The design and implementation of a tool to support capacity-decisions in health-care a case-study

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Award date:
2019

Technische Universiteit Eindhoven University of Technology

Department of Industrial Engineering and Innovation Science
Human Performance Management

The design and implementation of a tool to support capacity-decisions in health-care: a case-study

Master Thesis

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Final Version

Eindhoven, February 2019

Abstract

This thesis reports on my Master thesis project that dealt with the design and implementation of a tool that supports the tactical level of planning of the operative process at Groene Hart Ziekenhuis (GHZ) in Gouda. The main research question was: How to design and implement a tool to support the tactical level of planning of the operative process at GHZ considering the relevant data and the perspectives of the stakeholders involved?

To be able to answer this question, the operative process of GHZ was studied in detail and a gap analysis comparing the current situation with the desired situation was performed. Based on the gap analysis, it was concluded that GHZ needed a dashboard to support capacity decision-making in the operative process. In the next step, a literature study on the use of a dashboard to make capacity-decisions in a health-care context and the selection of indicators to be used in this dashboard has been performed. In parallel, a stakeholder analysis was performed.

The results of the literature study and the gap- and stakeholder analyses are translated into the design of a pilot version of the dashboard visualizing its indicators and linking the scores on these indicators to (steps in) the operative process and organizational changes that might be needed on the basis of these scores. In the final part of this thesis, an implementation plan for GHZ is presented, using literature on change management, with recommendations to heighten the chances for a successful future implementation and use of the dashboard.

Executive Summary

This thesis reports on my Master thesis project that dealt with the design and implementation of a tool that supports the tactical level of planning of the operative process at Groene Hart Ziekenhuis (GHZ) in Gouda. The main research question was: How to design and implement a tool to support the tactical level of planning of the operative process at GHZ considering the relevant data and the perspectives of the stakeholders involved?

GHZ is a hospital in Gouda for the surrounding region 'Midden-Holland'. The hospital aims to serve this region 'Groene Hart' with approximately 250.000 inhabitants (Schoonhoven, Bodegraven, Zuidplas). The hospital is an average sized hospital and the revenue in 2016 was €201.000.000. During the latest decennia, the 'traditional' focus of capacity planning in the GHZ was on maximizing the utilization of the Operating Rooms (OR) However, this led to the following complications:

- Unpredictable outflow of patients to the clinics
- Schedules (Outpatient, pre-operative screening (POPS)) are inaccurate, since there are always ad-hoc changes to the schedule

GHZ started at the end of 2017 with Integral Capacity Management (ICM), which differs from Capacity Management in that it looks at the entire process as shown in Figure 1, and not just at a part of the process. In ICM there are 3 levels: strategic, tactical and operational:

- Strategic: (Annual) assessing and assigning of capacities, hospital-wide. For example: Number of outpatient sessions per specialty, number of OR sessions per specialty, number of beds per specialty, number of needed FTEs
- Tactical: Periodical adaptation and redefinition of capacities, based on actual performance levels (KPIs), and patient prognoses
- Operational: Ad hoc changes (last-minute changes) due to e.g., drop-outs, hospitalization stops, blocking beds

In this Master thesis project, the focus will be on designing a tool and implementation plan that supports capacity decisions in the operative process on a tactical level. This includes establishing which data are needed, i.e. which KPIs will be used, how the data will be presented and who is entitled to make tactical decisions based on these data. This dashboard will be used to evaluate the choices that are made on the strategic level and help making decisions on the tactical level.

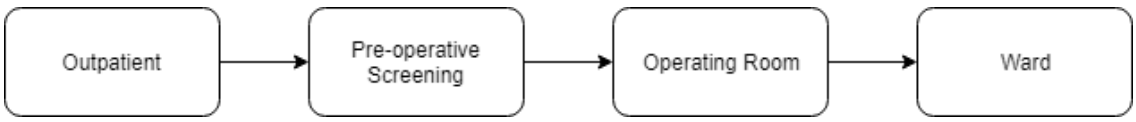

Figure 1: Operative process at GHZ

The research is divided into 3 parts: analysis, design and implementation. The analysis was made up of 3 parts as well: literature analysis, gap analysis and a stakeholder analysis.

Analysis

The process and gap analysis resulted in the following shortcomings in the operative process, which should be improved with the use of a performance management system:

- Different way of registration per specialty
- Insufficient insight into inflow of patients
- Insufficient insight in outflow of patients to the wards
- Different type of communication per (sub)specialty
- Fluctuations for POPS

A dashboard is a good tool to support capacity decisions. Therefore, a search for scientific literature on the use of dashboards and the selection of the contents of dashboards has been performed. The aim of this literature study was to find KPIs that can be used to measure all phases of the process depicted in Figure 1, so that the dashboard is a valid representation of the measurement of the process. Along with that, literature on the use of tools within the planning process of hospitals has been studied, to identify important factors which can support proper use of the dashboard.

This resulted in the following conclusions for the use of a dashboard:

- Selection of KPIs comes from a combination of using a bottom-up and a top-down approach.
- The dashboard should be built such that repeated measurement is made as easy as possible.
- Indicator selection is based not merely on the availability of data. For the dashboard in GHZ this means that it is important to specify what data is needed for the dashboard and its KPIs, but even if this is not immediately available for all indicators, the development and implementation of the dashboard should still start.
- The results of the dashboard should be open access, to show everyone involved, how calculations are made, and why this resulted into specific actions; thus, to create support for its use.

The literature analysis on the selection of KPIs resulted in the following guidelines:

- The objectives of the project should be kept in mind when selecting KPIs, which is the adaptation of capacity with the needed capacity. The goal of the dashboard is not to represent the entire organization, but to make decisions within the operative process, so let the indicators represent this process.
- The indicators should be a mix from four till eight leading and lagging indicators
- Indicators should be understandable, so that it is clear where changes in indicator scores come from, and which actions should be taken to achieve this
- Indicators should be linked to processes or part of processes
- For each indicator the lower and upper value needs to be given, if this is not possible yet clear documentation is needed.
- For each indicator the required data needs to be documented. When data is not available yet, indicate which data is needed and start developing the dashboard with the indicators that already have available data.

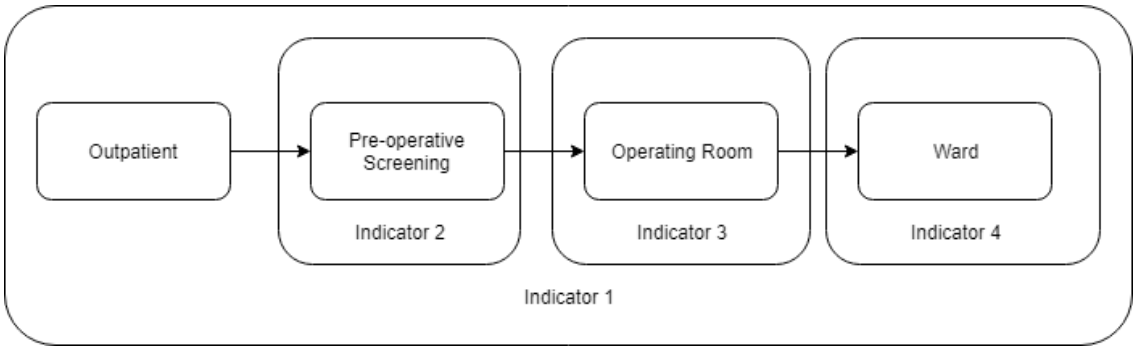

Figure 2: Lagging indicators in operative process

The stakeholders are categorized into direct and indirect stakeholders. The direct stakeholders are directly involved in the decision-making process, either as being responsible for a part of the operative process, or as a manager or having a supportive role within GHZ. The indirect stakeholders are influenced by the decisions being made by the direct stakeholders. Since the direct stakeholders are already actively involved in the ICM-project, the decision is made to also ask for the opinion of the indirect stakeholders. The direct stakeholders have plenty of options to make their wishes known (Works Council, ICM steering committee, board meetings), which does not hold for the indirect stakeholders. Interviews with the indirect stakeholders led to the conclusion that it was necessary to show these indirect stakeholders what the possible options for improvement in their way of working are, besides those that they already know. This resulted in the creation of several workgroups, existing of employees in the operative process, to share the possible options in the systems which give insight in the standings of the operative process.

Design

Based on the recommendations drawn from the literature study, the decision was made that the lagging indicators are used to represent the state of the operative process, with each indicator assessing the performance of the entire operative process, or the performance of a specific part of the operative process as shown in Figure 2.

The indicators that have been chosen:

- Throughput times
- Percentage of deadlines met per sub-specialty (POPS)
- Walk-in and run-out on schedule (OR)
- Pattern of bed occupancy (Wards)

Two leading indicators were chosen, both of them compare available capacity with needed capacity.

- Inflow (expected capacity) versus OR (available capacity)
- Outflow of OR (expected capacity) versus bed-days per ward (available capacity)

The leading indicators also measure specific parts of the operative process as depicted in Figure 3.

Each specialty should divide its patients into sub-specialties categorized per urgency of patients, with dead-lines linked to it for POPS visit and surgery on the OR. The dates of all patient contacts should be registered in the system, and the waiting list should be standardized for all specialties.

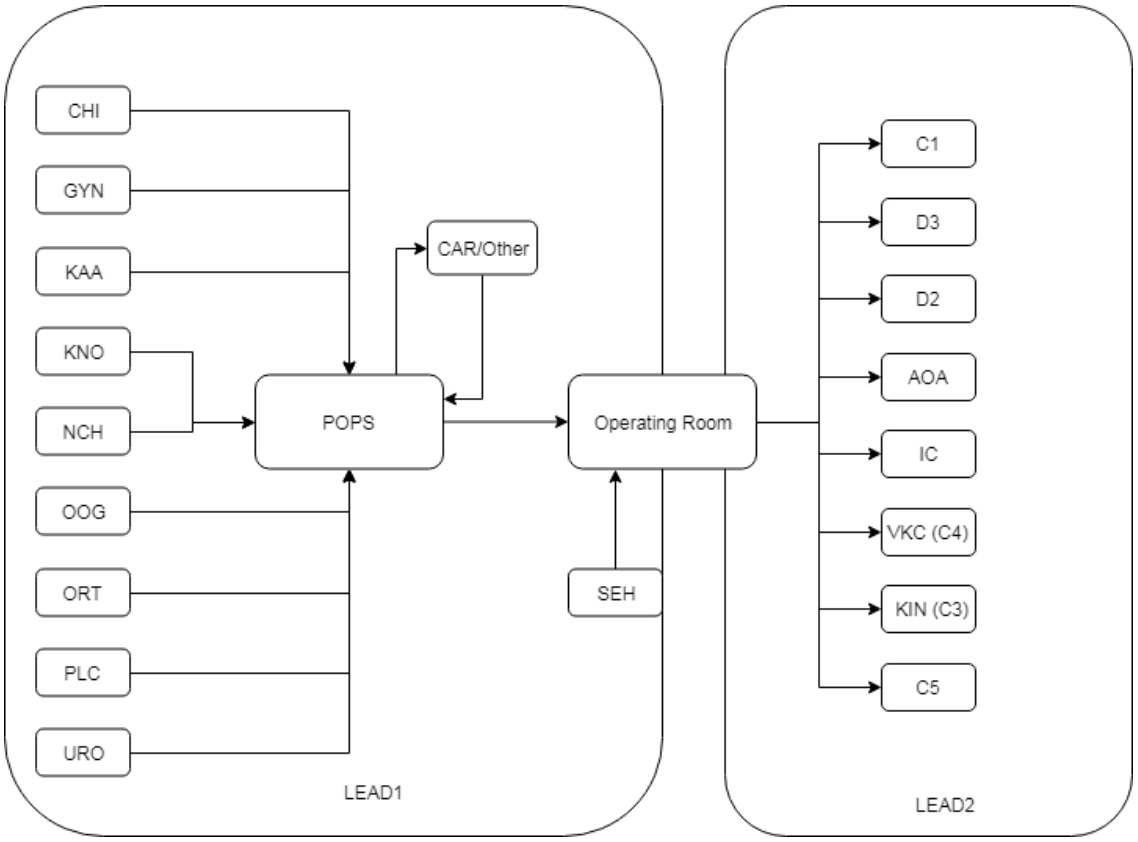

Figure 3: Linking of the leading indicators to the operative process

This will help the tactical decision-making in the operative process, since the lagging indicators provide a useful insight in the state of the operative process, where the leading indicators complement this view by forecasting the results of possible capacity-decisions for the state of the operative process in the near future. This will help the decision-makers since the dashboard gives them the data they need, so that they can focus on the assigning of capacity.

Implementation

The composition of the capacity allocation group should be as follows, in order to ensure a good representation of all parts of the operative process, with influence of all of the direct stakeholders, and context experts:

- A doctor on behalf of the specialties
- The OR-manager, which in GHZ also functions as POPS-manager
- A ward manager
- The capacity manager
- A representative on behalf of the financial department
- A data analyst, for the context of the used data in the dashboard; this is especially important in the starting phase, since a lot of data is not correct

The implementation of the dashboard requires extra data registration, amongst others the registration of the urgency of a patient. This change is brought into the organization by creating

willingness for change, which is done by the creation of workgroups. Showing the benefits of more extensive registration in their work process caused voluntary changes among the employees involved.

The dashboard itself should be used in the organization on a monthly basis in order to analyze the last period in the operative process, while looking forward to what is coming. The lagging indicators are used to report on the performance of the operative process during the last period to the members of the capacity allocation group and gives them an idea about which capacity choices to make; while the leading indicators show the expected results of these choices.

