: Information per record of profile data

Identifiers	Specifications	Determined info	Shared denominator
DBC-id	Specialism	Emergency class	Care product code
Activity reference No.	Department	Week No.	
Patient No.	ASA-classification	Cluster	
	Date	Location	
	Activity type	Duration	

The pattern data contains the information per record shown in Table 3.

Table 3: Information per record of pattern data

Retrieved info	Determined info
Week No.	Sum of the amount per specialism and resource type
Specialism	Percentage of share per week
Resource type	
Amount	

Since the calculation model is used to predict the required capacity for next year, while the current year has not ended yet, the tables are based on data from one year prior to the current year. In this case, the calculation model is used to predict the required capacity for 2019 while 2018 has not ended yet. The data of 2018 is not complete yet and therefore the data of 2017 is used. It is important for the data extraction to keep in mind the difference between the financial year and the production year. Since the care products are invoiced after the activities are executed, some data of 2018 might be relevant as well. Therefore, the profile data is based on all activities that belong to a DBC that has been opened in 2017 and invoiced in either 2017 or after 2017 (financial year 2017). This implies that some of the activities that are taken into account took place at the start of 2018 and that some of the activities that took place at the start of 2017 are not taken into account. Therefore the assumption is made that these activities are similar and that the missing activities of start 2017 can be replaced by the extra activities of start 2018. This is illustrated with Figure 16, where the grey surfaces represent the replacement activities. For the seasonal pattern data it is desired to know how ‘busy’ each specialism is each week. For this purpose the pattern data is based on the production data of 2017. To make sure the capacity profiles are as similar as possible to the current situation in a hospital, the first possible year that has complete data is used.

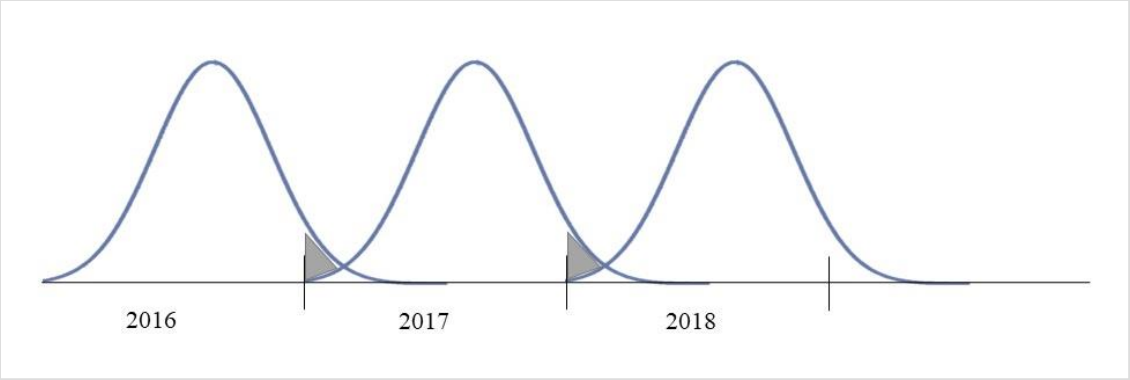

Figure 16: Financial vs. production year

6.3. Application of model on case study

The conceptual description of the calculation model of section 1.1 is applied in detail to the case study that was explained in section 1.2. The application is explained per sub-part of the calculation model, which are indicated in Figure 12 by the grey boxes.

6.3.1. Capacity profiles per care product

For each care product, a capacity profile is defined based on the historical data of the hospital. This implies that if the capacity is predicted for 2019, the capacity profiles are based on 2017 due to the fact that 2018 is not complete yet. The historical data of the outpatient clinic consists of all agenda appointments for a new patient or control patient consultation of which the DBC started in 2017. For the inpatient clinic, the historical data consists of all admissions (clinical and day) that are part of a DBC that started in 2017. Lastly, the historical data of the operating theatre consists of all surgeries of which the DBC started in 2017. All these data records are combined based on each unique DBC identifier. This way, for each DBC a package of care activities and the related duration can be identified.

As an example, it is explained how the capacity profile for the care product of a total hip replacement surgery is determined. The care product code for a total hip replacement surgery is 131999052, which is a national determined and used code. All records from the historical data that have this care product code are combined, keeping the characteristics of each record intact. A selection of similar fictive data is shown in Figure 17 to illustrate the explanation. For each combination of specifications, the number and average duration of the activity is calculated. The number is calculated by counting each record with the same combination of specifications. The average duration is calculated by adding up the duration of each record and dividing it by the number of records with the same combination of specifications. The specifications that are taken

into account are the care product code, specialism, location, type of activity, department, department cluster, ASA-classification and emergency classification. The meaning of the different types are operating room (OR), new patient consultation (NP), control patient consultation (CP), clinical admission (Admission (K)), and day-time admission (Admission (D)).

DBC-ID	Care product	Appointment	Specialism	Patient	Department	ASA	Emergency	Type	Week	Start DBC	Location	Cluster	Duration
0123456789	131999052	0001	ORT	A01	OR1	1	Emergency	OR	1	3-4-2017	Loc1		88
1234567890	131999052	0002	ORT	A02	OR2	2	Elective	OR	1	1-5-2017	Loc2		91
2345678901	131999052	0003	ORT	A03	Loc1	1	Elective	NP	1	10-2-2017	Loc1		15
3456789012	131999052	0004	ORT	A04	Loc1	2	Semi-elective	CP	1	20-6-2017	Loc1		10
4567890123	131999052	0005	ORT	A05	Loc2	3	Emergency	CP	1	21-1-2017	Loc2		10
5678901234	131999052	0006	ORT	A06	B1	1	Elective	Admission (K)	1	13-3-2017	Loc2	Cutting 2	55
6789012345	131999052	0007	ORT	A07	B2	1	Semi-elective	Admission (K)	1	20-8-2017	Loc1	Cutting 1	48
7890123456	131999052	0008	ORT	A08	B2	2	Elective	Admission (K)	1	19-5-2017	Loc1	Cutting 1	93
8901234567	131999052	0009	ORT	A09	OR1	1	Elective	OR	1	8-10-2017	Loc1		105
9012345678	131999052	0010	ORT	A10	Loc1	3	Semi-elective	CP	1	26-11-2017	Loc1		10

Figure 17: Illustration of data selection (total hip replacement surgery)

Since the goal is to determine the percentage of a specific activity resulting from a newly opened DBCs of a specific care product, the number of opened DBCs per care product in 2017 are used as well. For the care product 131999052, there were 357 DBCs that started in 2017. Since it is known from Figure 17 how much of those DBCs resulted in a certain type of activity, the abovementioned percentages are calculated by dividing these number by the number of opened DBCs. This results in the capacity profile of care product 131999052 shown in Figure 18, where each row represents an activity with specific characteristics and a percentage of how often this specific activity happens. *For example, the orange-lined row of the profile indicates that for each care product with code 131999052 that is opened, 44.8% has a clinical, elective surgery in operating room 1 at location 1, with a required capacity of 103 minutes of surgery time in the operating theatre.* Likewise, for each combination of specifications per care product a capacity profile is defined.

Care product	Specialism	Type	Location	Emergency	Department	Cluster	Number	Avg duration	Share
131999052	ORT	Admission (D)	Loc2	Elective	2A4	2A4	1	6	0.3%
131999052	ORT	NP	Loc3		Loc3	Loc3	1	10	0.3%
131999052	ORT	NP	Loc1		Loc1	Loc1	85	10	23.8%
131999052	ORT	NP	Loc2		Loc2	Loc2	88	11	24.6%
131999052	ORT	CP	Loc3		Loc3	Loc3	1	10	0.3%
131999052	ORT	CP	Loc1		Loc1	Loc1	68	9	19.0%
131999052	ORT	CP	Loc2		Loc2	Loc2	94	9	26.3%
131999052	ORT	IC	Loc1	Elective	IC	IC	1	2	0.3%
131999052	ORT	Admission (K)	Loc1	Elective	1A3	Cutting 1	1	3	0.3%
131999052	ORT	Admission (K)	Loc1	Elective	1C3	Cutting 1	56	99	15.7%
131999052	ORT	Admission (K)	Loc1	Elective	1D3	Cutting 1	89	87	24.9%
131999052	ORT	Admission (K)	Loc1	Elective	1D4	Cutting 1	1	3	0.3%
131999052	ORT	Admission (K)	Loc1	Elective	1E1	Cutting 1	1	124	0.3%
131999052	ORT	Admission (K)	Loc1	Semi-elective	1C3	Cutting 1	1	64	0.3%
131999052	ORT	Admission (K)	Loc1	Semi-elective	1E1	Cutting 1	1	9	0.3%
131999052	ORT	Admission (K)	Loc1	Emergency	1C3	Cutting 1	3	141	0.8%
131999052	ORT	Admission (K)	Loc1	Emergency	1D3	Cutting 1	4	97	1.1%
131999052	ORT	Admission (K)	Loc1	Emergency	1E1	Cutting 1	10	129	2.8%
131999052	ORT	Admission (K)	Loc1	Emergency	1F1	Cutting 1	1	115	0.3%
131999052	ORT	Admission (K)	Loc2	Elective	2A2	Cutting 2	23	37	6.4%
131999052	ORT	Admission (K)	Loc2	Elective	2A4	Cutting 2	157	53	44.0%
131999052	ORT	OR (K)	Loc1	Elective	OR1	OK U	160	103	44.8%
131999052	ORT	OR (K)	Loc1	Semi-elective	OR1	OK U	6	128	1.7%
131999052	ORT	OR (K)	Loc1	Emergency	OR1	OK U	9	121	2.5%
131999052	ORT	OR (K)	Loc2	Elective	OR2	OK Z	140	100	39.2%
131999052	ORT	OR (other)	Loc2	Elective	OR2	OK Z	45	97	12.6%

Figure 18: Capacity profile for total hip replacement surgery

6.3.2. Internal production budget per care product

As indicated in the previous chapters, the financial lump sum is translated to the internal production budget. This is a list of care product code and specialism combinations with the related amount of DBCs that are expected to start with each care product code. Since this information is decided upon by the business control department for each year, it is an input table for the calculation model. For the care product 131999052 combined with the specialism Orthopedics, the budgeted amount of DBCs is 400.

6.3.3. Seasonal pattern per specialism

In order to know at what time the capacity that is going to be predicted is required, a seasonal pattern is defined per specialism. The definition of the seasonal pattern is based on the assumption that the seasonal pattern applies for all activities within a specialism similarly. The seasonal pattern is based on historical data that includes all activities of the outpatient clinic, inpatient clinic and operating theatre that are executed in 2017. Based on the execution date, the number of activities for each resource type and per specialism are counted. As a result it is known how much activities the outpatient clinic, the inpatient clinic and the operating theatre execute per week and per specialism. Moreover, for each combination of resource type, specialism and week number it is calculated what the average number of activities is per week.