Conclusion and discussion

Ultimately, the use of a tool to support capacity decisions, a dashboard, should help the GHZ on a tactical level, but there is no specific right way to do it. The lagging and leading indicators should complement each other in providing a picture on the state of the operative process, but the underlying requirements to calculate the indicators and the way of implementing the dashboard are also essential for its success. Therefore, it is crucial that the direct and indirect stakeholders are kept updated on the situation, and that the recommendation that their evaluation is important for the use of the dashboard is not only an advice but stays true.

This recommendation has been prepared in the setting-up of workgroups, involvement of all stakeholders and writing documentation for the dashboard, so the pre-requisites, for the input of evaluation from both direct and indirect stakeholders, are available.

This research can be used by other organizations (health-care or non-health-care) as a guideline in the development-process of a dashboard. The steps that have been taken show the route to a prototype dashboard, and which steps are needed in the finalization of such a project. Starting from scratch, the gap-, process- and stakeholder- analysis combined with the theoretical research give direction towards the selection process for indicators. This analysis phase has also been useful during the rest of the project, since it helped with describing and documenting the requirements for the indicators itself. Additional recommendations given in this thesis will support the implementation of the tool in an organization. Therefore, the power of this research lies in bridging the theoretical, scientific literature and the daily practice in a complex organization such as a hospital.

Preface

The realization of this master thesis brings my student career to an end. It has been a great journey, in which I have learned a lot about Industrial Engineering, but also about myself.

Firstly, I would like to thank Adriaan who made the journey more bearable, it's been an honour fighting this battle together with you.

My gratitude goes to Elize Hooftman, who offered me an internship at GHZ to perform this research and to Johan Kuiper who has helped me during the times I did not know how to continue.

Also, I would like to thank my TUe-supervisor, Pascale Le Blanc, who helped me a lot and gave me very useful advice during our Skype sessions.

Finally, I would like to thank my father and give him his first reference (Verheul and Roubtsova, 2011), my mother and the rest of my family; and of course, my lovely girlfriend Lotte, who will become my wife in October this year.

As I am a faithful man, I know I could not have done this on my own, therefore I would like to thank the Living, who gave me the talents to get to where I am today.

I hope you will enjoy reading it.

Pieter Verheul

Monday 18th March, 2019

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List of Abbreviations

Table 1: Abbreviations used in this thesis

Abbreviation	**Meaning**
DBC	Diagnose Behandeling Combinatie
FTE	Full Time Equivalent
GHZ	Groene Hart Ziekenhuis
ICM	Integraal Capaciteits Management Integral Capacity Management
KPI	Key Performance Indicator
MSB	Medisch Specialistisch Bedrijf
OR	Operating Room
POPS	Pre-operative screening

Table 2: Abbreviations used for specialties and wards

Abbreviation	**Meaning**
AOA	Acute opname afdeling / Urgent ward
CAR	Cardiologie / Cardiology
CHI	Chirurgie / Surgery
GYN	Gyneacologie / Gynecology
IC	Intensive Care
KAA	Kaakheelkunde / Oral and maxillofacial surgery
KIN	Kinderafdeling / Child ward
KNO	Keel Neus Oor / Otorhinolaryngology
NCH	Neurochirurgie / Neurosurgery
OOG	Oogheelkunde / Ophthalmology
ORT	Orthopedie / Orthopedic surgery
PLC	Plastische chirurgie / Plastic surgery
URO	Urologie / Urology
SEH	Spoed-eisende hulp / First-aid
VKC	Vrouwkind centrum / Mother child ward

Chapter 1

Introduction

This report gives an overview of the research part of my Master thesis project that I performed at Groene Hart Ziekenhuis (GHZ) in Gouda from September 2018 until February 2019. In the first three chapters, the research that has been performed will be introduced by giving a brief overview of the organization (Chapter 1), the current issues regarding the planning of the operative process (Chapter 2) , and the main aims and questions of this research that concern to the design of a tool to support the tactical level of the planning process for the operative process at the Groene Hart Ziekenhuis (GHZ) located in Gouda as well as the development of an implementation plan (Chapter 3).

1.1 Background

1.1.1 General information

A hospital in some respects resembles a 'regular' company, but in other perspectives it is different. In a hospital, multiple specialties operate. Each specialty has its own result accountable entity (RVE, resultaat-verantwoordelijke eenheid) with its own financial results. The hospital facilitates these specialties by means of offering each specialty the needed resources to perform their operations (supporting systems, outpatient rooms, medical instruments etc.) while at the same time aiming to be profitable.

An important difference with companies is that a hospital, in this case GHZ works with consultant medical specialists. These medical specialists are hired and get paid per patient they see, so for them it is important to treat as many patients as possible. Since there is limited capacity of operating rooms (ORs), nursing and other paramedical staff, and beds, every hired specialist wants as much of this capacity as possible. Another difference is the culture within a hospital, it is very hierarchical (Bate, 2000), and a medical specialist has a big say in the time (s)he spends on different work activities.

The organizational structure of a hospital is for a large part defined by how it is financed, and how the medical specialists are hired. Medical specialists can be employed by the hospital, but often they are consultant specialists. Consultant specialists from the same medical specialty are united in a medical partnership. Consultant specialists have more freedom in how they allocate their work hours, since they often work at private clinics too, or at multiple hospitals. This leads to the situation that a hospital has little formal influence on these specialists, since they don't rely on the hospital for their entire income. This is an important reason why it is difficult to make organizational changes in hospitals (Doolin, 2002).

The government of the Netherlands is trying to control the ever-growing amount of health-care costs, and therefore every hospital should be profitable to prove its right of existence. A consequence of this new policy was that all specialties within a hospital are offered a minimum number of patients that they need to treat based on a nationally agreed compensation, while also achieving specific production targets. The financial compensation a hospital gets for a specific surgery is determined by the so-called DBC- structure. This DBC (Diagnose Behandeling Combinatie) is a set of hospital activities (diagnostics, surgery and controls) which has a price that is determined by the government or is in the free market. The aim of this new situation is that hospitals act more like regular companies, and the usual market principles are also valid for the health-care market. However, this system conflicts with the idea that a hospital has the obligation to help a patient, even if this results in a loss of money for the hospital. Because of the previously mentioned reasons, combined with a growing health-care demand, hospitals had to start thinking about their capacity management or capacity planning (hereafter referred to as capacity management). In short, **capacity management** in a hospital is the determination of the needed capacity, and the planning of this capacity in the most efficient way, while realizing the agreed production numbers (Olhager et al., 2001).

1.1.2 GHZ specific information

The Groene Hart Ziekenhuis (GHZ) is a hospital in Gouda for the surrounding region 'Midden-Holland'. The hospital aims to serve this region 'Groene Hart' with approximately 250.000 inhabitants (Schoonhoven, Bodegraven, Zuidplas). The hospital is an average sized hospital, with around 400 official beds, 2100 employees, and 93.000 hospital days per year. The revenue in 2016 was €201.000.000. About 100 medical specialists from Medisch Specialisten Bedrijf Gouda (MSB Gouda) are also working at GHZ, however they are not on the payroll of GHZ as they are hired, so about 60% of the medical specialists are consultant specialists. (Groene Hart Ziekenhuis, 2016)(MSB Gouda, 2018)

In Figure 1.1 an organization chart is shown for GHZ; next to the board (Raad van Bestuur), the Medisch Specialistisch Bedrijf is placed, to indicate that they are not employed by the hospital. The specialties that are in the scope of this thesis can be found under Snijdend and Beschouwend (Surgical and Diagnostic).

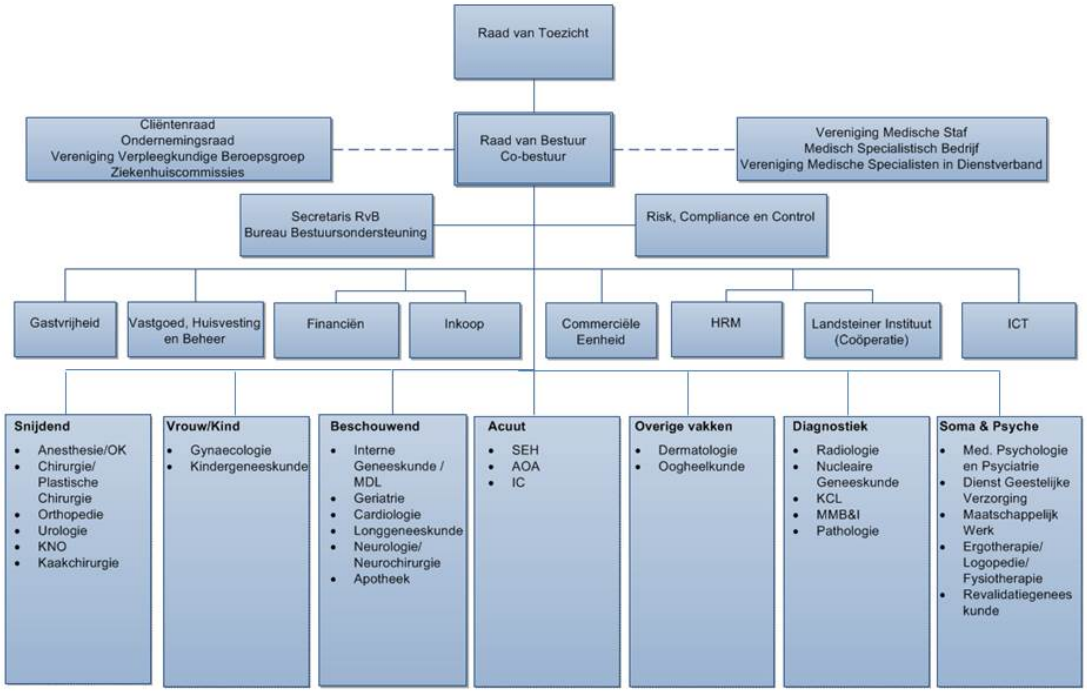

Figure 1.1: Organization chart GHZ

Chapter 2

Integral Capacity Management and Operative Process

2.1 Capacity Management

During the latest decennia, the 'traditional' focus of capacity planning was on maximizing the utilization of the Operating Rooms (OR). GHZ has 8 of these ORs. The entire hospital planning was based on a single principle: Maximizing the utilization of the OR. This is based on the thought that the OR is the most valuable hospital resource, and that it should be in use as much as possible. This principle however, creates a lot of capacity problems in the rest of the operative health-care process.

Some potential complications (when focusing on maximizing OR utilization) are:

- An unpredictable outflow of patients to the clinics, which results in difficulties with beds and staff planning and eventually in some extremely busy days for the nurses, and days that they have 'nothing to do'.
- Pre-operative screening (hereinafter called POPS) gets urgency requests for patients that need screening. For example, a doctor sees (s)he has empty spaces at his OR-session the next days and wants more patients. These patients must go to the POPS, before surgery, so this doctor asks if these patients can be seen urgently. So, specialties with no queue use urgency requests at the POPS to fill their OR-session, while specialties with long queues have to wait even longer.

Given all the previously mentioned factors (organizational structure, changing governmental demands, growing health-care demands, traditional focus on OR), GHZ decided that this situation should change. So, in 2014 GHZ started with the program 'Zorgen voor Morgen', appointed a capacity manager, Elize Hooftman, which was the beginning of Capacity Management at GHZ. Decisions no longer had to be made based on experience of employees, or on 'educated guessing', but on controllable data. The scope of this program was to optimize all the stages of the operative process shown in figure 2.1. This was done mostly on the operational level, which means that the

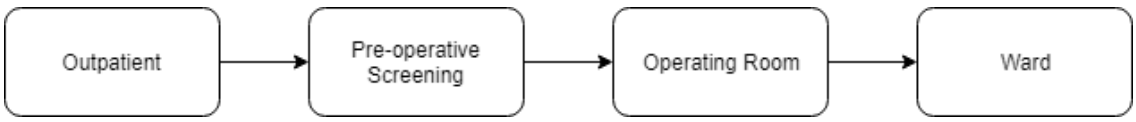

Figure 2.1: Operative process at GHZ

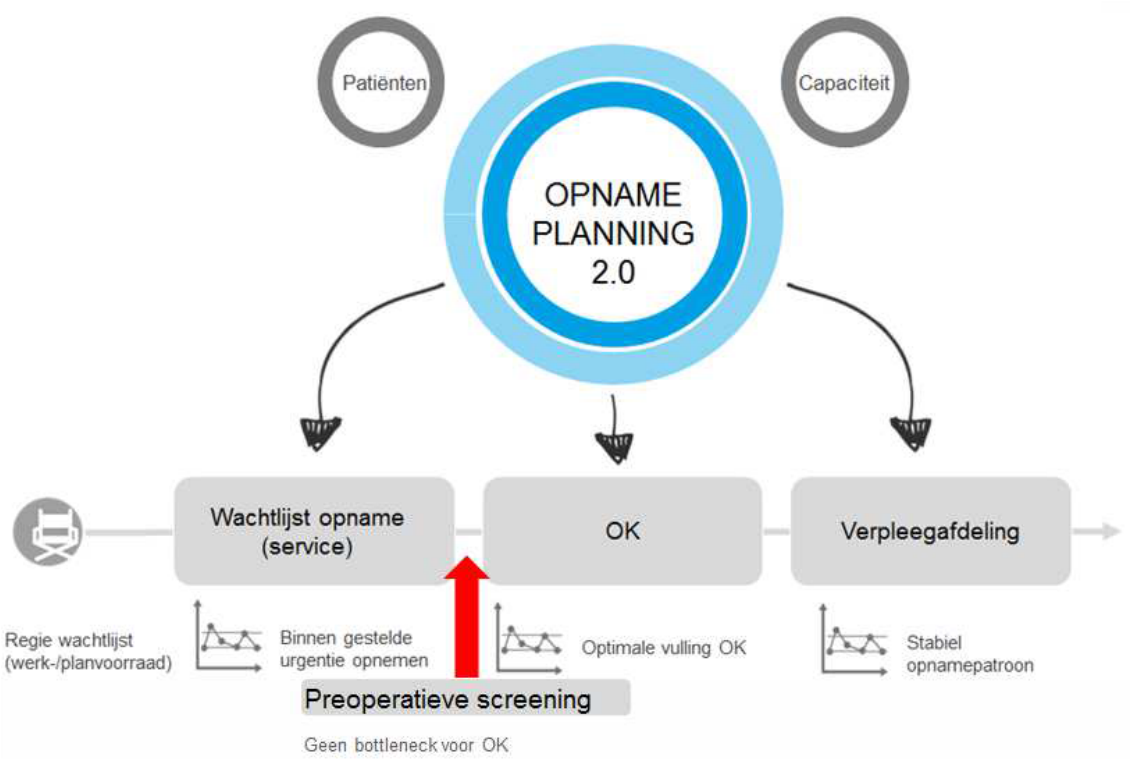

Figure 2.2: Desired way of planning in the operative process

focus was on optimizing the way of working, without making strategic and tactical decisions. This will be explained in more detail later on in this chapter, but it meant that strategic decisions (e.g. calculating capacity that is needed) was still done based on 'guessing', so mostly on professional experience of staff. To gain some insight in logistical steering, the HOTflo tool was implemented. This tool is mostly used within the OR-planning, and shows the needed capacity based on historical data. However, this tool was unable to forecast needed capacity within the entire process, so the scope of the project had to be extended, as seen in the next section. Also, a project group for 'Zorgen voor Morgen', was created in the GHZ (Hooftman and Veenstra, 2016).