To continue with the example given in 6.3.1. a selection of the results described above are given for the operating theatre of the Orthopedics in Figure 19. By dividing the realized number of activities in each week by total number for the same specialism and resource type a seasonal percentage results. The resulting percentage is used in calculation model to give a seasonal pattern to the resulting capacity per year. The total yearly required capacity for each combination of specialism and resource type is multiplied with the seasonal percentage related to each week of the predicted year.

Week nr	Specialism	Type	Number	Total	Seasonal percentage
27	ORT	OR	46	2245	2.0%
28	ORT	OR	40	2245	1.8%
29	ORT	OR	41	2245	1.8%
30	ORT	OR	25	2245	1.1%
31	ORT	OR	29	2245	1.3%
32	ORT	OR	37	2245	1.6%
33	ORT	OR	32	2245	1.4%
34	ORT	OR	52	2245	2.3%
35	ORT	OR	43	2245	1.9%
36	ORT	OR	46	2245	2.0%
37	ORT	OR	42	2245	1.9%

Figure 19: Part of seasonal pattern for Orthopedics

6.3.4. Resulting capacity budget

In order to know how much capacity is required such that the production agreements can be met, the budget per care product is multiplied by the capacity profile share percentages. For example, the 400 hip replacement DBCs result in $0{,}448 * 400 = 180$ elective surgeries at Location 1 of hospital D. Since the average duration of such a surgery is 103 minutes, the total required capacity for this specific care product at the operating theatre is $180 * 103 = 18.540\ minutes\ (= 309\ hours)$. In order to divide this amount of minutes (or hours) over the weeks in one year, the seasonal pattern is used. Continuing with the same example, for care product *131999052* in week 34 an amount of $0.023 * 309 = 7.1\ hours$ is required. This is calculated similarly for each combination of specifications of each care product, resulting in the required capacity in order to achieve the budgeted production agreements.

6.4. Validation of the calculations

In order to ensure the quality of the results of the calculation model is good, a validation is performed on the model. Within this validation the model is used to predict the required capacity for 2017 based on the historical data of 2016. The results of the model for 2017 are subsequently compared with the realized production in 2017. The results of this validation show that the model

predicts 4% more capacity in the inpatient clinic than the realization based on the entire year to be predicted. For the operating theatre the model predicts 1% less capacity than the realization, based on the entire year to be predicted. For the outpatient clinic the model predicts 9% more capacity than the realization, based on the entire year to be predicted.

6.5. Visualization and functioning of IT-tool

Based on the high-level process that is described in section 5.1 of the case study, different views on the results are designed. Since the goal of the IT-tool is to support the users in their current working process, the design of the tool follows this process. The calculation model requires input that is given by the user before the results can be calculated.

6.5.1. Results screens

The first results that need to be visualized for the user is the *yearly planning of the total required, available and realized capacity.* The realized numbers are shown for last year for comparison, since the realization of this year is not known yet at the moment of using this view. The visualization of this screen is further developed in the software that ChipSoft delivers to hospitals, HiX. For the purpose of this thesis, the design is shown in Figure 20.

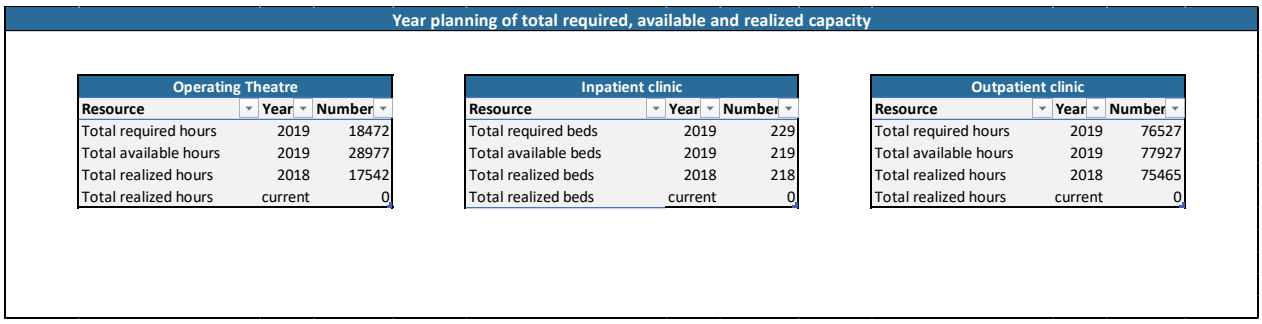

Figure 20: Design of result screen 1, year planning overview

By clicking on one of the three resource boxes, a more detailed second screen will open in the software. The second screen shows a graph that illustrates how the required and available capacity is divided over the different locations, specialisms and department clusters per month. This forms the base for the decisions that are made about the division of capacity for each specialism. The user has the ability to filter per location, specialism and department cluster, as can be seen in Figure 21. Similar to the first result screen, the final visualization of the tool is done by the software programmers of HiX. The graph shown in Figure 21 is the conceptual design of the HiX screen. As can be seen at the right bottom of the screen, a “detail” button is added. If the user clicks on this button a third screen will appear that shows details of the selection made with the filter buttons.

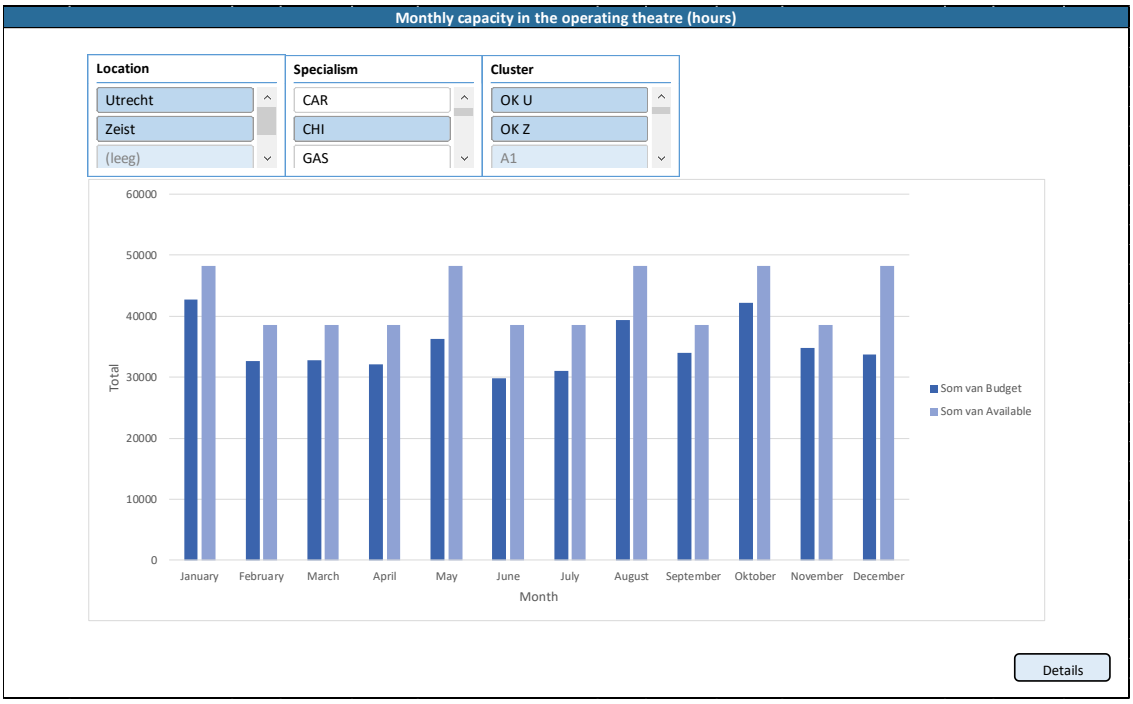

Figure 21: Design of result screen 2, monthly capacity

The third results screen remembers the already set filters at the second result screen. Moreover, the results now show the realized capacity next to the budgeted and available capacity per week. The resulting capacities of each type can be further filtered on sub-type and emergency classification. The design for this screen is shown in Figure 22.

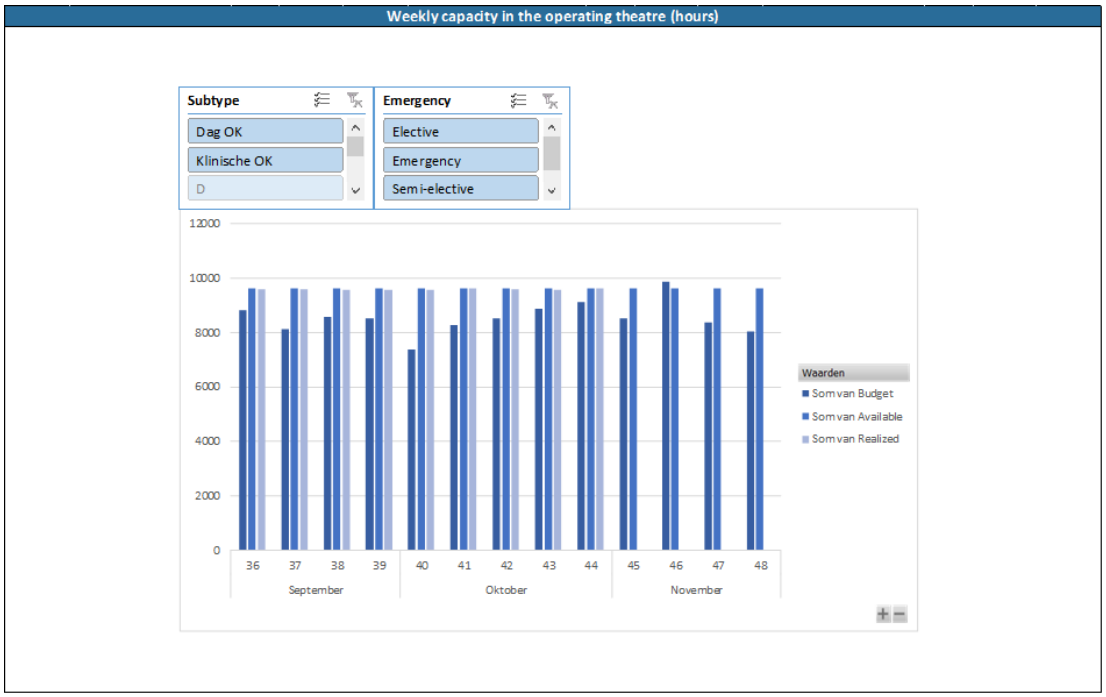

Figure 22: Design of result screen 3, weekly details

7. Implementation plan

In this chapter, an advise for implementation of the IT-tool is given. Due to time limitations, the solution design cannot be implemented in practice as a part of this research. However, the previous chapters give insights in points of attention throughout an actual implementation. Therefore, in this chapter it is explained what a process model of change for the implementation of the current IT-tool would look like. First, the process as a whole is explained, followed by a more detailed description of each step of the process. In order to relate the literature about implementation of change to practice, the knowledge in this chapter is validated by the case study hospital. After reading this chapter, the following sub-question is answered:
9. How can the solution be implemented in the current process to ensure a successful solution of the identified problem?

7.1. Roadmap for change

The roadmap for change that is used for the implementation, can be used to identify the issues that need to be addressed by the change-leaders to secure the desired outcomes (Hayes, 2014). The guideline involves seven core activities, that can be seen in Figure 23.

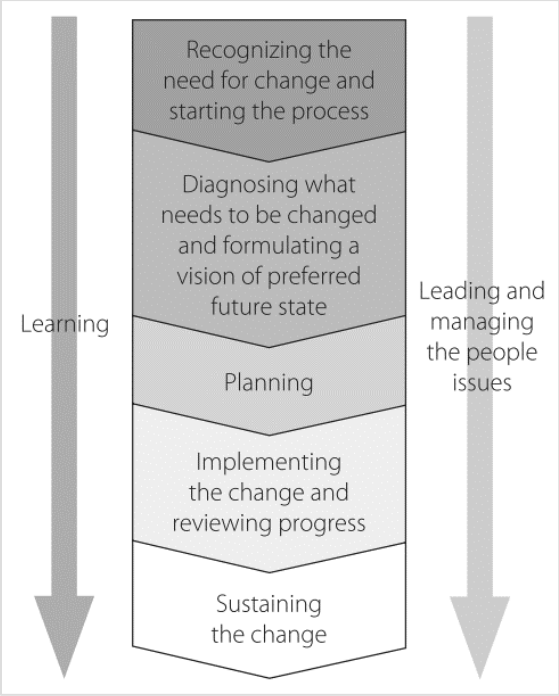

Figure 23: The process model of change (Hayes, 2014)

7.1.1. Recognition of need for change

The process starts with the recognition that (external) events require a change to take place. Once the need for change is recognized it should be translated to a desire and readiness for change (Hayes, 2014). In this research, this step of the change model is executed in Chapter 1. Different

negative consequences are explained in this chapter, like the inequality in access for patients and the increasing working pressure for hospital employees. This results from the lack of insights in the hospitals' care delivery and how this relates to the agreements made with health insurers. It can be concluded that a new way of working is required to solve this problem.

7.1.2. Diagnosing what needs to be changed

Before planning the change, it must be assessed what the problems and opportunities are and how they can be solved (Hayes, 2014). This is done in the second phase of the change process. The current situation is reviewed and the future, desired, situation is identified, resulting in a plan about how to transform from the current to the desired state (Hayes, 2014). In Chapters 3 and 4 both literature and practical information about the current and desired situation is gathered. Based on the literature it is concluded that in the current state the different planning levels work in silo's. The desired state, based on literature, is to have a continuous feed forward and backward communication loop between each level. In order to validate the information gathered in literature, it is compared with the practice by the interviews that are held for Chapter 4. In this analysis phase, it is concluded that in the current state only little or no communication exists between the strategic, financial budgeting process and the capacity budget. Both the capacity managers and sales managers agree upon the fact that a more integral form of capacity management with a link to the financial budget is desired. This results in the solution design of Chapter 5, designing a supportive IT-tool that enables the end-user to translate the financial budget to a capacity budget.

7.1.3. Planning

In order to eventually implement the designed IT-tool, a planning must be made on how the change goals will be achieved (Hayes, 2014). Several strategies have been identified that can be used to implement change which should be carefully chosen with an eye on the desired outcome of the change (Hayes, 2014). The three-dimensional model illustrated in Figure 24 is used to help choosing the change strategy for the implementation of the IT-tool. The three variables are time available for the change, type of change (incremental or discontinuous) and level of support for the change (Hayes, 2014). The left side of the model illustrates the change strategies that are effective when the change is implemented in an incremental way (Hayes, 2014). A more detailed illustration of the left side is shown in the left side of Figure 25. The right side of the model illustrates the change strategies that are effective when the change concerns a transformation (Hayes, 2014). A more detailed explanation of the right side is shown in the right side of Figure 25. Based on the

score of the three variables in a specific situation, the model can be used to determine the best fitting change strategy (Hayes, 2014).

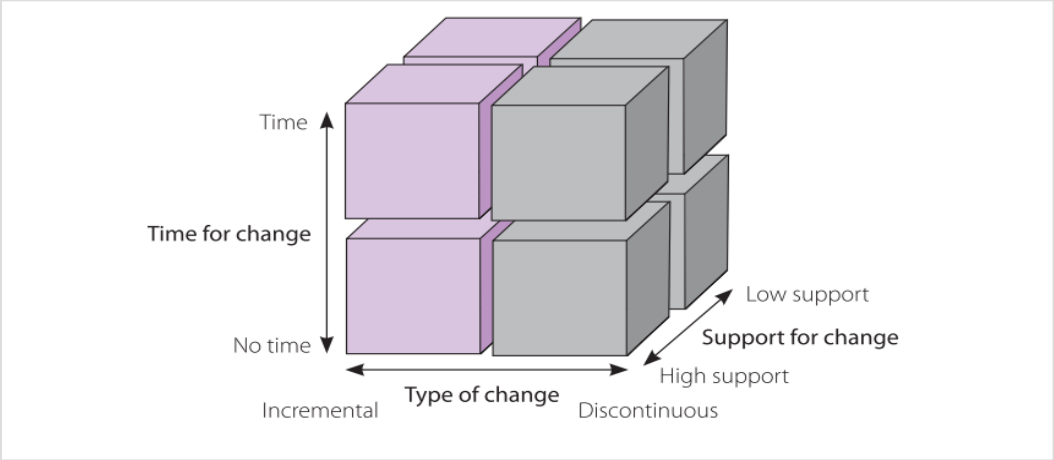

Figure 24: A three-dimensional model to aid choice of change strategy (Hayes, 2014)

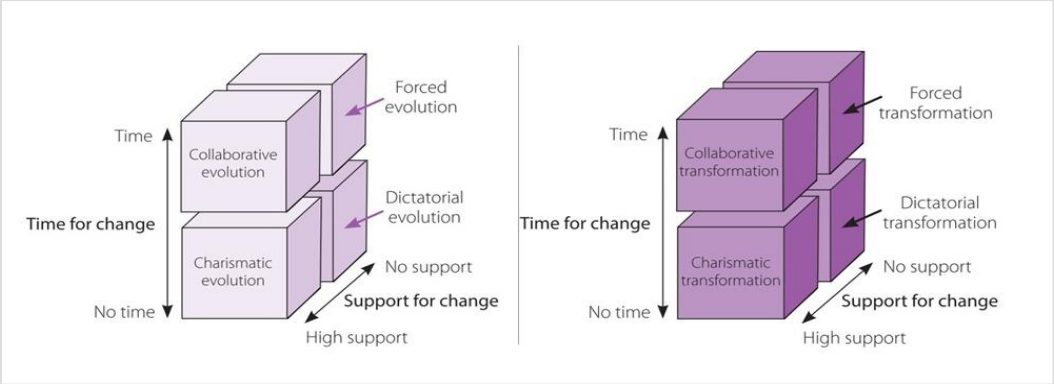

Figure 25: Detailed explanation of change strategies (Hayes, 2014)

In this research, two perspectives can be identified that result in two different change strategies based on the aforementioned model. *The first perspective* is based on the concept integral capacity management that was explained in Chapter 3. The solution design of this research is focused on the translation of the strategic hospital objectives to tactical capacity requirements. From this point of view, the implementation of the translation is an *increment* that is part of a bigger picture: achieving integral capacity management. Moreover, the *time available* for change in this point of view is large. In order to achieve a form of integral capacity management, many changes have to be made, not only at strategic/tactical level but on operational level and the translation from tactical to operational as well. The interviewed hospitals are very aware of the slow pace of change and the many changes that must be made in order to achieve an integral capacity management. Therefore, most hospitals have appointed (or should appoint) a capacity manager, whose job it is

to lead the change in the right direction over time. The same picture resulted from the interviews, in which both the sales as the capacity managers indicated that they recognize and desire this change: *"It is desirable to know for each care product not only the financial price, but also the capacity for the product"*. This implies that the main stakeholders will *support* the implementation of the solution design. Based on these values of the three variables, the best change strategy would be a collaborative evolution.

The second perspective is based on the focus of this research, which is the translation of the strategic financial budget to the tactical required capacity. Looking at the model of Figure 24 from this point of view, the model results in a different change strategy than for the previous perspective. Whereas the sales and capacity managers were main stakeholders in the previous perspective, the managers of the different business units are main stakeholders as well from this point of view. That is because the solution design consists of different screens that are going to be used by the different stakeholders. The stakeholders of the first screen are again the sales and capacity managers, of whom it was already established that they support the change. The department managers are the users of the second screen. It is indicated by the case study hospital that these stakeholders do *support* the change, but it is important to actively involve them in the process to maintain this level of *support*. The third and last screen is mainly aimed at the daily managers that operate the different resource types. Their role is more operational and in order for them to *support* the change, the tool must connect to their daily operations. Since the work processes of the stakeholders must be adapted to use the IT-tool, and since the other changes that relate to the integral capacity management are not being executed yet, the stakeholders will likely look at this chance from a *transformational* point of view. Taking into account that from this point of view the available *time* for the change process is sufficient, a collaborative transformation is the suggested change strategy.

Since the transformational point of view is more aligned with how the stakeholders are expected to experience the change, the collaborative transformation is the change strategy that is suggested for this implementation. Once the change strategy is identified, a change plan must be developed that involves thinking about what needs to happen in order to move towards the desired end state (Hayes, 2014).

7.1.4. Implementing the change, reviewing progress and sustaining the change

Since the change is not implemented in this research, the following two steps cannot be as elaborated as the other steps and are therefore shortly explained together in this section. The next

step, implementing the change and reviewing progress, is concerned with turning the plans for change into actual change efforts (Hayes, 2014). Due to the time limitations, this chapter describes an advise on how to implement the change, but the actual implementation is out of scope. It must be kept in mind that the implementation is not a one-step activity but an ongoing process that is often closely intertwined with other ongoing activities (Hayes, 2014). Throughout the implementation of a change it is desired to keep monitoring and reviewing the implementation. This way the managers can adjust and adapt the change plan to ensure that the organization moves towards a desirable future state (Hayes, 2014).

Once the change is implemented, the next step is to sustain the change (Hayes, 2014). The sustainability of the change can be managed throughout the change process by adding forces for change in the desired direction or by reducing the opposing or resisting forces (Hayes, 2014). If the change is sustained by adding forces for the change in the desired direction, the tension experienced by those affected by the change will increase (Hayes, 2014). Since the interviewed hospitals already indicated the resistance from the specialists, this might not be an advisable strategy to increase the sustainability of the change. Therefore, the strategy of reducing opposing forces will be more suitable in this situation.