An important lesson from this project was that GHZ tried to change too much at once, and the support within the organization turned into resistance. Another lesson was that the focus was too much on tooling, and the human factor was not considered, in terms of asking the stakeholders on their opinion, and involving them in the evaluation process.

Currently, GHZ is in a process to get to a situation where the planning is not only based on maximizing the utilization of the OR, but also on other factors:

- Waiting queues (per specialty)
- Capacity of the wards (bed per ward/specialty)
- Capacity of the POPS
- Medical urgency of the patient

2.2 Integral Capacity Management

At this moment there is no 1-on-1 relation between the planning of the OR and the planning of the POPS, which should be there in an optimal process, since every patient that goes to the OR needs to be seen at the POPS. Therefore, GHZ started at the end of 2017 with Integral Capacity Management (ICM), which differs from Capacity Management in that it looks at the entire process as shown in Figure 2.1, and not just at a part of the process. So, instead of optimizing the planning within the OR, or within the ward, ICM aims to align the capacity so that the entire chain functions more optimally. This leads to a completely new way of planning, "An approach such as this is greatly needed because most hospitals do not plan in advance how beds and other treatment spaces are going to be used. They also do not have a scheduling model that can immediately recompute activity timings and identify the hospital's state of occupancy in the near future." (Burdett and Kozan, 2017)

Within ICM there are 3 levels: strategic, tactical and operational:

- Strategic: (Annual) assessing and assigning of capacities, hospital-wide. For example: Number of outpatient sessions per specialty, number of OR sessions per specialty, number of beds per specialty, number of needed FTEs
- Tactical: Periodical adaptation and redefinition of capacities, based on actual performance levels (KPIs), and patient prognoses
- Operational: Ad hoc changes (last-minute changes) due to e.g., drop-outs, hospitalization stops, blocking beds

Currently, the actual planning is still mostly done on the operational level, which implies that a lot of capacity planning is done ad-hoc, without clear data to support it. This means that planning is done without underlying 'rules' (the rules are only known by the respective employees involved), and with no data-based choices.

In the long-term GHZ aims to have a planning process, where the hospitalization planning considers the capacity of all departments that are included in Figure 2.1. This is depicted in Figure 2.2. The project group within GHZ aims to have a standardized operational process, wherein all specialties plan in the same way, and can explain the choices they make. The choice to focus on standardization of planning decisions in all different specialties is made, since it is impossible to redesign the entire planning process from scratch. In Chapter 3 the scope of this research will be explained, which is focused on the tactical part of the planning process. The desired situation when implementing ICM is a planning process that is based on strategic, tactical and operational choices (Hooftman and Veenstra, 2016).

For GHZ, this is how ICM will be implemented on the different levels in the future:

- Strategic: The OR session-planning is based on objective and clear calculations, which include the history of surgeries, weeks with reduction of production over the past years, data for the time needed for a specific operation, strategic choices of the GHZ, but also the information of the insurance companies on compensations and the governmental policies for the (near) future
- Tactical: The queues for specific specialties are increasing, and for others they are decreasing. How can GHZ steer in the master OR planning, with underlying data that support the choices that are made. Which data do we need to steer on, and how do we collect these?
  Also: which people are entitled to make specific choices, how do we create support within the company for mid-term review of capacity decisions, while also giving all specialties and staff the feeling that the choices that are made are fair?
- Operational: In the end, the influence of last-minute ad hoc changes should be limited, for example: last-minute sick leaves, or other last-minute changes.

It is important how ICM is experienced and perceived by staff hospital-wide. In the past, this type of innovations often turned out to be another way of making cutbacks, for example in FTEs of staff at the wards. Also, other austerity measures such as strict norms (e.g. patients per nurse), more flexibility instead of fixed hours contract, were often a result of capacity management, at least this is how most employees perceived it. Therefore, for the current ICM project, it is important to communicate that it is not another cutback to save money, but that it is founded on 3 pillars: patients, staff and efficiency/capacity. Support among all stakeholders needs to be created for the desired situation of capacity planning at GHZ: ICM can only be successful, when there is hospital-wide support among all specialties, medical support departments, first aid departments etc.

Chapter 3

Research Aim and Research Questions

In this Master thesis project, the focus will be on designing a tool and implementation plan for a tactical-level OR planning process. First, however, it is important to map the current situation. The process as depicted in Figure 2.1 will be followed, to create a helicopter view of the operative process as it is functioning now. How does a patient move from outpatient to discharge, and how do the different departments involved currently exchange information (e.g. outpatient, POPS, OR, ward)?

As mentioned before, the tactical level of the planning process can be defined as follows: Periodical adaptation and redefinition of capacities, based on actual performance levels (KPIs) and patient prognoses (Hooftman and Veenstra, 2016). The design and implementation of this tactical level within the planning process will be twofold:

- Creating a dashboard with visualized data of KPIs that can be used to make tactical choices. This includes establishing which data are needed, i.e. which KPIs will be used, how the data will be presented and who is entitled to make tactical decisions based on these data. This dashboard will be used to evaluate the choices that are made on the strategic level and visualize the effects of these choices.
  For example: The new master schedule of OR-sessions per specialty came into effect since January 2018. After some period, the dashboard is used to evaluate the effects of this new schedule. How did queues per specialties evolve, how did the outflow of patients spread across the wards, etc.

- The implementation of this dashboard within the operative process, creating 'readiness for change' among the involved stakeholders and making sure that the dashboard is used in a proper way. This is also a design-phase, since the decision process should be designed in ways of:

  - Who are the relevant stakeholders/decision makers? These are the people that will use the dashboard.

  - Creating support and understanding within all specialties, for mid-term evaluation of the planning that is made on a strategic level, and willingness to change this planning if needed.

  For example: Responsible stakeholders from each specialty, and other stakeholders at GHZ, such as financial delegates, board members, etc. have a meeting in which the dashboard can help them to evaluate the effects of the strategic choices. A relevant question is: What will

be the optimal frequency of these meetings, and which stakeholders/decision-makers will have to take part in these meetings?

3.1 Organizational Change

In their book on organizational change in health-care, Austin et al. (2016), explain that transformation within a hospital is comparable to the tale of the blind men and the elephant. Everyone involved is focused on their expertise, i.e. their part of the elephant, which results in a complete lack of overview, and disagreement among all parties. One way of preventing this from happening is scenario planning. "Scenarios portray a series of plausible alternative futures. Each scenario tells a story of how various forces might interact under certain conditions. Scenarios are designed to open new ways of thinking about the future and provide a platform for strategic dialogue - new questions, new conversations - as the basis for strategic action. Scenarios are not predictions or forecasts; rather, they combine existing trends and key uncertainties into a few future worlds within the realm of possibility." (Austin et al., 2016) This does not imply that this research will work with scenario planning as a ground for change, but that the dashboard can be used to visualize what the effects are of specific capacity decisions. As mentioned in Chapter 1, there are multiple reasons for GHZ to start with ICM, and to show stakeholders what the future effects (e.g. financial, utilization, etc.) are when ICM is implemented, scenarios can be used. The dashboard can be used to show what the effects of planning decisions are, and what the effects would be when nothing is changed in the organization.

A part of the research will be to identify the different stakeholders with their specific needs. All the specialties within GHZ can function as if they were stand-alone organizations. They have their own way of planning, staff and protocols; but also shared interests and capacity (the ORs are shared among all specialties). According to literature on change management (Cawsey et al., 2012), the needs and wishes of the stakeholders should be considered in the design. Another aspect of the research will be the appointment of decision-makers, who will be the users of the dashboard. It should be clear on which ground they are elected to be decision-makers, and also their authority in decision making should be specified.

To find out whether people are ready for change, interviews will be held. Readiness for change is best predicted by combining organizational (Armenakis et al., 1993) and individual models (Prochaska, 2018). A study by Cunningham et al. (2002) showed that employees in active jobs with more control over challenging jobs reported a higher readiness for organizational change scores and were more likely to participate in organizational redesign. This is consistent with research suggesting that active jobs foster personal empowerment, improve performance, increase initiative and contribute to organizational innovation (Conger and Kanungo, 1988; Spreitzer, 1995; Theorell and Karasek, 1996).
Stakeholders will also have conflicting goals, and with that difference opinion on the weights of the indicators in the dashboard. On these weights' consensus should be reached among the stakeholders, otherwise stakeholders might be presented with a fait accompli.

3.2 Dashboard

The aforementioned tool that these people are going to use is a dashboard that shows the effects of the choices regarding capacity decisions that are made on a strategic, but mostly tactical level and support decision making on a tactical level. To gain insight into and give an overview of the standings of the operative process, KPIs need to be formulated, for example on: current queues at specialties, bed utilization the last months. Using the right KPIs is very important, since it is the underlying ground for decision-making as shown by El Hadj Amor and Ghannouchi (2017):

"Despite the difficulties in defining, selecting and monitoring effective indicators, measuring performance is crucial in the current health agenda. Indeed, Key Performance Indicators (KPIs) provide critical information to the organization for monitoring and predicting business performance in accordance with strategic objectives." Another way of finding appropriate KPIs is to get information on the KPIs that are used by other hospitals, which KPIs they use, and how these could be used at GHZ. This should mostly be found in a literature review, but also in sources of GHZ and other hospitals in The Netherlands. These KPIs will be analyzed and optimized for use within the context of the GHZ. Then, a clear way of describing requirements and developing of KPIs needs to be found, to present it in the dashboard.

According to Berler et al. (2005), the data collection process is extremely important "since it is a basic feature of populating successfully the KPIs." Therefore, the guidelines given in their article are followed in the data collection process. This means that the KPIs need to be checked, tested and assessed by a panel of experts (data-experts, users, practitioners), before agreeing on using them, to verify that the KPIs measure what we want to measure, and that the current information systems, that are used by GHZ, can provide this data. "By implementing this, the quality level of the proposed KPIs is such that technological issues are greatly reduced." (Berler et al., 2005)

The dashboard will be used during tactical planning meetings, which are held periodically. The frequency of these meetings will be determined by comparing internal planning horizons, with periodical trends in health-care demand. From historical data it is known that certain specialties have a fluctuating inflow of patients, depending on the time of year. During these tactical planning meetings, where decisions are made on how much capacity is used, and where it is deployed, this dashboard will be used as underlying ground for capacity-decisions, for example: the allocation of OR-session from a specialty to another specialty, or the number of outpatient sessions a specialty should perform.

3.3 Research Questions

The main research question of the current project can be formulated as follows:

How to design and implement a tool to support the tactical level of planning of the operative process at GHZ considering the relevant data and the perspectives of the stakeholders involved?

Related sub-questions are:

1. ***What does the current situation look like? And what is the gap between the current and the desired situation?***
2. ***Who are the important stakeholders in the design and implementation of a tactical level of planning in the operative process?***
3. ***What data should be considered in the design and implementation of a dashboard to support the tactical level of planning of the operative process at GHZ?***
4. ***What will the tactical level of OR-planning look like in practice, regarding decision-makers involved, frequency of meetings, grounds to change capacity distribution?***

Chapter 4

Method

In this chapter the research methodology will be described, which is used to answer the main research question.

Before working on the design and implementation of the dashboard, a detailed analysis has been performed, both on literature and in the hospital. Therefore, the research can be divided into 3 parts: analysis, design and implementation, each answering different sub-questions.

The **analysis** was made up of different parts:

- Literature analysis on the use of a dashboard in health-care, and on the selection of KPIs that fill the dashboard.
- A gap analysis The gap analysis refers to the assessment of present state and desired state with respect to the planning of the operative process. It is performed in order to determine what is needed/has to change in the organization in order to move from the present state to the desired state.
- Next, a stakeholder analysis was performed to gain insight into the needs and interests of the different groups of employees involved in the operative process. These are the doctors and managers, but also the planners at the specialties and OR, and the nurses at the ward.

Based on the results of the analysis phase, sub-question 1 and sub-question 2 can be answered:

1. What does the current situation look like? And what is the gap between the current and the desired situation?
2. Who are the important stakeholders in the design and implementation of a tactical level of planning in the operative process?