7.1.5. Leading and managing the people issues

Throughout the entire change process, the change leaders must attend to people issues (Hayes, 2014). It is important to keep in mind the politics of organizational change, implying that each group pursues their own objectives. In order to gain insights in the stakeholders and the related people issues, the stakeholders are set up in a stakeholder grid. A stakeholder grid can be used to locate all stakeholders who can affect or might be affected by the outcome of the change (Hayes, 2014). The stakeholder grid of Figure 26 illustrates the position of all stakeholders that are previously described. From the stakeholder grid it is concluded that the specialists must move from their current position to the upper part with the positive attitude. This might be achieved by providing them with information that could persuade them to be more supportive, involving them in the change process and this way giving them more control over the outcome (Hayes, 2014).

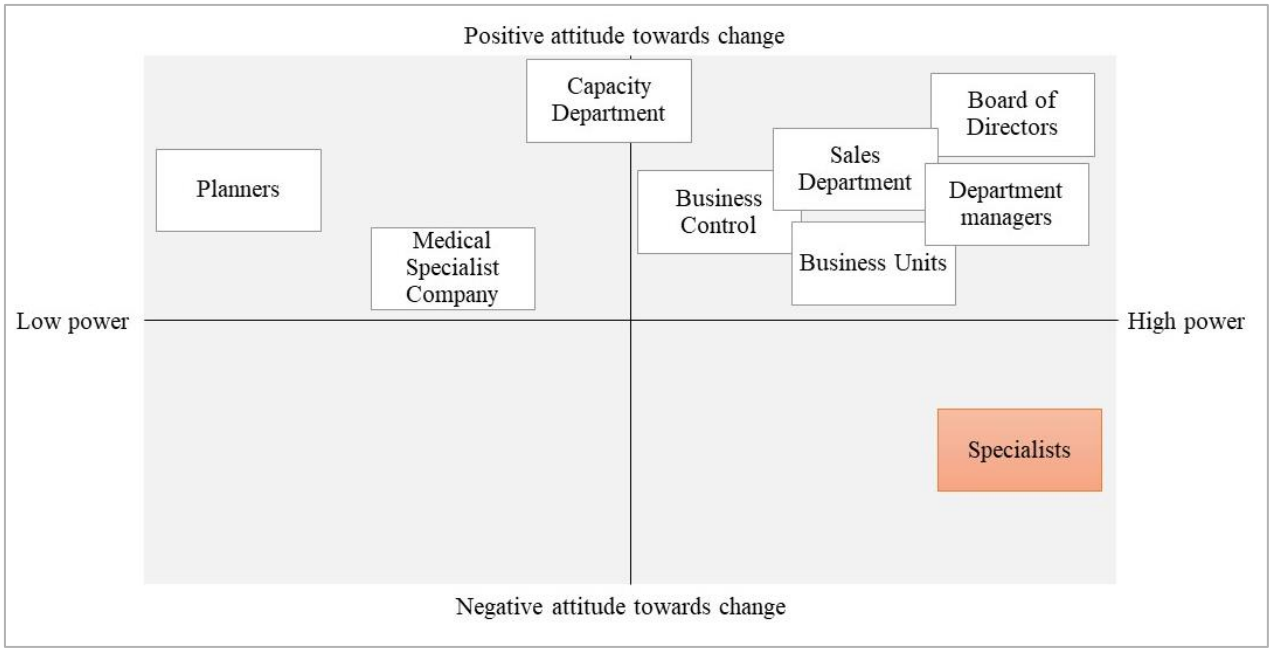

Figure 26: Stakeholder grid

The position of each stakeholder is based on the interviews with the four hospitals and experiences in the case study hospital. For each stakeholder the reason for their position is explained below.

The *Board of Directors* decides what the total budget for next year must be. When the translation tool is successfully implemented in a hospital, the board of directors can deliver input for different scenarios that the tool could translate to capacity. Because of their position in the hospital's hierarchy they are likely to have high power. Moreover, their goal is to improve the hospital's financial and efficiency position which can be achieved with the help of the IT-tool.

The *sales department* represents the hospital in the negotiations with the health insurers. Their position in the negotiations can be improved if the tool is used to gain knowledge on the needs and possibilities of the hospital, before starting the negotiation. They have relatively high power because they are responsible for the agreements with the health insurers.

Department managers are responsible for checking whether the agreements and objectives that are made are feasible within their department. With the new way of approaching the production objectives and capacity, they are provided with information on how much capacity they have to deliver and when. This implies that it is easier for them to manage their department. Their power is on the higher side of the axis because of their say about their department.

It is the *business units'* task to ensure that the specialists and supporting staff are able to deliver the care that is expected. Since the business units' have their own objectives as well and have to account for the agreements they make internally, they are less positive about the IT-tool. However, since the tool will make the comparison between the objectives and the capacity easier, they will benefit from the implementation as well which implies a positive attitude.

Ensuring that the strategic agreements that are made by the board of directors and the sales department are in line with the internal budget is the responsibility of the *business control* department. Their attitude towards the change is likely to be positive, since it makes their job to translate agreements to the budget easier. Their job is mainly executive and therefore their power level in change processes is low.

Several hospitals are currently recruiting capacity managers to set up a *capacity or operational excellence team*. Since it is relatively new for the hospitals, and trust has to be build, the capacity teams currently only have mediocre power. Their influence is mainly of an advisory type. However, it is the capacity teams' main task to ensure an efficient use of resources. Using the translation tool is a big improvement in the process of the capacity teams and therefore their attitude is likely to be very positive.

The *medical specialist company* of a hospital has a supporting and advisory role for the Board of Directors. Therefore, their power in changing the way of working will be relatively low. Moreover, the new way of working will not directly influence their activities, resulting in their attitude towards the change being neutral.

In order to define the capacity schedules of the resource types, *planners* are generally involved. They form a schedule commissioned by the department managers and based on preferences from the specialists. When the IT-tool is implemented, they can give less attention to personal preferences, which could make their job more difficult. However, their position in the hospital's hierarchy is relatively low and therefore they have little power in and influence over the change process.

The last stakeholders are the *specialists*, playing a key role in the care delivery. Since they are essential in the process and could quit their job if they are not satisfied, their power is high. In this research, the specialists are expected to show some resistance. According to the interviews, this results from their objective to have enough surgery time when they need it, while the Board of Directors' goal is to have a financially healthy and efficient organization of activities. For the Board

of Directors it is important to divide the surgery time in a way that there is enough capacity for each business unit to fulfill the production objectives. The resistance from the specialists results from a lack of trust in the capacity managers and fear of not having the operating time when they need it. Following the abovementioned advise, it could be helpful to explain to the specialists how the calculation model works. Once the specialists agree with the calculations, this increases the trust that the specialists have in the results of the model. As indicated previously, they are used to a certain amount of capacity that they got assigned. Over the years they have built-up this amount and they might not be willing to give this capacity up. It is key that common trust is built between the specialists and the capacity team, implying that when the specialists need capacity they will still get it, but only hand in the capacity that was assigned to them while they do not need it.

7.1.6. Learning

The last part of the change process is examining how the change leaders can learn from their experience and how they can help others to involve themselves in a process of learning (Hayes, 2014). This is relevant in the change process because the organizational effectiveness is partly determined by the quality of individual and organizational learning throughout the change process (Hayes, 2014).

7.2. Conclusion for case hospital

For the case study hospital, this roadmap for change implies some steps that need to be taken towards a new way of working. The need for change is identified on a general level, but it is important that all stakeholders are aware of this need for change and understand the underlying problem. For the case hospital, it is identified that their way of working must be changed for a successful implementation of the IT-tool. The main difference between the current situation and the desired situation is the addition of a capacity manager/team. It is important for the case hospital to position the capacity team in a way that they have influence and an important role in the communication within the hospital. In the process flow of the capacity team, the case hospital should use the IT-tool to support and validate the decisions they make. Based on the collaborative transformation change strategy, the situation must move towards the desired end state with the involvement of all stakeholders. In the case study hospital the capacity team is the leader of this change. Therefore it is their responsibility to schedule meetings with the different departments, business units, team leaders and specialists. These meetings should be used to explain and involve all stakeholders in the transformation. As indicated above, some resistance from the specialists is

expected during the implementation. In order to reduce these opposing forces, the case hospital could identify the current surgery time of each specialist and compare this with the forecasted values. It is likely that the sum of surgery time throughout the year will not change very much, since the budget is based on history as well. The main difference lies within the fluctuations and flexibility in the surgery time per week. This information can be used to explain to the specialists that their total surgery time will not change very much. Moreover, they will receive the surgery time that they need, each week. Supporting this conversation with the numbers will help convincing the specialists that the change is a good change. Once the change is implemented, the case hospital should provide learning modules to their employees. In order for the new way of working, including the capacity team, to be continuously evaluated and improved, all stakeholders should be able to provide input for improvement. Moreover, it could be helpful to ensure that the stakeholders are aware of new features and updates of the IT-tool.

8. Conclusion and discussion

In this chapter, a conclusion is drawn on the results from the performed research. The research question and its sub-questions are generally looked back at and answered. Afterwards, several points of improvement are discussed. Lastly, recommendations for ChipSoft are given considering future developments. After reading this chapter, it is clear how the lack of insight in the production budget and the relating capacity budget is increased with the use of the designed tool.

8.1. Conclusion

This thesis formulated an answer to the research question through several research phases. Based on these phases, a conclusion will be given to summarize the answer to this research question. Based on the problem identification and the relevant context discussed in the introduction, the following research question was formulated:

"How can the process of translating health insurer agreements to capacity planning be supported with a user-friendly tool and to what requirements must the design of the tool adhere?"

From both the theoretical framework and the interviews that were held in phase 2, it is concluded that the current process lacks integration. The hierarchical levels described in section 3.2 follow a top-down structure with little communication back and forward. The same conclusion is drawn from the interviews with hospitals: little input is received and provided between each level. This results in a lack of knowledge about the production performance of the hospital which makes it difficult for department and capacity managers to achieve efficient capacity use. The process is even more obstructed by the lack of knowledge, the sales department has difficulties with making feasible negotiations and often has a weak(-er) negotiation position because of this.

Both literature and the interviewees indicate that it is desirable to know how much capacity is required for the budgeted care delivery, gaining insights in the feasibility of the objectives for next year. Important to keep in mind while designing the tool are both the understandability and usability by different stakeholders. Moreover, attention should be paid to the seasonal pattern. Currently it is not known at what moment the demand is expected and therefore the managers cannot anticipate on this knowledge. Lastly, it is important that the desired process is designed in such a way that each level communicates with each other. The goal is to achieve an integral management of capacity in which communication and trust between all stakeholders are key.