The results of the analysis part defined the design of the dashboard, more specifically, the selection of the KPIs that were used to represent and measure the operative process. Therefore, for the **design** of the dashboard, the following steps have been taken, with clear landmarks.

- The selection of KPIs, that form a representative set for the operative process, based on the results of the previous analyses.
- Discussing the requirements that are needed to develop a fully functional dashboard, specifically the data that is needed to calculate the indicators, and the requirements in the organization to supply this data.
- According to the literature review, the linking of indicators to the process, and describing possible outcomes, is an important factor for a successful dashboard. This was the last step in the design phase.

When the design phase was completed, sub-question 3 could be answered:

3. What data should be considered in the design and implementation of a dashboard to support the tactical level of planning of the operative process at GHZ?

The **implementation** of the dashboard, which followed after the design choices had been made, contained the following steps:

- The implementation of the required registration in the operative process among the relevant employees
- Drafting of an action plan on how the dashboard should be used in the tactical level, and who the involved stakeholders are
- Recommendations from scientific literature on change management to ensure a successful the implementation of the dashboard.

The results of these steps enabled answering the final question:

4. What will the tactical level of OR-planning look like in practice, regarding decision-makers involved, frequency of meetings, and grounds to change the capacity distribution?

Chapter 5

Detailed Analysis

In this chapter, the results that were needed to answer the following sub-questions are presented:

1. What does the current situation look like? And what is the gap between the current and the desired situation?
2. Who are the important stakeholders in the design and implementation of a tactical level of planning in the operative process?

As discussed in the last chapter on methodology, to design the dashboard with the selection of a set of KPIs, analysis needed to be done on the following subjects:

- Analysis of literature on the use of dashboards within health-care. Literature about the use of tools within the planning process of hospitals was examined in order to find important factors which can support proper use of the dashboard.
- Analysis of literature on KPIs within the operative process. The aim of this part of the literature study was to identify KPIs that can be used to measure all phases of this process, so that the dashboard is a valid measurement of the process.
- Process and gap analysis. The goal of these analyses was to answer sub-question 1 on the difference between the current and the desired situation.
- Stakeholder analysis including interviews in order to answer sub-question 2. Interviews were held among different staff from the entire operative process (outpatient department, pre-operative, operating room and ward planners). This was also needed to gain more insight into what the tactical planning will look like in practice, especially with regards to the decision-makers involved.

The gap analysis has been performed before the literature analysis since it showed why a dashboard is a good solution for the problem that GHZ wants to address, and therefore defined the aim of the literature study.

5.1 Process and Gap Analysis

Before analyzing the current operative process, it was necessary to have some information on the way GHZ has organized their information systems. This description is highly simplified, as it only serves to understand the description of the operative process that is described in paragraph 5.1.1.

In Figure 5.1, a simplified overview of the information systems in GHZ is presented, the main (core) system is xCare, this is used to do all basic patient administration like hospitalization and

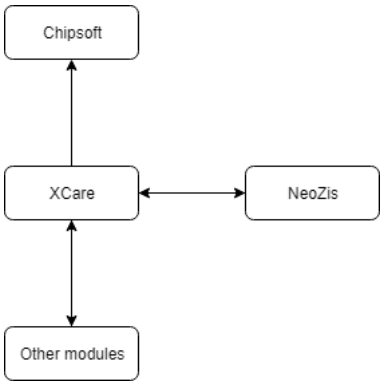

Figure 5.1: Information systems GHZ

Table 5.1: ASA-scores

ASA-score	Type of patient
Score 1	Normal healthy patient
Score 2	Patient with light mild condition that does not have influence on its daily life
Score 3	Patient with debilitating systemic condition, that restricts normal activity
Score 4	Patient with debilitating systemic condition, constant threat to life.

discharges from the hospital, billing etc. It also has features that are used by some specialties only, like the option to plan all the patients from a digital waiting list. CHI, which is one of the big specialties, uses this option. NeoZis is a software package that is used for medical information and the electronic patient files and that communicates with xCare both ways. Chipsoft is the operating room software package, the surgeries are planned in here, in sessions. Chipsoft gets its information from xCare but does not change information in the xCare database.

It is also important to know that in GHZ the patients are classified with an ASA-score (ASA stands for the American Society of Anesthesiologists) to describe their health status (Fitz-Henry, 2011), in Table 5.1 these scores are described.

In the remainder of this report, the OR-scheme is mentioned when referring to the division of OR-sessions among the specialties. In Table 5.2 two fictional OR-schemes are shown, to understand what they look like. Every OR has 2 sessions, a morning (8.00 - 12.00) and an afternoon session (12.15 - 16.00 or 12.45 - 16.00). The OR-scheme is divided into even and odd weeks, and every day there are four long afternoon sessions, and four shorter sessions (3.25 and 3.75 hours). This is due to the fact that there is an extra OR-team that can help filling in four lunch breaks, so the OR does not need to close during lunchtime.

5.1.1 Current Situation

When looking at the operative process in the GHZ, the first step is to examine the input of this process. In a hospital there are 2 types of specialties: surgical and diagnostic (snijdend en beschouwend). The specialties that are surgical use the operating room. The normal process is that a patient gets a reference from a general practitioner for a (sub)specialty. The doctor from this specific (sub)specialty sees the patient, and diagnoses whether this patient needs a surgery. In Figure 5.3 the specialties that are surgical are visible in the first step.

In Table 5.2 the meaning of the abbreviations used in Figure 5.3 are given. When a patient needs surgery, the specialty starts the procedure by entering this patient in a waiting list. Every

EVEN

	OK1	OK2	OK3	OK4	OK5	OK6	OK7	OK8
MA 1	CHI	GYN	KAA	KNO	NCH	OOG	ORT	PLC
MA 2	CHI	GYN	SPOED	KNO	NCH	OOG	ORT	PLC
DI 1	CHI	GYN	OOG	ORT	PLC	KNO	KNO	ORT
DI 2	SPOED	GYN	OOG	ORT	PLC	NCH	NCH	ORT
WO 1	CHI	GYN	URO			OOG	ORT	PLC
WO 2	CHI	SPOED				OOG	ORT	PLC
DO 1	CHI		OOG					NCH
DO 2	CHI		OOG	SPOED				
VR 1	CHI		CHI				CHI	NCH
VR2	CHI		CHI		SPOED		CHI	

ONEVEN

	OK1	OK2	OK3	OK4	OK5	OK6	OK7	OK8
MA 1	CHI	GYN	KAA	KNO	NCH	OOG	ORT	PLC
MA 2	CHI	GYN	SPOED	KNO	NCH	OOG	ORT	PLC
DI 1	CHI	GYN		ORT	PLC	KNO	KNO	ORT
DI 2	SPOED	GYN		ORT	PLC	NCH	NCH	ORT
WO 1	CHI	GYN	URO		OOG		ORT	PLC
WO 2	CHI	SPOED			OOG		ORT	PLC
DO 1		ORT	OOG		OOG	CHI		NCH
DO 2		ORT	OOG	SPOED	OOG	CHI		
VR 1	CHI		CHI				CHI	NCH
VR2	CHI		CHI		SPOED		CHI	

Figure 5.2: Fictional OR-scheme even/odd weeks

Table 5.2: Abbreviations and departments in the operative process

Abbreviation	Meaning	Department day-care	Department clinic	Child day-care	Child clinic
CHI	Surgery	D2	C1/D3	KIN (C3)	KIN (D2)
GYN	Gynecology	D2	C4	KIN (C3)	KIN (D2)
KAA	Oral and maxillofacial surgery	D2	C1/D3	KIN (C3)	KIN (D2)
KNO	Otorhinolaryngology	D2	C1/D3	KIN (C3)	KIN (D2)
NCH	Neurosurgery	D2	C1/D3	KIN (C3)	KIN (D2)
OOG	Ophthalmology	D2	C1/D3	KIN (C3)	KIN (D2)
ORT	Orthopedic surgery	D2	C5	KIN (C3)	KIN (D2)
PLC	Plastic surgery	D2	C1/D3	KIN (C3)	KIN (D2)
URO	Urology	D2	C1/D3	KIN (C3)	KIN (D2)
SEH	First-aid	AOA or another department			

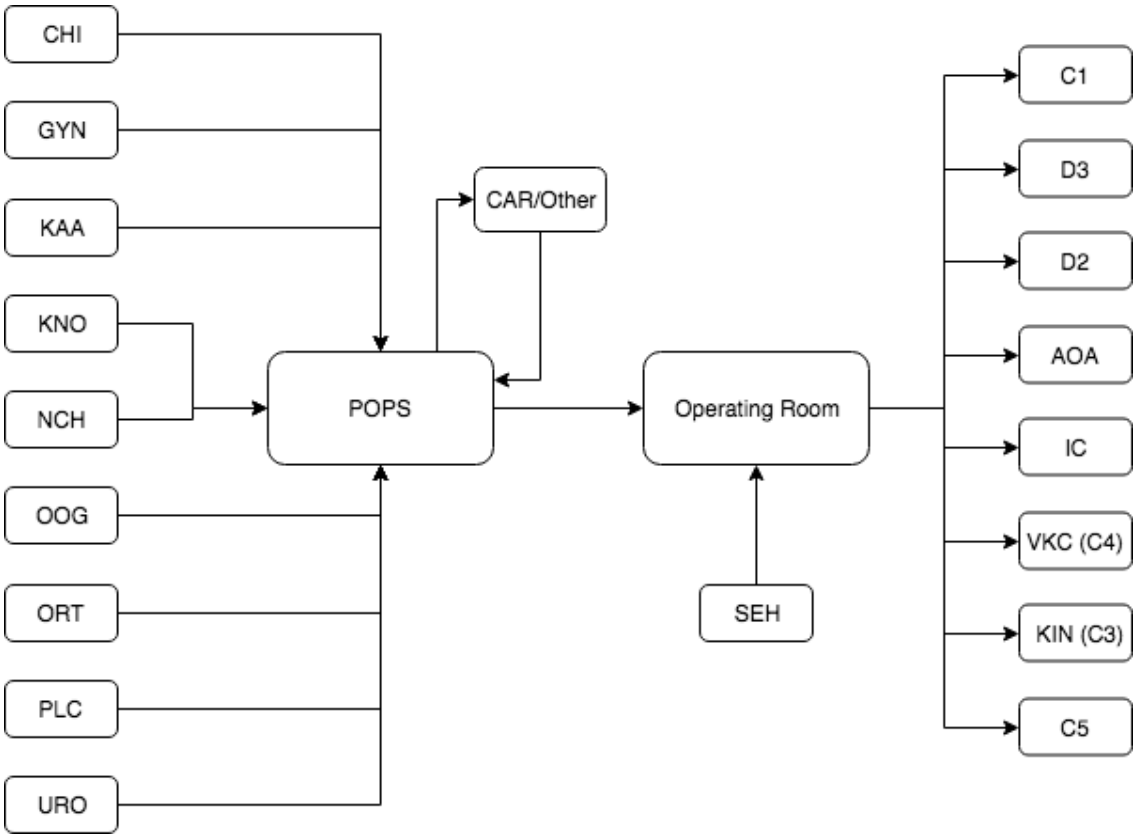

Figure 5.3: Extensive operative process at GHZ including emergency patients, legend: see Table 5.2

specialty does this their own way, certain specialties have made the entire process paperless by using xCare, other specialties use a paper agenda, while others use NeoZis, as it is optimized for quick switching between patient-information, which comes in useful when the doctor sees a lot of patients in a short period of time, for example when placing tubes in the ears of children.

A patient cannot go to the surgery, without a valid agreement from the anesthetist. This is the Pre-Operative Screening (POPS), wherein the anesthetist checks which sedation technique should be used, and if the patient is healthy enough to go for surgery. If there are doubts, for example on the heart rhythm, the patient needs to go to the cardiology (CAR in Figure 5.3), to get a check from the cardiologist. If a patient does not get a POPS-agreement, the surgery cannot take place. This is checked right before the surgery.

So, when a patient hears from the doctor that a surgery is needed, the patient is added to the waiting list by the specialty and needs to make 2 appointments. The first appointment is to get to the POPS, and the other appointment is for the surgery, and the hospitalization afterwards. There are differences between specialties about when these appointments are made, some specialties make them right away, so the patient immediately knows when his/her surgery will take place. However, the planning horizons of the systems in GHZ are 6 weeks, so if specialties make appointments after these 6 weeks, the dates are planned in paper agendas. This is still common practice. Some specialties note the urgency of the patient, or the final date before which the patient should have had surgery.

Every specialty has its own planners, and there is little to no communication between the planners of different specialties. Among others, tasks of the planners are:

- The registration of a patient in the system
- The placement of a patient on the waiting list
- Planning the patient for POPS and surgery
- Communication with the patient

There are two categories regarding the length of stay of patients. The so-called Dagbehandelingen (day-care), where the patients go to the short-stay department after their surgery and go home the same day. The other length is all the surgeries that have a planned length of stay that is longer. In Table 5.2, for each specialty the meaning of the used abbreviation is given, and the possible department that the patient goes to after surgery.

Finally, there is always the alternative route of patients entering the OR, via the SEH (first-aid department), when this is the case no POPS is needed, since the patient goes for surgery immediately.