In phase 3, a two-fold solution design is described. A calculation model is designed to translate the production budget per care product to required capacity. This is done on the basis of

capacity profiles per care product. These profiles are based on historical data and indicate the required amount of and relationship between each capacity type. Added to the capacity profiles, the hospital's internal budget and the historical seasonal pattern are identified as important influences and therefore incorporated in the capacity calculations. Besides the calculation model, the solution design indicates the desired process flow, which implies a new way of working. Based on the conclusions of phase 2, a design for the output visualization is made that follows the identified desired process with three different output screens.

The calculation model and the solution design are both applied to a case study in phase 4 of the research. From this application it can be concluded that the model correctly follows the desired process flow, both in calculations and the visualization of outputs. Moreover, a validation was done on the results of the calculation model. From this validation it can be concluded that the high-level predicted values are in line with the realized values and therefore the model is a good first indicator of the expected required capacity.

After designing a solution, phase 5 gives an advise on how to implement the solution, keeping in mind the different way of working that is required. Based on phase 5, it is concluded that it is important to involve all stakeholders. The main focus is on the lack of trust of specialists.

8.2. Discussion

This thesis started with explaining the situation in which patients of specific health insurers had to be denied care because the production ceiling was reached. After implementing the current solution design, data and knowledge is generated that can be used in the negotiations for next year. This way, the sales department of the hospital has information and numbers that support their objectives for next year. This way, the production agreements with health insurers are more in line with the expectations and capacity use is more aligned with the demand. This decreases the chance that patients of specific health insurers have to be denied.

For example, based on last years' results of the IT-tool the hospital knows that they had to refuse patients for a total hip replacement surgery. Moreover, the IT-tool learned them that they frequently had capacity available for hip replacement surgeries that was not used, because it was not in line with the production budget. Besides, they know that 50% of their hip replacement surgery patients are insured with health insurer A and 50% with health insurer B. With this information they are empowered to negotiate with each of their health insurers that their budget should increase next year because the results of the model indicate that there is room and demand

to fill this production budget. This way, the IT-tool can result in a change of negotiations between the health insurers and the hospitals.

Many other changes are currently developing in the health care sector. Examples are substituting or exchanging specific hospital care with general practitioners or other hospitals, efficiency programs that decrease the stay of the patient and the continuous shortage of employees. The developed tool is a first set-up to calculate different scenario's and their consequences. A concept that is currently upcoming is exchanging specific care between hospitals that are most experienced in that specific care. If one hospital is specialized in hip replacements and another hospital in knee replacements, the IT-tool could give insights in the required capacity if each hospital would only perform the replacements of their specialization. The current tool should be further developed to calculate with such scenario's and enabling the relevant managers to make decisions based on the resulting outcomes.

Another suggestion for future development of the tool is focused on the seasonal pattern of the calculation model. It is a unique selling point for ChipSoft, compared to competitors, that the model incorporates a seasonal pattern. However, the pattern could be more specified in order to achieve better weekly forecasts. A factor that should be taken into account is the difference between coincidental events and recurring events. If in one week a department is overproducing or under producing, that could be very coincidental, dependent on the demand of the patients. On the other hand, it could be the consequence of an event that is not so coincidental. For example, the flu epidemic is a concept that returns every year around the same time. Other events like national population screenings that can result in an increased demand at specific moments should be integrated as well. This way, the seasonal pattern can be adjusted and return the best prediction for the weekly required capacity.

Another recommendation for future development concerns the results of the outpatient clinic. For the outpatient clinic, the model currently calculates the amount of hours that are required for the new patient and control patient consultations. However, the outpatient clinic schedules the capacity in terms of consultation hours (*Dutch: spreekuren*). Moreover, other types of consultations can be part of such consultation hours, such as small operation consultations and telephone consultations. The consultation hours are based on specific sub-specialisms. For example, within the orthopedics department there is an arthrosis consultation hour. Based on the current results,

required time per specialism and consultation type, the outpatient clinic manager cannot schedule consultation hours yet.

The last recommendation concerns implementing a so-called plan margin. In the current results for the operating theatre, it is assumed that each operating room is scheduled perfectly. However, it can occur that at the end of a surgery day, 20 minutes of surgery time are not used because there is no surgery with that length. This implies that the current results of the model underestimate the total required surgery time. Using a plan margin could solve this problem, for example adding a plan margin of 10% to the required surgery time and enabling the user to adjust this plan margin according their wishes. Important to keep in mind that a specialism with mainly surgeries with a short duration do not need a plan margin that is as big as the plan margin of a specialism with mainly surgeries of a long duration. How to best identify a plan margin for different situations should be investigated further. The same problem exists for the inpatient clinic. The model calculates the number of beds based on the assumption that each bed is continuously used.

It can be concluded that the designed IT-tool is a good improvement of the current situation, with many possibilities for future development. The calculation model and the visualization of the results are currently being developed within the HiX software of ChipSoft, by a HiX programmer. This indicates that ChipSoft believes in the potential of this research and its results. A screenshot of the developments of the (Dutch) IT-tool in HiX, up to now, is shown in Figure 27.

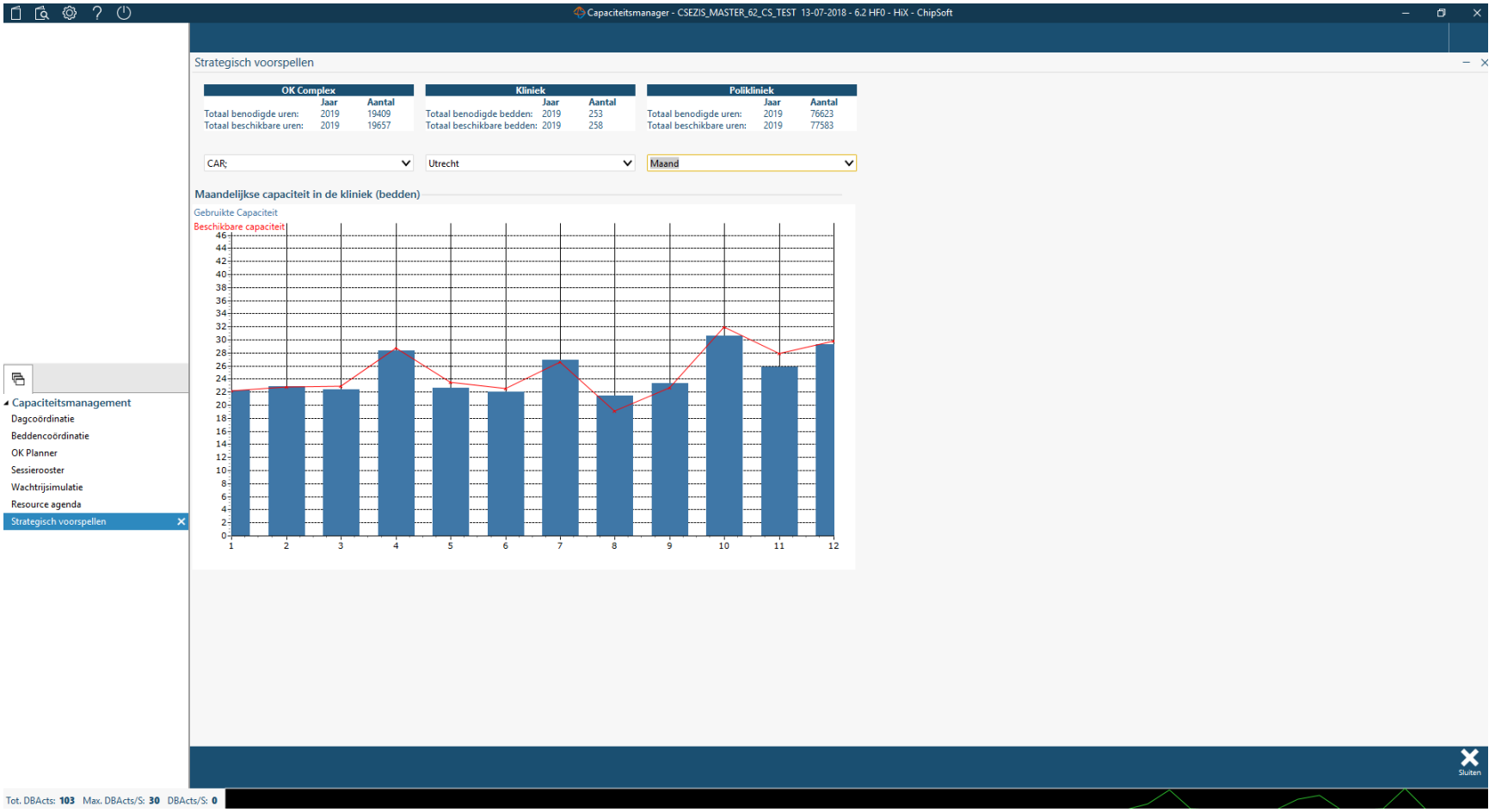

Figure 27: Screenshot first mock-up strategic tool

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Appendix A: Literature Study Method

The protocol used for this literature study is based on the literature review protocol that was described by (Vanwersch et al., 2011). Since the protocol does not incorporate time constraints, the protocol is used as a base but is adapted to the limited time available. This appendix describes the approach that is used to conduct the literature study which is the base for the theoretical framework of this research. First it is described how the literature is collected. Thereafter the literature selection strategy is explained.

A.1. Literature collection

The literature collection consists of a primary search and a secondary search. The primary search is used to identify an initial set of studies (Vanwersch et al., 2011). The primary search is then followed by a screening of relevance and quality, based on several criteria for inclusion or exclusion (Vanwersch et al., 2011). Based on the resulting relevant studies, forward and backward tracing techniques are used to identify additional relevant studies (Vanwersch et al., 2011). These are also screened for relevance and quality.

The search engines that are used for this literature study are Scopus, PubMed and Web of Science. These search engines are consulted with a combination of search terms that cover specific areas. This implies that the search term must involve a certain planning level, an activity related with decisions about capacity, the object under consideration and the environment in which the decisions are made. The different areas and their relationships are shown in Figure 28.

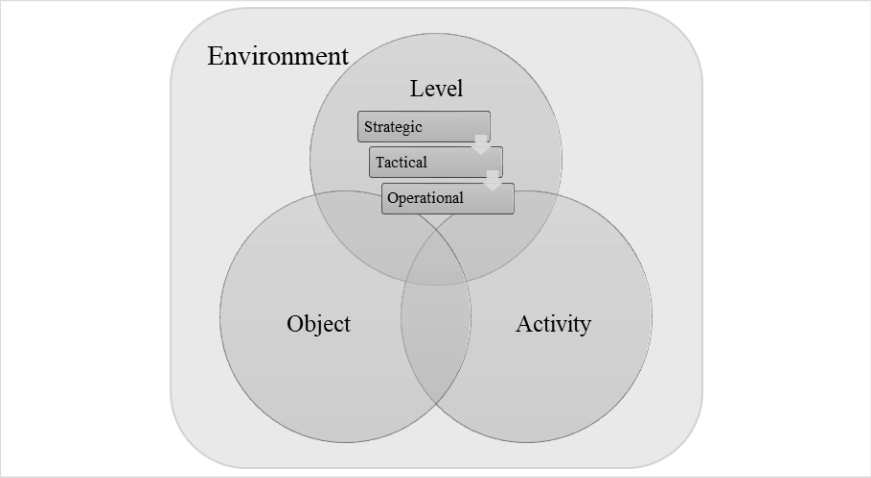

Figure 28: Different research areas for search term definitions

The search terms that are used, resulting from the different areas, are illustrated in Table 4. The asterisk is used when multiple conjugations of the word are useful for the review. Because of time constraints, the search areas level, activity and object for these search terms are limited to the

title of the article. The environment search area is limited to the title, abstract and key words of the article. Within each level an OR-relationship is used between the search terms and between each level an AND-relationship is used.