This way of working in the operative process is not based on any capacity policy besides maximizing the utility of the OR. It has evolved over the years, and has some downsides:

- Different way of registration per specialty. Since every specialty uses its own method of planning the patients for POPS and OR, there is no clear overview of the number of people on the waiting list per specialty. Since some specialties plan the patients immediately for surgery, it may look like this specialty does not have any waiting list, while new patients might have to wait 4 months before they can be treated. But when a patient is planned, there is no record of this patient on a waiting list.
  An example: OOG gives every patient immediate a surgery date, although it can be 3 to 6 months in the future, therefore in the systems no waiting list for the OOG specialty is given. CHI, with other specialties, uses 6 weeks as a planning horizon, which is the planning horizon in the systems, when a patient cannot be treated in the coming 6 weeks, this patient is placed on a waiting list.
  Also, since there are two systems being used for registration, it is difficult to make one overview of the entire list of patients that don't have a surgery date yet. This makes it difficult to compare the size (number of patients or total OR-time in queue) of waiting lists between specialties, and therefore impossible to determine which specialty should get less or more capacity.
- Insufficient insight into the inflow of patients, due to waiting list registration, seasonal trends and first-aid inflow. When adding a patient to the waiting list, the system asks for an urgency of surgery. Based on this urgency the system gives the patient a final surgery date. Since most specialties don't use this urgency field, the system just gives the default date of 1 year. When sorting the waiting list of all specialties on urgency, this gives an unreliable view of the need for capacity of all specialties. First, the number of patients per specialty is not correctly represented in the list (patients are not removed when going to another hospital for example), and second, the patients on the list cannot be sorted on urgency, since most specialties do not use the field, and other specialties use different urgencies with attached dates.
- There is insufficient insight in the utilization and planning of beds at wards. Because the focus of the planning (of a specialty) lies on assigning the patient to a surgery date, there is no attention paid to the outflow of this patient to the ward. The assumption is that there is always a bed available (which is not always true), but this causes high fluctuations in the outflow of patients to the wards. When there are emergency patients, the planners have no idea about the current utilization of beds at the wards, and there is no digital insight (at least the planners don't know about it), which causes a lot of unnecessary communication between the planners and the wards before an emergency patient can be assigned. One reason for this problem is that the planners use the system differently when planning patients, and

don't enter details like expected duration of stay, which is needed to calculate the utilization of the ward departments.

- Since all specialties function in different ways, the patient gets a different type of communication per (sub)specialty. Not only the way of communication is different, by e-mail, post or telephone; whereas for some specialties the patient immediately gets to know the dates of POPS and surgery but is informed about the time one week before the appointment, for other specialties the patient gets a call when there are available slots in the surgery schedule. There is a big difference between large and small specialties (CHI is big, KNO is mid-sized and NCH is small). When a CHI patient needs to go for surgery, there is a waiting list of approximately 100 people for some operations, since the planning horizon is 6 weeks, CHI does not plan further than this, and the patient gets called for a date and time when (s)he is first on the waiting list. An NCH patient on the other hand, has only a handful of people that also need surgery in this specialty, and therefore it is possible to plan a date for this patient in the same or next week. The patient immediately gets to know all the details. At KNO, there are usually dozens of patients that are higher on the waiting list, but since KNO uses a paper agenda to plan surgeries, the patient also immediately knows when his/her surgery will take place. However, this can be even after more than 3 months, which lies far outside the planning horizon of 6 weeks. An additional problem is that with this way of planning, it may look like KNO does not have a waiting list, and therefore will not get assigned extra capacity.
- POPS fluctuations. As said before, every patient that is not an emergency patient, should have a POPS agreement before entering the OR. Each specialty needs the same number of POPS places as it has surgeries. It is imaginable that a patient from NCH who hears on Friday that there is a place for him to go to OR on Tuesday next week, needs a last-minute POPS appointment. This causes problems in the POPS planning, since regular patients (which might be waiting for several months already), need to give way to this patient who has barely waited. One might say that it is not necessary to help this NCH patient so soon, but then the OR is only used for 50% of the time, which costs both the specialty and the hospital money.

5.1.2 Desired situation

The project that GHZ started internally, the 'Integral Capacity Management' project, that aims to divide capacity more efficiently over the specialties, was implemented on three levels: strategic, tactical and operational.

On the strategic levels the long-term choices are made, based on the history of inflow of patients, expectations, governmental decisions and the insurance budget. On the tactical level periodical adaptation will happen, which is based on the waiting queue, performance within the operative process, capacity availability of OR and the capacity of the wards.
In this situation, the OR scheme is set for the long-term (half-annually or annually), based on extensive calculations. Periodically (monthly, bimonthly), the status of the operative process is evaluated and whenever needed, additional capacity decisions are made. An example:

The master OR-scheme (long-term OR scheme) is calculated, based on a model that uses as much relevant information as possible, this is done by an econometrics student from Erasmus University Rotterdam. The model uses the expected inflow of patients, the expected length of stay per patient per department, the current waiting list, the urgency of patients, and seasonal trends, and thus comes up with an optimal OR-scheme that divides capacity as fair as possible among specialties, while aiming to keep the outflow of the process within the limits of the wards. Frequently, let's say, every 4 weeks, on the tactical level the effects of the chosen scheme are evaluated: Changes in waiting list per specialty, OR-utilization, POPS-utilization, and outflow of patients are discussed and it is evaluated whether they are in control or out of control. Suppose for CHI the waiting

list is still within target, but for NCH the waiting list is growing too much, on tactical level the decision can be made that OR-sessions that become available are first offered to NCH, since this specialty needs them the most.

So, in the desired situation, on a tactical level, all information that is available is presented in a clear way and in one overview, and the possible actions that can be taken follow logically from that overview. In the desired situation, the 5 points discussed in paragraph 5.1.1 will look as follows:

- Waiting lists: When all information on the state of the operative process is presented in a clear way in one overview, it is important that this information is correct and has the same meaning for all specialties. So, the registration of patients should be performed in a similar way by all specialties.
- Insight into inflow of patients: It is known what the state of the waiting list is per specialty, i.e. how many patients are on the list, with which urgency (maximum surgery date), and how many extra patients the hospital can expect from the first-aid flow and due to seasonal trends.
- Insight in outflow of patients to the wards: The same holds for the outflow of patients to the different wards. Since the hospital knows what to expect as incoming in the process, this expectation can be extrapolated to the outflow.
- Patient communication: A patient can expect the same standards across the entire hospital. Differences between specialties disappear, so for every specialty, agreements are made on how and when to inform the patients, which includes but is not limited to: Date of receiving POPS-date, surgery-date, unambiguous information.
- POPS: Due to the insight the hospital has on the flow of patients, better planning agreements are made, which gives the POPS insight into which patients to expect and when to expect them, and this enables POPS to prepare for this.

This is just a short preview what the desired situation will look like, in Chapter 6 and 7 this will be described more in depth.

Based on the gap analysis, the following list of bottlenecks can be derived:

1. Difference in registration per specialty
2. Different communication between specialties
3. Different urgency levels between specialties
4. No urgency registration for a surgery
5. Inconsistent waiting list (between specialties)
6. Incomplete waiting list
7. Different communication to patients per specialty
8. No supervision on waiting list
9. Incorrect waiting list
10. Historical data (first-aid, trends) not reliable
11. Insufficient insight into inflow of patients
12. POPS fluctuations
13. Insufficient insight into outflow of patients to the wards
14. Division of capacity is not supported by data
15. Big differences in workload at the ward
16. Inefficient use of organizations capacity

These bottlenecks can be translated into a cause-effect diagram, which is shown in Figure 5.4.

This cause-effect overview can be translated into a diagram that shows the core problems GHZ deals with, the problems that arise from this, and the outcome or symptoms from these problems. This overview is given in Figure 5.5. This overview is helpful, since it shows the underlying problems which should be fixed to solve the symptoms.

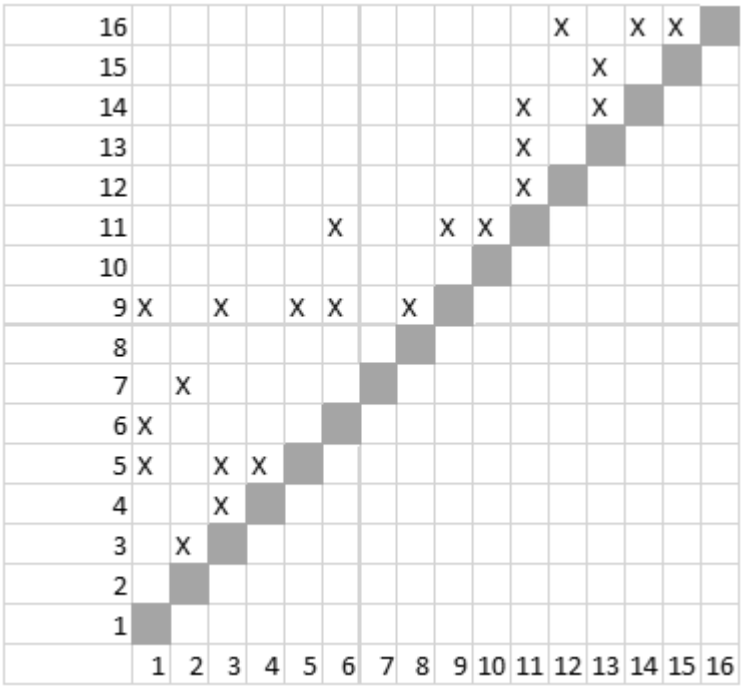

Figure 5.4: Cause-effect overview

In the bottom right corner of the diagram the capacity issues are grouped, to indicate the causes of the inefficient use of capacity. As visible this is caused by the differences between specialties, unreliable historical data and an incorrect waiting list. In the desired situation, the use of the organizational capacity is divided based on the needs of each specialty. What the hospital is looking for, to get to this desired situation, is a performance measurement/management system. A performance management system uses information from the process to report on performance, and one way of presenting this is as a dashboard. The balanced scorecard is another way of visualizing and reporting on the measured set of KPIs (Lebas, 1995).

According to Weiner et al. (2015), a dashboard is a good tool to support capacity decisions. Therefore, a search for scientific literature on the use of dashboards and the selection of the contents of dashboards has been performed and is reported in paragraphs 5.2 and 5.3. The aim of this literature study was to find KPIs that can be used to measure all phases of the process depicted in Figure 2.1, so that the dashboard is a valid representation of the measurement of the process. Along with that, literature on the use of tools within the planning process of hospitals has been studied, to identify important factors which can support proper use of the dashboard. Therefore, the research area is the entire elective planning process within hospitals, extended with literature on change management for this particular situation of implementing a dashboard to support the planning of the operative process in a general hospital.

Much of the points discussed in this paragraph (5.1) and in the cause-effect diagram (Figure 5.4) need to be solved to make the use of the dashboard possible and successful, this will be discussed in the coming chapters.

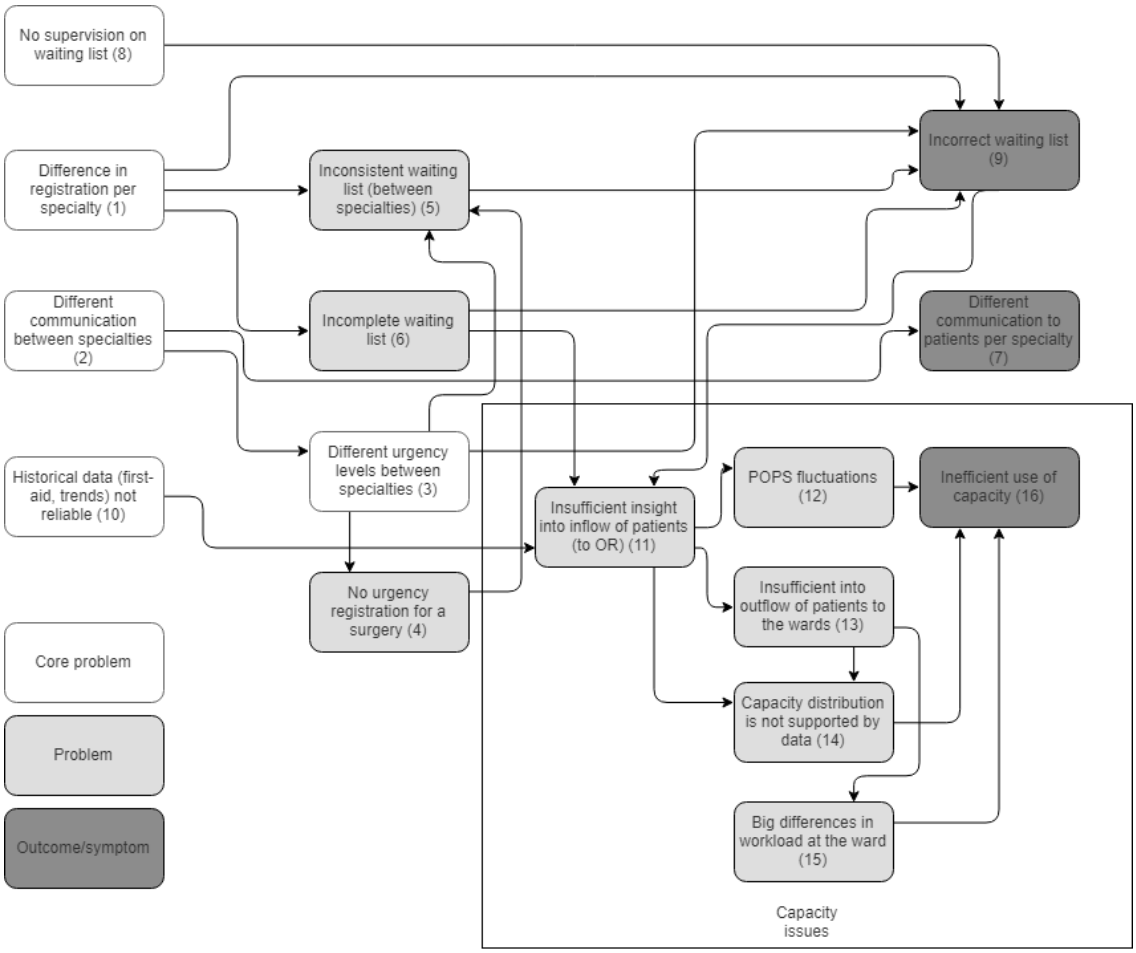

Figure 5.5: Cause-effect diagram

5.2 Literature research on the use of dashboards

In this paragraph literature on the use of tools within the planning process of hospitals is discussed, to identify important factors that can support proper use of the dashboard. The Netherlands was one of the first countries to measure the performance of the health care system, the DHCPR (Dutch Health Care Performance Report), and the article of Van den Berg et al. (2014) reflects on important lessons learnt seven years later. The DHCPR reports on health care performance regarding quality, access and affordability. The DHCPR has been developed and regularly evaluated in two phases:

- Development of conceptual framework
- Indicator selection

Indicator selection is done by a mixed top-down and bottom-up approach, as seen in Figure 5.6. The researchers found that the optimal way to select indicators was a result from balancing the top-down approach with the bottom-up approach. The top-down approach means that the indicators are derived from the strategic objectives of the performance management system. The other way, the bottom-up approach, is that available data, knowledge or time determines the selection process. Therefore, the final selection of indicators is often a compromise of strategic objectives and the practical possibilities.