Table 4: Search terms covering 4 different areas

Level	**Activity**	**Object**	**Environment**
Strategic	Appointment	Patient*	Health care
Tactical	Schedul*	Resourc*	Healthcare
Operational	Plann*	Hospital	Hospital
	Control*		
	Decision*		
	Logistic*		
	Allocate*		

A combination of the search terms is used in each search engine, combined with a filter on the publication years. In order to find the most recent and relevant articles, the publication years of the articles must be between 2000 and 2018. The results are checked for duplicates. The search query and results per search engine, as well as the number of unique results are shown in Table 5.

Table 5: Results query per search engine

	Scopus	**PubMed**	**Web of Science**
Search query	(TITLE (strategic OR tactical OR operational) AND TITLE (appointment OR schedul* OR plann* OR control* OR decision* OR logistic* OR allocat*) AND TITLE (patient* OR resourc* OR hospital) AND TITLE-ABS-KEY (health AND care OR healthcare))	((((strategic[Title] OR tactical[Title] OR operational[Title])) AND (appointment[Title] OR schedul*[Title] OR plann*[Title] OR control*[Title] OR decision*[Title] OR logistic*[Title] OR allocat*[Title])) AND (patient*[Title] OR resourc*[Title] OR hospital[Title])) AND ("health care"[Title/Abstract] OR healthcare[Title/Abstract])	TITLE: (strategic OR tactical OR operational) AND TITLE:(appointment OR schedul* OR plann* OR control* OR decision* OR logistic* OR allocat*) AND TITLE: (patient* OR resourc* OR hospital) AND TOPIC: ((health AND care) OR healthcare)
Years	2000-2018	2000-2018	2000-2018
Results	73	31	38
Unique results		76	

A.2. Literature selection

The results of the primary search are selected based on relevance and quality. For this screening procedure, criteria are used that evaluate whether the article should be excluded. These criteria are applied to the articles in the same order, and if an article does not meet the criteria it is excluded from the literature search. The exclusion criteria are:

1. The article must be English or Dutch.
2. The focus of the article must be on health care.
3. The focus of the article must be on capacity or resources.
4. The object under consideration is preferably a hospital, or a health care organization that can be generalized to hospitals.
5. The article must focus on either health insurers or at least one of the planning levels (strategic, tactical, operational), implicitly or explicitly.
6. The article must be available online.

The results of the primary search are narrowed by using the selection criteria, which results in a small range of articles. This small range is then investigated more extensively and the

references of the articles are searched for relevant literature as well by snowballing. The results of the exclusion procedure are shown in Table 6. Moreover, in Appendix A the list with all articles is added, including the exclusion criterion for each article.

Table 6: Exclusion procedure and resulting amount of articles

Exclusion criterion	Articles left
1. English or Dutch	76
2. Focus on health care	76
3. Focus on capacity/resources	40
4. Hospital/health care organization	32
5. Health insurers/planning levels	23
6. Available online	16

A.3. Evaluation of literature selection

After scanning the resulting 16 articles and evaluating the relevance of the articles, one article remains to be used in the literature review which is referred to with 'primary' in the first column of Table 7. After snowballing through the references of all 16 articles another 6 articles are found to be relevant articles and are referred to with 'snowball' in the first column of Table 7. When evaluating these results, it is concluded that the articles are relevant within each planning level. However, literature about the entire process of capacity management is lacking, as well as articles about health insurance and the health system in the Netherlands. The latter is explained due to the fact that such information is mostly documented in background studies and little in academic literature. Therefore additional information is searched in background studies, resulting in an addition of 4 articles concerning the Dutch health care system. When reflecting on the search terms, the lack of an 'integral' term explains the fact that all articles focus on specific planning levels. The resulting articles are referred to with 'secondary' in the first column of Table 7.

In order to validate that all relevant literature is incorporated in this literature review, an expert opinion is obtained with the manager of capacity management at ChipSoft. Upon this recommendation, the publications of CHOIR are consulted. CHOIR is a research center within the University of Twente, focusing on healthcare operations improvement and research and publishing articles that are very relevant for this review, incorporating the integral process of capacity

management as well. This results in an addition of 7 articles to the review, bringing the total amount of articles to 18. These articles are shown in Table 7 with the term 'expert' in the first column.

Table 7: Resulting articles of each search

Search	Article
Primary	Hulshof, P. J. H., Boucherie, R. J., Hans, E. W., & Hurink, J. L. (2013). Tactical resource allocation and elective patient admission planning in care processes. *Health Care Management Science*, *16*(2), 152–166. https://doi.org/10.1007/s10729-012-9219-6
Snowball	Hans, E., Van Houdenhoven, M., & Hulshof, P. J. H. (2011). A Framework for Health Care Planning and Control. *Chemistry & ...*, 1–23. https://doi.org/10.1007/978-1-4614-1734-7
Snowball	Hulshof, P. J. H., Kortbeek, N., Boucherie, R. J., Hans, E. W., & Bakker, P. J. M. (2012). Taxonomic classification of planning decisions in health care: a structured review of the state of the art in OR/MS. *Health Systems*, *1*(2), 129–175. https://doi.org/10.1057/hs.2012.18
Snowball	Murray, M., & Berwick, D. M. (2003). Advanced Access: Reducing Waiting and Delays in Primary Care. *JAMA*, *289*(8), 1035. https://doi.org/10.1001/jama.289.8.1035
Snowball	Vissers, J., & Beech, R. (2005). *Health operations management : patient flow logistics in health care*. London : Routledge.
Snowball	Vissers, J. M. H. (1998). Patient flow-based allocation of inpatient resources: A case study. *European Journal of Operational Research*, *105*(356). Retrieved from https://ac-els-cdn-com.eur.idm.oclc.org/S0377221797002427/1-s2.0-S0377221797002427-main.pdf?_tid=fad609d0-75b0-4e86-aeed-1f083b7a1e2f&acdnat=1522068946_d8ef5b2206d83cd7a0af116c0706ed64
Snowball	Vissers, J. M. H., Bertrand, J. W. M., & De Vries, G. (2001). Production Planning & Control A framework for production control in health care organizations A framework for production control in health care organizations, *12*(6), 591–604. https://doi.org/10.1080/09537280175039771 6org/10.1080/095372801750397716
Secondary	Heida, J.-P. (2008). *Onderhandelen met zorg Achtergrondonderzoek naar het contracteren van zorg door verzekeraars en zorgaanbieders*. The Hague. Retrieved from https://www.raadrvs.nl/uploads/docs/Achtergrondstudie_-_Onderhandelen_met_zorg.pdf
Secondary	Kroneman, M., Boerma, W., Van Den Berg, M., Groenewegen, P., De Jong, J., Van Ginneken, E., … Van De Ven, W. P. M. M. (2016). Netherlands Health system review Health Systems in Transition, *18*(2). Retrieved from http://www.euro.who.int.eur.idm.oclc.org/__data/assets/pdf_file/0016/314404/HIT_Netherlands.pdf
Secondary	Kuijpens, J., de Booij, K., & Nijbroek, M. (2018). 'Geachte patiënt, u bent bij ons tijdelijk niet verzekerd voor deze behandeling.' *Fizier*, *35*(2), 14–17. https://doi.org/10.1007/s40739-018-0016-2
Secondary	Wammes, J., Jeurissen, P., Westert, G., & Tanke, M. (n.d.). Netherlands : International Health Care System Profiles. Retrieved June 22, 2018, from https://international.commonwealthfund.org/countries/netherlands/

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Appendix B: Interview questions

In this appendix the interview questions that were used during the analysis & diagnosis phase are described. All interviews were held in Dutch, therefore the questions are shown in this appendix in Dutch but with an English translation.

Zorginkoop:

Care purchasing:

1. Wie is er verantwoordelijk voor de zorginkoop?
   Who is responsible for purchasing care?
2. Wie is er betrokken bij het maken van de afspraken?
   Who is involved in making the agreements?
3. Hoe wordt het maken van afspraken voorbereid?
   How do you prepare for making the agreements?
4. Waar wordt jullie voorgestelde prijslijst op gebaseerd?
   What do you base your proposed price list on?
5. Welke input zou beter/wenselijk zijn om beter voorbereid in deze onderhandeling te gaan?
   What input would be better/wished for to enter this negotiation more prepared?
6. Wanneer wordt er extra zorg bij gecontracteerd?
   When do you extend your contracts for more care?
7. Bereiken jullie vaak je omzetplafond?
   Do you often reach the production ceiling?
   a. Op basis van welke afspraken? (hoofdomzet of detailafspraken)
      Based on what agreements? (turnover or detailed agreements)
   b. Hoe wordt met deze informatie omgegaan in toekomstige afspraken met zorgverzekeraars?
      How is this information used in future agreements with health insurers?

Van zorginkoop naar strategisch:

From care purchasing to strategic:

8. Wordt de zorginkoop gebruikt om op strategisch niveau capaciteit te plannen?
   Is the care purchasing used to plan capacity at the strategic level?
   a. Zo ja; hoe en door wie?
      If so; how and by whom?
   b. Zo nee; waarom niet?
      If not; why not?
9. Welke andere input wordt er gebruikt voor een strategische planning?
   What other input is used for a strategic planning?
10. Wanneer en hoe vaak wordt er een evaluatie gehouden om het begrootte en het gerealiseerde capaciteitsgebruik te vergelijken?
    When and how often is an evaluation held to compare the budgeted and realized capacity use?
    a. Hoe?
       How?
11. Hoe wordt er momenteel ingespeeld op de resultaten van de evaluatie in vraag 10?

How are you currently anticipating the results from question 10?

12. Hoe zou deze evaluatie meer structuur en frequentie kunnen krijgen volgens jullie?
    How should this evaluation get more structure and frequency according to you?
    a. Waarom gebeurt dit momenteel niet?
       Why is this currently not happening?
    b. Hoe zouden jullie daarin ondersteund willen worden?
       How would you like to be supported in this proces?
13. Welke gevolgen ervaren jullie door het gebrek aan input van bovenliggend level?
    What are the consequences of the lack of input from the upper levels?
14. Naar welke tijdsperiode kijken jullie voor een strategische planning?
    What is the time period that is used for the strategic planning?