Seven years after performing the first health care performance report, the researchers have formulated seven recommendations that are essential when designing a health care system performance assessment:

1. Think about the conceptualization of the system: what aspects to include and in which depth? Don't get lost in 'framework discussions' but focus on the goal of the performance measurement.
2. Repeated measurement is more important than highly qualified scientific studies. Policy makers find more use in development over time; however, one-time studies may be relevant. This does not mean, that scientific studies are useless, but a mediocre indicator with clear trends will be more useful than a highly time-consuming indicator, for which there is no capacity to calculate it on a regular base.
3. The added value of performance reports is that they combine multiple perspectives on the same situation. This is done by having multiple indicators that reflect a process, system or organization.
4. Patient experiences need to play a central role. In the first edition these experiences were covered in a separate domain, but in subsequent editions they were integrated with the subject concerned, for example: patient experiences with safety were integrated with other safety measures.
5. Don't let unavailable data influence the choice of relevant indicators. If there is unavailable data, name the indicator and which data is needed to assess it.
6. Use already existing performance measurement networks in health-care
7. Policy makers and researchers need to exchange information continuously. Lately, researchers found that they went through a thorough, rational and long process of doing research, where policy makers had to make ad-hoc decisions and were sometimes ignoring or missing essential data.

The most important lesson from this article is that there should be a mix of the top-down, and bottom-up approach. The decision makers in GHZ can often perfectly describe what they see as the ideal solution to a situation, but this solution is impossible to create, since there is no data

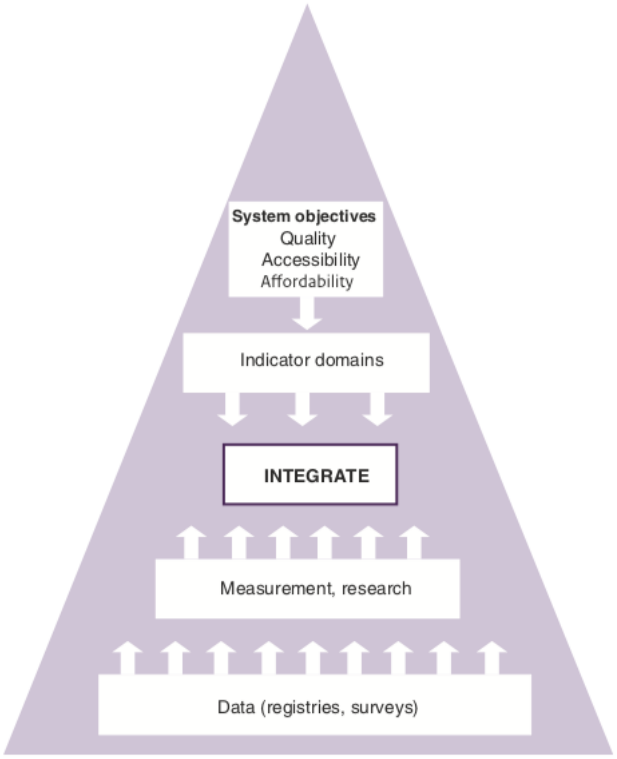

Figure 5.6: Top-down and bottom-up indicator selection process

available which can be used to build it. Therefore, the wishes of the decision-makers should be taken stock and matched with the available data and options at this moment.

Dashboards are often used in performance assessments. Their main appeal lies in their ability to present KPIs in an easy-to-use and visually engaging graphical format (Weiner et al., 2015). In their case-study, Weiner et al. (2015) used a dashboard, since it allowed monitoring of KPIs from four different perspectives (Kaplan and Norton, 1992):

1. Financial (shareholder) perspective: The way the organization or process looks to shareholders or other creditors. Focus on its financial health and performance.
2. Internal (business excellence) perspective: What the organization must do to excel, wherein the organization must excel. Focus on internal operations.
3. External (customer) perspective: The view of customers on the organization. Focus on the expectation of the customer.
4. Innovation/learning (value creation) perspective: The changing organization needs to stay successful and maintain quality. Focus on innovation and development in the organization.

When implementing a dashboard in a hospital, you don't need state of the art requirements, in terms of specification, data-collection and support. In the case of the St Joseph Mercy Oakland hospital (Weiner et al., 2015), the dashboard implementation changed the way the hospital looked at quality and other processes. In the beginning of the project there was little support throughout the organization, however once it started to show its merits, the use of a dashboard gained the support and participation of various user groups. Not all data that was needed according to the specification was available when the first version of the dashboard became public. The dashboard started with what was already available and was expanded as support for its use increased. An important aspect of the dashboard used in this study was that it was open to everyone in the

organization, except the screens containing sensitive personal and clinical data (Weiner et al., 2015). For the situation in GHZ this means that although not all data is already available to calculate and visualize the KPIs, a start should be made with what is possible. This can make the involved stakeholders get used to using a tool to support their decision-making.

Weir et al. (2009) have five tips when implementing a balanced scorecard system, a form of a dashboard, in a public health unit, based on their research experience:

1. Involve management and front-line staff in the development of indicators to increase the likelihood of understanding, uptake and sustainability
2. Start with as many indicators as possible, to reduce the chance of overlooking an indicator
3. Target the initial scorecard at the governing board with fiscal responsibility
4. Consider using an easy to understand example and present it to generate discussion and consensus over indicators
5. Indicators will become more informative over time as trends in results of indicators will emerge and staff becomes more familiar.

These tips apply to situations where the framework is used as a performance measurement tool within the entire hospital, to ensure financial health, quality management and efficiency.

To summarize, the literature discussed in this paragraph leads to the conclusion that the development and use of a dashboard in the GHZ will be more successful when:

- Selection of KPIs comes from a combination of using a bottom-up and a top-down approach.
- The dashboard is built, such that repeated measurement is made as easy as possible, and trends in indicator values are visible. Research shows that indicators become more meaningful when their history (trend) is visible.
- Indicator selection is based not merely on the availability of data. However, for some indicators data should be available, since Weiner et al. (2015) showed that the development of the dashboard should start at some point, even without finished requirements, to show its merits. For the dashboard in GHZ this means that it is important to specify what data is needed for the dashboard and its KPIs, but even if this is not immediately available for all indicators, the development and implementation of the dashboard should still start.
- Make the results of the dashboard open access, to show everyone involved, how calculations are made, and why this resulted into specific actions; thus, to create support for its use.

5.3 Literature research on the use of KPIs

As discussed in paragraph 5.2 the dashboard should be filled with KPIs. In this paragraph literature is reviewed to find what the best method is to select KPIs, see which KPIs are used in similar organizations/situations and how to implement these KPIs in a dashboard and in the GHZ.

5.3.1 General recommendations

In the article of Chambers (2002) on how to measure success for a dentist practice, the author comes up with a way to build a performance management system for a dentist clinic. The first five steps that must be taken are identifying some key organizational characteristics, in the following order: **Mission**: Reason why the organization exists
Vision: Which way the organization wants to go in the future, functions as a 'north star'

Core values: Expected behavior and orientation/attitudes of the organizational members
Key Success Factors: Determinants of success, when is the organization perceived as successful, what are the requirements?
Performance Indicators: Representative samples of the organization's or process's functioning. The(se) indicator(s) aim(s) to show the current or future state in a number.

When these steps are followed, the chosen KPIs that will fill the performance management system come from logical follow-up, and have clear foundation in the organization, or for GHZ, clear foundation in the operative process. Often these steps are not followed, and indicators are chosen without this background; this results in failing indicators, that don't accurately represent what they need to represent.

For GHZ this means that the indicators that are chosen should follow logically from these steps. Since the goal of the dashboard is not to represent the entire organization, but to make decisions regarding the operative process, the strategic objectives of the Ma-thesis project should be taken instead of the organizations' strategic objectives. This can be translated as follows:

Mission and vision: Making capacity decisions in the operative process on a tactical level
Core values: Transparency, honesty, healing, integrity
Key Success Factors: The dashboard can be seen as successful when it represents the state of the operative process in a given period in the past and forecasts the needed capacity in a given period in the future. This information can be used to make decisions in the assigning of capacity in the operative process.

Chambers (2002) also shows that performance indicators can be divided into two general categories: leading and lagging indicators. The difference is that leading indicators are for results that are associated with likely future changes, whereas lagging indicators are for results of decisions typically made sometime in the past. Lagging indicators are most common because they are the easiest to measure and accurate, but a disadvantage is that they reflect strategic choices from the past that may not fit the current (or future) situation anymore. Leading indicators are in-process measures and predictive, and as such more difficult to measure. A good performance management system uses a mix of both types of indicators, while considering the relevant characteristics of the performance indicators (i.e., reflecting mission/vision, core values and key success factors) as mentioned above. Based on practical experience, Chambers (2002) found that a good average number of indicators for one specific organization is 12 to 20, since more than 20 indicators is too much work to collect and makes it difficult to focus on specific individual indicators and managing them. The last issue is that for each indicator the target value should be set, which can be coupled to actions that can be taken when the indicator is too high or too low. The determination of this target value is often hard to come up with, since the history or the trend of the indicator needs to be known, before recognizing whether an outcome is good or not. Therefore, when it is possible, the target value should be set based on history, or on knowledge of experts. This results in the following procedure:

1. Define the relevant background characteristics for the indicators, start from mission and vision, find core values and key success factors and define performance indicators
2. Create a mix of leading and lagging indicators
3. Find a reasonable number of indicators, which depends on the goal of the performance management system. For an entire organization this lays between 12 and 20, for a department or process this can be between 4 and 8 (Chambers, 2002).
4. Create targets for the indicators, with corrective actions in case of over- or underperforming.

For the selection of indicators for the operative process in GHZ, which is just one process among many others in this hospital, this means that the abovementioned steps should be translated to this specific situation. Find the strategic objectives for the Ma-thesis project in GHZ and translate this to success factors and select or compose performance indicators. The indicators should be a

mix of four till eight leading and lagging indicators, with target values for every indicator whenever possible. In some cases, it is hard to determine the upper- and lower boundary for an indicator and this has to be determined based on history or trends of the indicator.

The categorization of indicators into leading and lagging indicators is not the only way of categorizing them. Another categorization can be to divide the indicators in structure, process and outcome indicators. Giltenane et al. (2016) made a protocol for a mixed methods study which, among others, showed that improving quality of health care is an integral component of effective health care delivery, and the measurement of health care practices plays an integral role in quality improvement. The researchers use the following categorization of performance indicators:

- Structure
- Process
- Outcome

The distinction of Giltenane et al. (2016) into structure, process and outcome indicators is not unique as Mainz (2003) performed a research on the definition and classification of clinical indicators and also used these three categories.
Structure denotes the attributes of the setting in which care occurs, process denotes what is done in giving and receiving care, and outcome indicators attempt to describe the effects of care on the health status of patients and populations. Examples of related indicators are:

- **Structure**:
  - Proportion of specialists to other doctors
  - Clinical guidelines revised every 2nd year
- **Process**:
  - Proportion of patients with a specific disease given a specific treatment (for example: proportion of patients with asthma given oxygen-treatment)
  - Proportion of patients assessed by a doctor within 24 hours of referral
- **Outcome**:
  - Mortality
  - Patient Satisfaction
  - Quality of Life

Structural indicators should be used when structural components have been shown to improve the likelihood of a good outcome, this can be based on scientific literature or professional experience. Process indicators assess what the provider did for the patient and how it is done. Outcome indicators are states of health that follow care, ideal outcome indicators measure the effect of care provided on the health and wellbeing of patients and populations.

An important question when setting up a performance measurement system is which indicators are selected: structural, process or outcome indicators. Some points of attention based on Mainz (2003) are:

- It is important to realize that process and structural indicators need to be verified with outcome indicators ('outcome-validated') to assure that they are associated with good/better results
- Process indicators are especially useful when a goal is to improve quality
- Process indicators are easier to interpret than outcome indicators
- The broader the perspective required, the greater the relevance of outcome indicators

Mainz (2003) also emphasizes that in all choices, feasibility is always a key consideration. Feasibility refers to the alignment of the interests (top-down), and the possibilities (bottom-up), as well as the alignment of the availability of data and the availability of development time.

For the selection of KPIs to represent the operative process, the first question that should be answered is what the goal of the set of KPIs or the dashboard is. Since the goal is to improve efficiency, while keeping quality of care out of scope, some indicators can be more useful than others. According to the research of Mainz (2003), process indicators will be a good match for the dashboard that will be developed in the current project, since they are relatively easier to interpret than outcome indicators; and since the goal of the indicators is to give advice on capacity choices, it is important that it is clear where changes in indicator values come from.

Persaud and Nestman (2006) make a distinction between two types of indicators, also called measures: process or outcome indicators. Outcome indicators are intended to assess and hopefully improve health-care by informing stakeholders of the outcome they can expect from its provision. Process indicators assess what is done in the process of providing care, while outcome indicators are the result of these processes or activities. When reading their paper, it seems that the authors added the 'structure' indicators to the process indicators: "It has been argued that the movement to measuring outcomes rather than structures and processes of care...". From this sentence, it becomes clear that the researchers know about the structural category, but don't use it as a separate category in their research.

Persaud and Nestman (2006) also found that generally, performance management is done by first deciding what are important criteria (accessibility, effectiveness, efficiency) and thereafter finding and setting indicators that reflect this. A negative by-effect is that such a performance measurement system fails to map an action to an indicator that is underperforming. Using systematic outcome planning, which is the mapping of possible outcomes of in indicator to a specific activity or part of the process, the criteria (accessibility, effectiveness and efficiency) are built into the processes from the beginning. However, in health care most processes are already in place, and therefore often the alternative path is taken, i.e. the performance indicators that are chosen are linked to identifiable activities. When this is done, an indicator that is not reaching its target can be used to adjust a process, since it is directly linked to an action. This enhances the chances of successfully changing activities to improve outcomes. Therefore, the designing phase of KPIs is important, since it forms the basis of successful performance management. The most important is that when selecting the KPIs, the decision maker needs to constantly keep the strategic goal of the hospital (or the project) in mind. This prevents the KPIs from being irrelevant to what is needed to reach the strategic goals; it also prevents that no one knows which action to perform when a KPI is over- or underperforming. The goal of the dashboard is the periodic adaptation of the available capacity with the needed capacity.

In GHZ, the situation is such that the processes are also already in place, and therefore the criteria cannot be built into the processes from the beginning. This means that indicators should be linked to identifiable activities, to assure that the users of the dashboard know what to do when an indicator gives a result that is out-of-target. For each indicator, it should be clear what the upper- and lower bounds are, and which action or activity is linked to this value.

Abelson et al. (2017) also state in their article that it is important to link each indicator to activities and setting up upper and lower bounds. According to these authors there has been an increase in efforts by governments to publicly report on their health systems' performance. Because there is an increasing volume of data, a litany of health system performance indicators is available. The article speaks about an 'indicator chaos', since it is unclear what these indicators truly indicate and takes a novel approach by exploring the perspectives of senior civil servants on the main objectives of their health care systems, how these objectives are prioritized and how indicators can be used for these objectives. They found that an objective such as quality of care or efficiency is often measured with the wrong, or a partially wrong indicator.

This means that for the project in GHZ, for every indicator it should be documented why this

indicator is a good representation of the operative process, and determine boundary values and related actions (i.e., when is the indicator's value is too high or too low, and which actions can or should be taken to change that).

Another categorization that is important for the dashboard in GHZ is given by Berg et al. (2005), who developed the first national, public and obligatory set of performance indicators for hospitals in the Netherlands. Berg et al. (2005) state that performance indicators can also be subcategorized into internal and external ones. Internal indicators are used by health care providers themselves to monitor and improve the outcome of their care processes. Professionals use this information to identify potential problems and how they can be solved.
External indicators are used by the government, patient organizations, insurance companies and patients to assess the quality of care. These indicators are used to compare the quality of care of different health care providers. They need exhaustive validation, by correcting them for all possible differences between different care contexts, to prevent perverse effects such as 'creaming and dumping', which is the selection of patients that guarantee high scores, thus creating an indicator that has inflated scores. This is not required for internal performance indicators.

It is necessary to take the differences between internal and external indicators (and their target groups) into account, since external indicators require much more effort to finalize them before publication due to the reasons mentioned before. This finalization is the process of validation and verification that makes the indicator appropriate for comparing it with the indicator of other organizations. The conclusion for GHZ is that fort his project only internal indicators need to be used, since the goal is the improvement of capacity distribution in the operative process.

Identifying indicators is a time-consuming and costly project because in order to increase the validity of these outcomes, additional registration work is needed. Performance indicators come with high expectations of changing and optimizing processes in a simple and fast way, this holds both for the health care sector and for other private and public sectors. Researchers repeatedly experience that it is impossible to identify a 'valid' set of indicators that represents an entire process or organization perfectly. It would take endless work, data correction and endless debates about assumptions made in the specification process of the KPI. Therefore, feasibility is key in the selection process and following from that: choose indicators that are good enough for the purpose they are used for. Internal indicators require less validation, the power of the indicator comes from the repetition of measuring. Think pragmatic when selecting indicators. If there is no support to change the processes that are required to supply data for the indicator, the indicator is simply not usable at this moment.

The project in GHZ is internal, the indicators are only for a specific group of decision makers, who know the context of the numbers. It is important that this is clearly documented, to prevent misconceptions about the meaning of numbers. Don't expect the processes in the hospital to change in order to supply data that is needed for specific indicators. When building the first version of the dashboard it is better to focus on the data that is already available and document the indicators that cannot be calculated yet.

To summarize, the literature discussed in this paragraph gives some clear guidelines on the mix of KPIs that is needed in terms of categories. Other guidelines that are important:

- The objectives of the project should be kept in mind when selecting KPIs, which is the adaptation of capacity with the needed capacity. The goal of the dashboard is not to represent the entire organization, but to make decisions within the operative process, so let the indicators represent this process.
- The indicators should be a mix from four till eight leading and lagging indicators
- Process indicators with a focus on efficiency are a good match for the dashboard that supports the decision-making process, since the dashboard will be used to make changes in the process to optimize efficiency within the entire operative process

- Indicators should be understandable, so that it is clear where changes in indicator scores come from, and which actions should be taken to achieve this
- Link indicators to processes or part of processes
- For each indicator the lower and upper value needs to be given, if this is not possible yet clear documentation is needed.
- For each indicator the required data needs to be documented. When data is not available yet, indicate which data is needed and start developing the dashboard with the indicators that already have available data.

5.3.2 Specific recommendations

In this paragraph recommendations are given for KPIs on specific parts of the process, and examples from comparable case-studies, or literature-reviews.

The perioperative process encompasses all phases of surgery: preoperative (including the pre-assessment phase), interoperative and postoperative. The article of Ryan et al. (2017) discusses the development and use of key performance indicators within each stage of the perioperative process. The perioperative process is complex, since it involves multiple interconnected sub-processes that provide surgical care for patients. The perioperative process has 5 patient end-state goals:

1. A correct diagnosis for surgical intervention
2. A patient undergoes a surgical procedure
3. A patient exhibits minimal exacerbation of existing disorders
4. A patient avoids new morbidities
5. A patient experiences prompt procedure recovery

For all this end-state goals the hospital aims to perform as good as possible, however, the hospital is not always in control of what happens to the patient. The researchers state that the perioperative process is often measured in OR-metrics, as are:

- The percentage of surgical cases that start on time
- OR turnaround time
- OR suite utilization
- Labor hours per patient care hours

An important thing to keep in mind is that the outcome of the entire perioperative process (the way in which the patient meets the 5 end-state goals (Shulman and Myles, 2016)) is dependent of all of its sub processes, and therefore Ryan et al. (2017) split-up the perioperative-process into 5 sub processes and determine KPIs for each of these sub processes: Pre-assessment, pre-operative, intra-operative, post-operative and central sterile supply. In Appendix A - Table A.1, an overview is given of the 4 sub processes and related KPIs of Ryan et al. (2017).

Comparing the article of Ryan et al. (2017) with the GHZ, some aspects of the planning are different, e.g. in some cases, the patient gets his/her anesthesia evaluation right before the surgery, which makes that indicator best-practice targets are different in both hospitals. Some indicators apply more to what is needed for the operative process than others, since this is an overview of multiple perioperative indicators for all purpose in the perioperative process. KPIs that are usable for the dashboard of the GHZ are indicators that indicate lead time, utilization, efficiency, since the goal of the dashboard is to support capacity-decisions in the operative process. The total needed capacity is the sum of all lead-times, the effective use of capacity can be expressed in utilization and efficiency-indicators express in which extend the capacity is used, for example:

Table 5.3: KPIs on anesthesia according to Haller et al. (2009)

Indicator
% Patients without Evaluation
% POPS Assessment day before surgery
% Patients <24h day cancel due to anesthesia reasons
Length of stay due to multiple reasons (ASA)
Multiple throughput indicators for example (patient arrival to admission)
Complications of anesthesia rate per 1000 surgeries

- From department 1 to department 2 throughput-time indicators (example: arrival to admission)
- % of patients seen / evaluated / delayed
- Efficiency indicators on delay
- Length of stay indicators

Additional indicators for the perioperative process can be found in the article of Chazapis et al. (2018), who performed a systematic review on perioperative structural and process indicators. The researchers use the existing categorization in structure, process and outcome indicators.

In Appendix A, Table A.2 the 3 structure indicators that are most frequently used for each stage are given as well as the indicators which fall within the scope of this literature research because they are related to performance management. In Appendix A, Table A.3 the same is done for process indicators. The columns are as follows: column 1: F-frequency, column 3: E-evidence, column 4: D-dimension. The specific indicators are not used in the selection procedure for GHZ, but it shows the possible types of indicators that can be used. Type of indicators and examples that can be candidates for selection, because of their relevance to efficiency and performance, which are the goals of the current project, to be used in the dashboard for the GHZ project are:

- Structural data availability indicators: complete waiting queue data, hospitalization (bed utilization) data, surgeries data
- The agreed processes are followed: % of patients that received an anesthesia assessment on-time
- Efficiency and planning indicators: on-time starts
- Elapsed time and other length of stay and throughput indicators (from department 1 to department 2)

As already mentioned before, the operative process in the GHZ has 4 stages in the GHZ as seen in Figure 2.1. Anesthesia is involved in phase 2 and phase 3 of the process. During the pre-operative screening the doctor (anesthetist) checks the patient's health condition and determines which way of anesthesia is needed during the surgery. In the OR an anesthesia operator is present, which monitors and controls the sedation.

Haller et al. (2009) performed a systematic review on quality and safety indicators in anesthesia, which is relevant for this literature research because anesthesia is involved in phase 2 and phase 3 of the process in GHZ as mentioned before. The indicators that apply to the scope of this literature study, since they are efficiency, throughput-time and planning indicators, are mentioned in Table 5.3. To be selected, the indicator should be related to performance management, by measuring efficiency, throughput and lead times, and utilization.

The researchers state that systematic reviews, of clinical indicators are highly recommended when implementing new indicators, however, it is difficult to determine which indicators are relevant to

Table 5.4: KPIs on OR in the article of Hassanain et al. (2017)

Indicators
OR utilization (during prime time)
On-time starts for first cases
Room turnover times
% Overrun cases (cases that are taken over for example by first-aid patients)
Weekly procedure volumes

the subject, and therefore additional ways of determining indicators can be used to assure that the indicators reflect the process well, such as:

- Opinion and vision of medical staff or managers
- 'Gray' literature (information from users, books, other hospitals, websites)
- Data-based indicators

Hassanain et al. (2017) studied whether Lean methodology improves operating room efficiency. The implementation of Lean is done by (among others) the implementation of a dashboard that enables starting the first case on time, and by creating a governance structure with policies and procedures for surgeries. The focus of the project was on the OR, since 60% of the gross revenue of hospitals is contributed by operating rooms, while they also contribute to 40% of the cost Macario et al. (1995). Therefore, optimal use of the ORs is one of the key elements in efficient hospital management. The study assesses the impact of implementing by comparing 5 key OR performance indicators, which are shown in Table 5.4.

These indicators reflect well whether the implementation of a new way of working improved the efficiency of the processes that involve the OR; it is questionable if these are the right KPIs for a performance management system, since they focus on one aspect, namely efficiency. A right performance management system should give a good image of the entire process or organization.

Adding to the conclusions drawn in paragraph 5.2 and paragraph 5.3.1, the selection of KPIs cannot only be based on a literature review and copying examples found in other hospitals or in other health care settings. These examples can be used as a starting point, but new KPIs should be based on be a combination of theory and practice, which will be explained further in the conclusion of this chapter.

Some attention should be paid to the use of waiting time data as an indicator too. Logically, it is a good practice to divide the total capacity in the hospital among all specialties, based on the demand each specialty has. The easiest way of doing this is by comparing the waiting time of a patient. This is not only done by the hospital itself, consumers of care and insurance companies often make health care decisions based on comparing waiting time data from different hospitals too. A general assumption on performance indicators is that they need to be available to everyone, since it is a prerequisite for a well-functioning health care market (Marshall, 2000). However, empirical evidence shows that performance data only has limited impact on choices. Stoop et al. (2005) examine the use of waiting time data indicators by analyzing those in detail. The researchers show four different themes that need further analysis:

1. The patient behind the number: the significance of waiting times: the waiting time does not tell us anything, since it does not differentiate between patients, for example their severity of illness. Some patients are not urgent at all, while others need to be treated immediately.
2. The treatment behind the number: there is very little knowledge on the relation between quality of care and waiting time. A long waiting time can reflect a good doctor with high quality care, but also internal problems in the organization.

3. The strategy behind the number: waiting times are a political issue that involves all actors in health care. For example, waiting times can be decreased by tightening indications that are needed for referral, but this is not always in the benefit of the patient because a doctor may hesitate to refer the patient, which causes a delay in treatment, which has a big impact on the health of the patient.
4. The validity of waiting times: the researchers found that the hospitals all had different kinds of coming up with the waiting time data. Therefore, each hospital used different ways to come up with their data, and therefore they cannot be compared. Also, there are differences between types of hospitals (academic and peripheral for example), but also within hospitals different numbers are being used.