Van strategisch naar tactisch:

15. Wordt de zorginkoop en de strategische capaciteitsplanning gebruikt om op tactisch niveau capaciteit te plannen?
    Is the care purchasing and the strategic capacity planning used to determine the capacity planning at tactical level?
    a. Zo ja; hoe en door wie?
       If so; how and by whom?
    b. Zo nee; waarom niet?
       If not; why not?
16. Welke andere input wordt er gebruikt voor een tactische planning?
    What other input is used for the tactical planning?
17. Wie is er bij betrokken en verantwoordelijk voor de tactische planning?
    Who is involved with and responsible for the tactical planning?
18. Wordt er op tactisch niveau ook vergeleken met de begroting?
    Is the tactical planning compared with the budget?
    a. Hoe vaak en wanneer?
       How often and at what times?
    b. Wie is er betrokken?
       Who is involved?
19. Hoe zou deze evaluatie/monitoring meer structuur en frequentie kunnen krijgen volgens jullie?
    How would you like to give this evaluation/monitoring more structure and frequency?
    a. Waarom gebeurt dit momenteel niet (volledig)?
       Why is this currently not done?
    b. Hoe zouden jullie daarin ondersteund willen worden?
       How would you like to be supported in this process?
20. Welke gevolgen ervaren jullie door het gebrek aan input van bovenliggend level?
    What are the consequences of the lack of input from the upper levels?
21. Naar welke tijdsperiode kijken jullie voor een tactische planning?
    What is the time period that is used for the tactical planning?

Van tactisch naar operationeel:

22. Hoe wordt de operationele planning gemaakt?

How is the operational planning made?

23. Wie is er verantwoordelijk voor en wij is er bij betrokken?
    Who is involved with and responsible for it?
24. Welke input wordt er momenteel gebruikt?
    What input is currently used?
    a. Betrokkenen per input aanlevering?
       Who is involved with this input?
25. Welke input zou beter/wenselijk zijn?
    Which input would be better or desirable?
26. Hoe worden de andere levels en de zorginkoop momenteel gebruikt?
    How are you using the other levels and care purchasing currently?
27. Hoe worden er online wijzigingen doorgevoerd als dat nodig is?
    How are adjustments currently made in the planning (when required)?
28. Wordt er op operationeel niveau ook vergeleken met de begroting?
    Do you compare the operational planning with the budget?
    a. Hoe vaak en wanneer?
       How often and at what moments?
    b. Wie is er betrokken?
       Who is involved?
29. Hoe zou deze evaluatie/monitoring meer structuur en frequentie kunnen krijgen volgens jullie?
    How would you like to give this evaluation/monitoring more structure and frequency?
    a. Waarom gebeurt dit momenteel niet (volledig)?
       Why is this currently not done?
    b. Hoe zouden jullie daarin ondersteund willen worden?
       How would you like to supported with this?
30. Welke gevolgen ervaren jullie door het gebrek aan input van bovenliggend level?
    What consequences do you experience from the lack of input from the upper levels?

Appendix C: Results of the interviews

In this appendix the results of the interviews are transcribed and coded. The descriptions are divided in the five categories that are discussed in Chapter 4. The legend for the marked text is as follows:

Wishes/desires
Stakeholders
Bottlenecks
Balance
Process

Hospital A

Functions of interviewees (0:00 – 2:00)

Interviewee 1: Business controller with a focus on sales, purchasing care. Besides that I look at cost prices and I am involved with contracting care.

Interviewee 2: Department head care logistics. I'm involved with capacity management within the hospital. Capacity planning, outpatient clinic, clinic, operating theatre and in- and outflow from and to other care organizations. Corporation with sales when plans are to make changes within our care portfolio, this way we know whether it is going to fit or whether adjustments in the capacity are necessary.

Care purchasing process (2:00 – 14:00)

What does the care purchasing process look like?

Interviewee 1: The sales conversations with health care insurers start around the summer. These conversations look at the quality, capacity and financials. First an agreement is made on the size of the contract, consisting of an all-in amount of X million euros. Based on this contract size, agreements are made about the price list of each care product. In such sales conversations it is common that there are certain products that the hospital doesn't want to buy anymore. These follow from trends, for example the trend that prostate treatments are done more in provincial organizations, which will eventually will be done even regionally. These are movements that are taken into consideration. On the other hand it can also be that the insurers don't want to buy certain care products from our hospital. Besides this there also exist certain internal movements, specialisms that want to do their job differently. From these movements all sorts of capacity and financial questions result.

How is this price list determined?

Interviewee 1: The prices for the price list are determined by the hospital, based on our cost price and some margin. Not each product covers its costs, that's not realistic to achieve. Therefore all prices are filled in, an observation is done on the deviations from previous years and attention is payed to specific objectives that fit within the policy, mission and vision of the hospital.

So the realized numbers of last years are not taken into account yet?

Interviewee 1: This is already done within the budgeting process. In this process it is investigated what turnover the hospital wants to realize. Usually this is the same as previous years plus some growth. Based on this the hospital knows that if the budget has to grow 2% with the same capacity, the price has to increase with 2% as well.

Does this process consult with logistics as well? To validate if the anticipated growth is possible with the available capacity?

Interviewee 1: This usually happens in consultation with the departments. Each month they sit together with the business controllers to see what the agreed upon production for that month was and whether this is being realized.

And at the start of the year? Is than checked whether the anticipated production for the year is achievable with the available capacity?

Interviewee 1: It is always consulted with the specialisms whether it is an achievable production. The specialists judge this together with the cluster managers.

Interviewee 2: Before this process, the capacity is also incorporated in the budgeting process. For example, if we want to do more hip replacements, we check if there is room to grow in the related department, not only the operating rooms but the clinic as well.

Before the negotiations with the health insurers begin?

Interviewee 2: Yes, these kind of decisions are more strategically, they don't change every year. Otherwise you would have to turn around your entire hospital each year, after negotiating with the health insurers.

Interviewee 1: Besides, we assume that such strategic movements are budget-neutral. For these movements it is checked whether we have enough capacity at the right places.

How do you check this?

Interviewee 1: We use a tool that calculates different scenario's. These scenario's come from the Board of Directors, and based on their decisions or proposals we use the tool to calculate the consequences.

Interviewee 2: This is mostly financial, the same decisions are also calculated in terms of bed occupancy, organization of the clinic, impacts for departments, etc. That's my responsibility. It is important to keep overviewing the entire process/chain of care.

Who is involved in this care purchasing/budgeting process?

Interviewee 1: The Board of Directors makes the agreements with health insurers and are represented by the concern controllers, someone from the medical specialist company and someone from sales. These three negotiate within a mandate set by the BoD and make different kinds of agreements. Year agreements, ceiling agreements, p*q. This is the base for the price list. It is desirable to make more integrated contracts. For example combining agreements in the hospital with the home care and GGZ. This way it does not matter where the production is made and care can be more easily substituted.

Monitoring agreements (14:00 – 19:00)

Do you monitor whether each specialism is within its agreement?

Interviewee 1: Within each health insurer agreement we monitor whether we are within the agreement production or whether there are values at risk. If we exceed an agreement with a certain health insurer we have to decide what to do and see whether we can increase the budget. Within the same health insurer it does not matter how the relations between each care product are, so if the number of hip replacements is lower than expected and the number of groin ruptures are higher, they are allowed to balance each other out.

How do you monitor this?

Interviewee 2: Each month we have a tactical planning consultation together with the medical specialist company, sales and care logistics to discuss how we did the past month, what the prognoses are, is a specialism lacking behind or running ahead. We also look at the access times, the waiting times and the bed occupancy. If it is necessary you can still adjust some things. For these numbers we use an IT-tool. In such consultations we also discuss things like the influenza epidemic and how to deal with that. So on a high level agreements are made and each month we evaluate how we are doing.

Translating to capacity (19:00 – 33:00)

Are the agreements translated to a weekly or monthly capacity plan for the year?

Interviewee 2: That's something we don't do very specifically yet, but it's on the planning for the future. It is desirable to know for each care product not only the financial price, but also the capacity for the product. For example, each hip requires a certain amount of outpatient clinic time, an amount of operating theatre time and an amount of clinical time. We already try to do this for the outpatient clinic schedules, we very simply distract how many time is required based on the desired turnover. It's not higher mathematics, just dividing the total capacity over the number of available weeks. We want to keep it simple for the employees, to make sure they can use the information to steer their department.

Is the operational planning also your responsibility?

Interviewee 2: The hospitalization department is responsible for the OT planning and they are within my responsibility. The outpatient clinic does their own planning but they do align with the OT planning, weekly or two-weekly (depending on the size of the department).

Is the operating theatre leading in the planning?

Interviewee 2: No, it is about the balance between access times and waiting list. We try to approach this as integral as possible. It is desirable for the future maybe to have an integral planning office in which the time slots for each department are already set and aligned. The completion of these slots can then be done by the departments itself.

On what is this operational planning based?

Interviewee 2: This is based on the capacity cycle. The agreements made at strategical level are translated to a tactical level and these are translated to an operational planning. If changes are made they follow this same cycle and are evaluated at each level, continuing within the cycle.

Do you have the feeling that you are ahead of other hospitals at this topic?

Interviewee 2: Yes, at some steps we are further than others.

Interviewee 1: The lines within the hospital are very short.

Interviewee 2: We could try to organize this process with more structure and with the support of our systems. It is about balancing the triangle between quality, capacity and finance and calculating different scenarios and processes with an integral view. We are already doing that quite well, but the structure is lacking. For example, the budgeting cycle, you want to look at the cycle at the right time in a year, such that action can be undertaken and observations can be anticipated. It is important within this cycle to all talk the same language. The financial length of stay is essentially different from the capacity length of stay.

In what period is the operational planning made?

Interviewee 2: The operational planning is a rolling planning of 6 weeks, in week 1 the planning is made for week 7. The nursing employees get their planning even earlier, we leave some room in the planning which we fill from a flex pool. So when it's going to be busy we can adjust the planning where necessary. That is the operational offline planning. The operational online planning consists of a consultation each day, discussing how the bed occupancy and staff is going to look like tomorrow and the day after tomorrow. That is the daily steering together with the unit leaders of the clinical departments, the IC unit leaders, the ED unit leader and a planning employee.

Designing a tool (42:00 – 44:00)

What are requirements for a supporting IT tool in this process?

Interviewee 2: I think it is very important that the tool is usable and understandable for the employees on the work floor. We are not waiting for very complicated tools, for a capacity manager a more complex tool is fine, but it must be possible to have a simple view that easily translates to what the employees must do. Interpretation is a key term, the user must know what to do and understand the cause-consequence of what he/she sees.

Hospital B

Functions of interviewee (0:00 – 2:00)

Interviewee 1: Manager sales, my job consists for 20% of making agreements with health insurers and for 80% of internally ensuring that the agreements that are made are also fulfilled.

Interviewee 2: Program manager 'operational excellence', consisting of capacity management, care logistics and change management.

Care purchasing process (2:00 – 6:00)

What does the care purchasing process look like?

Interviewee 1: We follow a management control cycle, which starts in April with the preparations for the agreements of the following year. Together with the planning and control department, each specialism is visited to discuss the resulting numbers of the past year. These are numbers in terms of market information, number of patients, GP referrals, etc. Hereafter every specialism is going to make a budget, incorporating the plans for the coming year. At the same time it is my job to negotiate with the health insurers. Both parts should be finalized in November. Than it is checked whether the external agreements match with our internal ambitions. That is translated to an internal

budget, which is leading for our capacity planning, not the health insurer agreements. So the health insurer agreements add up to a lump sum of an X amount of euro's, based on the price of individual treatments an amount is defined for production objectives per specialism.

Monitoring agreements (8:00 – 13:00)

How do you monitor and guard for over- and underproduction?

Interviewee 1: Throughout the year we monitor these production objectives in financial terms, per month. Each specialism has its own management team, which discusses these numbers each month. Unfortunately there is some registration time until these numbers are insightful of 2 months. This implies that at this moment we are looking at the numbers of two months ago. So it is difficult to steer and anticipate according these numbers because we will not see the effect of our changes until over three months. For some of the care products, specific agreements are made with the health insurers. For example for the hip replacement a specific number is agreed upon, for these numbers there is a monthly review of production to guard for over- or underproduction.

Translating to capacity (13:00 – 20:00)

How is the internal budget translated to a capacity planning?

Interviewee 2: The budget is based on what the hospital has done in previous years, our capacity plans are also based on history. It is likely that this year will be sort of the same as previous years, adjusting for some specific trends, for example the length of stay of specific treatments that are reduced due to nation-wide developments. If there are big differences happening compared with previous years the management team is involved. At operational level such changes are incorporated in the planning, but at the strategic level there is much history about the strategy and vision of the hospital. Because of such changes, it is reviewed monthly or six-monthly if we have enough capacity or not.

There is no capacity-check at the beginning of the year, when the agreements are made?

Interviewee 2: If there are no big differences between what we expect/agree upon and what we have done in the previous years, it is assumed that there is enough capacity.

Interviewee 1: Some market developments influence this as well. If in our nearby surrounding no more eye-surgeries are done in the eye-clinic, it is expected that these patients will come to us. Than we have to re-negotiate with the health insurers and add OR and clinical time to make sure that we have the capacity for these extra patients.

Designing a tool (33:00 – 35:00)

Interviewee 2: It is desirable to be able to look at our planning in an integral, managerial manner, but based on the patient. To know how the patient flows through the hospital and to adjust and relate the capacity accordingly.

Hospital C

Functions of interviewees (0:00 – 0:30)

Interviewee 1: Manager care purchasing and strategy
Interviewee 2: Manager care logistics

Care purchasing process (0:30 -12:00)

What does the care purchasing process look like?

Interviewee 1: The sales process is a structured process that results in contracts that are finished in January. At this point it is known what the total budget for the year is. Hereafter, people are mostly formulating the price list to make sure it adds up to the total budget. It's about constructing the right prices p and deciding the right amounts q that together p*q adds up to the total budget.
The remainder of the process cannot start until the price list is finished, so January and February focus on this part of the process. Around march the process starts for the next year again. Each business unit (RVE) is asked what their plans are for next year and the current results are monitored. We currently use a tool to predict what the results of the current year are going to be. There's a lot of fuz being made about this prediction because the results of the tool are very fluctuating. With man and power we try to make this prediction into a stable forecast. These numbers are combined with the knowledge of the business units about what is going to happen upcoming year. Possible events are that the units are introducing new treatments, or a cooperation with another hospital. This results in the salesletter in June/July, a policy document that shares the forecast for next year. Then in September the negotiations start and in November the contracts are being set up. The key of the process is that is is about the triangular relationship between sales, budget and capacity.
Interviewee 2: It are simultaneous processes. In the budgeting process the departments of finance and capacity and the business unit managers are involved.

Are specific agreements made about de pricelist and the realization?

Interviewee 1: In previous times the hospital had enough financial room to correct any differences. However, currently the prices are more and more evolving and therefore it becomes more important that we make a point landing. If we agree an amount X, we don't want to produce anything more or less than X. This research is therefore quit interesting. In one way or another the realized care in the year must be tweaked to make sure that the realization does not exceed or fall short compared to the budget.

At what point in time does the current tool allow you to make a trustworthy prediction about where you are going to land in a year?

Interviewee 1: The forecast does not get really reliable until October, but at that point in time we can do it ourselves as well and then it is to late to make any adjustments. It's hopeless for the Board of Directors because they cannot make any substantiated decision about such questions.

What input would be better/wished for to enter this negotiation more prepared?

Interviewee 1: Currently there is no link between sales and the budget. Based on the sales forecast a budget is calculated by the finance department and based on that the entire budget is filled and finalized. However, when the BoD adjusts the forecast, the entire process of filling the budget has to start again. And even when the budget is final, it is based on several assumptions that can change

as well. Every time something chances, the entire circus has to be executed again. It is a time-consuming iterative process, moving back and forward in a triangle.

How is this budget used in the hospital's further operations?

Interviewee 2: Based on the production budget the capacity is divided in a blue print which is fixed for 16 weeks. Based on the production budget it is calculated how many OR hours are required for example and translated to a block diagram for each 4 months. These schedules incorporate some flexible capacity which is spended each 8 weeks. The block diagrams are synchronized with the moments at which the performance is monitored. Currently, this process does not incorporate a seasonal pattern, but it is desirable to gain more insights.

Monitoring agreements (15:00-18:00)

When and how often is an evaluation held to compare the budgeted and realized capacity use?

Interviewee 2: In the current year we have reviewed the budget once, looking at both the utilization and waiting list, as well as the production and the realization of agreements. For 2019 it is desirable to do this 3 times in the year. Looking at the development of the production and the reasons therefore. Since the prediction of the production is very unreliable it is currently not desirable to do this monitoring more often. The unpredictability of the production results in big changes that have to be made every time the production is monitored, that is not desirable to do even more than 3 times per year.

Translating to capacity (18:00-20:00)

Are the agreements about the production translated to required capacity?

Interviewee 2: The business units are asked to propose the productionbudget for next year. This is calculated to the amount of capacity required for this budget. If this does not fit within the ceiling, another mix of production must be chosen to fill the ceiling (of the contract) in a different manner. This translation to capacity is made this year for the first time. For this translation another tool is used that calculates what the 'warm' capacity is related with the financial Diagnosis Treatment Combinations (DBCs). At a high-level this tool shows what the required capacity is approximately going to be and how it is changing under influence of certain big changes.

Designing a tool (20:00-25:00)

Do you think an IT-tool could support this process?

Interviewee 1: That would definetly help us. In an ideal world we would want to know for each care product what the required capacity is. For example for a hip replacement surgery we need these diagnostics, this amount of nursing days, and this amount of time an operating room. It's all quite standardized, adding this up together would result in the budget.

Interviewee 2: The question that the tool must answer is how much patients must I treat for this care product, taking into account the seasonal pattern, to achieve the production goals at the end of the year.

Bottlenecks (25:00-33:00)

What bottlenecks are currently preventing you from improving this process?

Interviewee 2: The speed of this process and improving the process over the years is slowed down because of the resistance of the surgeons. Their operating time is saint. The surgeons currently don't have the trust that if they have to give in some operating time now that they won't have it available anymore when they need it. For that one time they might need it, they want to keep their surgery time block in each week.

Interviewee 1: As a hospital it are expenses that are made when the OR is continuously not fully utilized. However, the surgeons do not experience any consequences if they do not use their operating time. We need to create a feeling of trust such that each surgeon trusts in us when we say if you need operating time, you will get it. That's currently the biggest bottleneck.

Interviewee 2: Currently each business unit is responsible for their own planning (decentral). This does not result in the most optimal filling of the or program. It's desirable to have control on the planning, earlier in the process. Currently the OR-planner's (imposed) objective is to simply fill the planning of the or. The planner does not care about wheter or not an intensive care bed is available as well, because that's not his/her job – he/she is blamed if the or planning is not fully utilized. The bottleneck here is that it is a sensitive subject for the surgeons (losing OR time) and that there is no consciousness that it's not going well. From the surgeons' and planners' perspective everything is going well, while from our hospital perspective it's not going that well.

Hospital D

Functions of the interviewees (00:00-00:30)

Interviewee 1: Manager Care and Sales

Interviewee 2: Program Manager Patient Logistics

Care purchasing process (00:30-13:00)

What does the current care purchasing process look like?

Interviewee 1: Currently the sales department makes financial agreement at high level, with only little detail. The agreements consist of a price component p and a volume component q. For each health insurer we make purchasing combinations about the volume agreements. We like to compare it with one big bag of fruit that is to be divided. We are using some prognosis tooling that predicts what care products we expect to 'produce' the coming year. The more specific the agreements are made, the bigger the chances are at 'cutting losses'. The prognoses are based on all products that have started already and a part of what we are expected to start in the remainder of the year, based on historical patterns. Because of the registration and invoicing there is a 2-month slack in the usability and trustability of the historical data. Based on this information the sales department starts making a sales plan and simultaneously the business control department starts their budgeting process. Around June the Board of Directors decides what the budget for next year must be, approximately, resulting in a framework budget. This framework budget is iteratively constructed and adjusted until in October the final budget is made.

Interviewee 2: It can be looked at as a circle that can start at any point en keeps repeating until the final budget is made. The different points at this circly concern the expected patient care demand, the required capacity and the agreed production. The resulting challenge is to make sure that all three points are aligned with each other.
Interviewee 1: The budgeting process takes place from May until October and at the same time we are thinking about what to ask from the health insurers. What we are asking from health insurers is partly based on the budget and what is in the budget is partly based on the budget. So during August until October/November we are continuously switching between the budget and the health insurer agreements. A difficulty in this process is the fluctuation in demand. Some care products have different patterns than others. For example the breast cancer volume has a two-yearly pattern, depending on the pattern of the national breast cancer research.
Interviewee 2: Another example of complications in the patterns is the influenza epidemic. For example in 2016 we had the flu season two times in one year. The flu in 2015 expanded to 2016 and the flue of 2016 start early as well. This resulted in 2017 in a very small flu epidemic. These are patterns that exceed the contracting year.

Translating to capacity
Are the agreements translated to capacity?
Interviewee 1: In August 2017 the some ORs were closing because of the summer period. The finance department did perform some calculations about the consequences of the closure for the prognosis.
Interviewee 2: With the capacity management team we performed a calculation as well about this topic, but the two calculations were never brought together. At moments with such questions you notice there is a structural need for capacity management and sales to pull together to see what changes capacity-wise if financial adjustments are made.