All these reasons combined cause that the waiting time is not a reliable indicator for a hospital to allocate capacity, and also not for a patient when choosing between hospitals. A simplified example: The eye doctor always keeps three places open for emergency patients, so that a patient that gets an indication that (s)he needs to be helped within one week can be helped. The hospital and people that don't know the context can think of it as that the waiting time is one week. However, when a normal patient (without an urgency need) gets a reference from his/her general practitioner, and chooses this hospital based on the waiting time, the eye doctor will give him a surgery waiting time that is usually longer than one week.

However, there is still usefulness in waiting time data when making the following distinction:

- Internal indicator: Internal waiting times can be used for management purposes and quality improvement. This implies that the indicators are being used by professionals and managers only, who know the context
- External indicator: These indicators are meant to inform the public in general and other actors. They require time-consuming research, large samples and correction for all possible relevant differences between health care settings.

Looking at internal and external indicators from this point of view leads to the conclusion that the indicators for the current project should be primarily used for internal use, with the specific context given. The data is available and gives an extremely useful view of the current differences in capacity need of different specialties but cannot be used without knowledge of the context. Waiting time and lead-time data can be used, but with the remark that it is only for the use in the dashboard, to support decision-making on the assigning of capacities in the operative process.

To summarize, the literature discussed in this paragraph gives some examples of and starting points for selecting KPIs and indicates what is useful in which situation.

A good way to start is with the following mix of indicators which assess efficiency and utilization:

- Throughput indicators (from dep. 1 to dep. 2, length of stay)
- % of patients seen / evaluated etc.
- Delay and planning indicators (On-time starts)
- Structural indicators on the availability of data: complete waiting queue data, hospitalization (bed usage) data, surgeries
- Structural indicators on the execution of process steps

Another conclusion is that it is impossible to find all the indicators that make a 'valid' set solely in the literature. It should also be based on the opinion of stakeholders, 'gray' literature and information sources (other hospitals) and on already available data.

- Opinion and vision of medical staff or managers
- 'Gray' literature (information from users, books, other hospitals, websites)

- Data-based indicators

In Appendix B a per-article summary of the literature review can be found.

5.4 Stakeholder analysis

To determine what the tactical level of planning will look like in practice, it is important to know which stakeholders are involved. At first, a categorization is made into two types of stakeholders, direct and indirect stakeholders. The direct stakeholders are directly involved in the decision-making process, either as being responsible for a part of the operative process, or as a manager or having a supportive role within GHZ. The indirect stakeholders are influenced by the decisions being made by the direct stakeholders, for example the doctors from a specialty that get extra OR-sessions in order to reduce their waiting list, or the nurses that have a higher inflow of OOG-patients due to an extra session for this specialty. These indirect stakeholders don't have a say in the division of capacity, but it is important that they can understand why choices have been made, what the underlying reasons (calculations) were, and that the data that is being used to make decisions provide a realistic picture of the current situation. Three years ago, GHZ also started to allocate and forecast needed capacity based on data, but a big shortcoming then was that in the eye of the stakeholders involved the data that were used did not provide a correct view of the situation, which caused dissatisfaction on the work floor. In the current project this should be prevented, by involving all stakeholders (direct and indirect) already in the design phase of the new planning process, and for this report, specifically on the tactical level.

An overview of the direct stakeholders based on (parts of) the operative process as depicted in Figure 5.3:

- The doctors from the different surgical specialties: As mentioned earlier in this report, there are two types of medical specialists in the hospital: in-house medical specialists and consultant specialists, which have a different way of being paid. The consultant specialists are firstly direct stakeholders, since a capacity decision can result in a higher or lower number of patients that is treated on his/her behalf. However, consultant specialists and in-house medical specialists are united in the Works Council, where it has been discussed that the capacity and demand (in terms of patients/surgeries) should be more balanced. This resulted in an understanding by the consultant specialists that a more fair and calculated division of capacity was indeed needed.
- The OR - manager: The manager of the OR (who in GHZ is also responsible for the POPS) is a direct stakeholder, since (s)he makes the decisions on the allocation of the OR-sessions. There are some options, when looking at the allocation of OR-sessions:
  - The allocation of the so-called 'flex' session to a certain specialty
  - The allocation of sessions that become available (for example due to drop-out of patients, or doctors)
  - Making changes in the OR master scheme (this is unusual, and should be done on a strategic level)

  During the tactical planning meetings (details will be discussed later during the design-phase, Chapter 6) the OR - manager is one of the main decision-makers.
- Capacity manager: The capacity manager is a direct stakeholder, since (s)he is responsible for the ICM-project in the GHZ, and has supervision and responsibility over the strategic, tactical and operational choices.
- Financial department: Allocation of sessions to other specialties or changes in the POPS or ward utilization come with financial consequences. Therefore, the financial department is a

direct stakeholder and has influence on decisions that are made too.

With respect to the indirect stakeholders, first an example of a realistic situation is presented: During a tactical team consultation, the decision-makers found that the maximum number of surgical dates on the waiting list of CHI exceeded the threshold, and the decision was made that capacity that comes available will be allocated to OR-sessions for CHI to reduce their waiting list. For the doctors from CHI, the consequences are that there is less time for them to run the outpatient post, and that they have to shift to running the OR.

- The consultant specialists, together with the in-house specialists are both also indirect stakeholders, since capacity decisions can cause their schedules to change. Doctors have always been used to the idea that their wishes are dominant in the scheduling of sessions, but with the integrated method of capacity planning, efficiency and a fair division of capacity (OR, outpatient sessions, POPS-places) are more important than their personal wishes.
- POPS - doctors: The anesthesia doctors will probably notice the same consequences of the new planning system as the doctors from the specialties, i.e. that decision making is based on efficiency, strategic choices and calculations; and that this is going to the basis of their schedule.
- POPS - staff: The staff (planners, supporting staff) are indirect stakeholders, as they will notice the effects of decisions, such that because of the increase of OR-sessions for CHI, more patients of that specialty will visit the POPS, and these patients are often in better health than the patients that came from the specialty that gave up a session. This causes that the average time of a POPS-visit decreases.
- The planners from the surgical specialties: The planners from the CHI-specialty will notice that they have more capacity to assign their patients to, and this has a positive effect on the (reduction of the) waiting list.
- OR - staff: An effect for the OR staff is that when an OR-session comes available, the first specialty that is candidate to receive this session is CHI. Another consequence is that there are more CHI surgeries, which are more sensitive to delay.
- OR - program coordinator: The program coordinator checks whether the planning of all specialties in the short term is realistic, i.e. whether the OR utilization is not too high or too low, and whether all patients meet the requirements that are needed before having surgery (POPS-agreement). The program coordinator has to deal with the consequences of decisions, since it will affect the OR-planning.
- The staff on the wards: Since the average duration of a CHI-surgery is high (compared to others), less patients can have surgery in one OR-session. This has the effect that the outflow of patients is lower than it was in the original situation. However, if the session that is now allocated to CHI used to be for a specialty that has its own ward, then the outflow is higher than the original situation, since in the original situation there were no patients that went to the ward of CHI.

Since the direct stakeholders are already actively involved in the ICM-project, the decision is made to also ask for the opinion of the indirect stakeholders. The direct stakeholders have plenty of options to make their wishes known (Works Council, ICM steering committee, board meetings), which does not hold for the indirect stakeholders. Therefore, interviews have been held among members of all stages of the operative process. The main goal of the interviews was to have a helicopter view of the wishes and opinion of the indirect stakeholders for this project in the operative process, with the main objective to prevent overlooking potentially important issues. Representatives from the following groups of employees were interviewed, two of every group.

- Specialties: The planners that plan the patients on the POPS and to the OR.
- POPS: The staff that supports the POPS doctors, and helps in planning issues

- OR: The program coordinators
- Wards: The planners of patients on the wards

The interviews were held in the semi-structured format, since that makes it easier to compare the answers of different interviews between themselves and maintaining structure, while keeping the possibility to dig deeper into specific topics. The interviews are held in Dutch, the Dutch version is shown in Appendix C. The interview questions were categorized per sub- research question.

1. KPI-related questions:
   (a) What are important criteria for you to know if the plan process runs fine? (11)
   (b) Which information do you need to improve the planning process? (12)
   (c) How would you use that information? (13)
2. Current and desired situation questions:
   (a) About what are you satisfied in the planning process? (5)
   (b) What problems do you encounter in the planning process? (6)
   (c) What do you suggest as a solution for these problems? (7)
3. Stakeholder related questions:
   (a) Who would be involved in these solutions, and what is their role? (8)
   (b) What do you think that their opinion is on such solutions, and do you expect their cooperation? Why or why not? (9)
   (c) What is your biggest wish for improvement? (10)
4. Direct stakeholder (users of the dashboard) questions:
   (a) Who have direct influence on your working activities? What is this influence? (3)
   (b) What is their role in the planning/operative process? (4)

In the next paragraphs the main findings of the interviews are given.

5.4.1 KPI-related questions

There seemed to be no need for extra information on the state of the operative process, possibly in the form of indicators, among the interviewed people, when asking it with open questions (question 12). This is notable, since there is a lot of data available which can be used to give the planners of the different specialties, or the program coordinators of the OR useful insight in how accurate their planning and forecast was.

This led to the conclusion that it was necessary to show these stakeholders what the possible options are, besides those that they already know. This resulted in the creation of several work-groups, existing of employees in the operative process, to share the possible options in the systems which give insight in the standings of the operative process. The results of these workgroups are explained in paragraph 7.1.

5.4.2 Current and desired situation questions

The answers to this category of questions were very different for the four parts of the operative process. The interviewed stakeholders all came up with practical problems that they experienced, which had not much to do with the ICM-project or the development of a dashboard. Notable

were the complaints on the lack of communication between specialties and managers in the hospital; many of the interviewed people indicated that they would appreciate it when they would be involved in changes in the operative process. Therefore, this became a focus point in the implementation of the dashboard.

5.4.3 Stakeholder related questions

The last category of questions was on the relation with other stakeholders in the process. Some questions were meant to examine who the interviewees saw as their direct colleagues in the operative process. It turned out that stakeholders/parts of the operative process understood what their own role was in this process but had no idea about what the consequences of their work was on the other stakeholders/parts in the process. For example: the program coordinators knew their position in the process, and what the input and output of their part (the OR) was; but they had no idea on what choices to make in order to let the process as a whole run as optimal as possible.

Another outcome of the interviews was that the general opinion of the different groups of employees that are involved in the operative process on each other was positive. Everyone was very involved in the process and was keen to cooperate in order to improve the operative process. There was also a positive attitude towards colleagues, both as regards their commitment as their willingness to change.

5.5 Answers to sub-questions 1 and 2

The answers to the sub-questions discussed in this chapter can be formulated as follows:

1. What does the current situation look like? And what is the gap between the current and the desired situation?

In the current situation, every specialty has a different way of working when it comes to the registration of a patient and the further handling of this patient (use of waiting lists, planning horizon). In the desired situation, the ways of working of the different specialties should be as uniform as possible. This requires that every specialty uses the same planning horizon and does not use paper agendas or different systems, but the same system. When the same systems, registration method and planning horizon is used, the waiting list will be unambiguous across all specialties.

This will also help to solve the problem that GHZ has in the current situation, which is that there is insufficient insight in the inflow of patients to POPS and OR, which is due to a non-consistent waiting list. In the desired situation the state of the waiting list is known per specialty (number of patients on the list, urgencies, and extra inflow based on the first-aid inflow, outpatient visits and seasonal trends.

In the current situation, besides insufficient insight in the inflow of patients, there is also insufficient insight in the utilization and planning of beds at wards. In the desired situation, where all specialties register patients in the same way, and other inflow is known (first-aid inflow, outpatient visits and seasonal trends), this can be used to give GHZ insight in the expected outflow from the OR to the wards.

Another difference between the current and desired situation is the communication that the patient receives from each specialty. Currently, there are differences between each specialty in informing the patients on dates of going to POPS and surgery, but also in information the patient receives on the surgery and stay in the hospital. This communication is done by phone, per e-mail or by post, which also differs per specialty. In the desired situation all specialties inform their patients in the same way with the same method.

These points should be improved or solved when using a dashboard with indicators, which gives insight into the entire flow of the operative process, with uniform working standards per specialties, for the planners and for the patients.

2. Who are the important stakeholders in the design and implementation of a tactical level of planning in the operative process?

The stakeholders were categorized into direct and indirect stakeholders: Direct:

- Doctors from surgical specialties
- OR manager
- Capacity manager
- Financial department

Indirect:

- POPS staff
- POPS doctors
- Planners from specialties
- OR staff
- OR program coordinator
- Staff on ward departments (including nurses)

The direct stakeholders are closely involved in the development and evaluation process of the dashboard and the indirect stakeholders are informed on the project and asked to share their opinion. Special workgroups have been set-up to involve the latter group of employees.

Chapter 6

Design

In this chapter sub question 3 is answered: What data should be considered in the design and implementation of a dashboard to support the tactical level of planning of the operative process at GHZ?

The answer to this question will be based on the results of the gap analysis (5.1, the stakeholder analysis (5.4) and the literature research (5.2 and 5.3). In this chapter, firstly, a translation will be made of the recommendations drawn from the literature study to a dashboard and the KPIs that were included (paragraph 6.1 and 6.2). Secondly, in paragraph 6.3, it is described what the future situation should look like to successfully use this dashboard and KPIs, with specific information per indicator.
The final step in the design process is the linking of the indicators to the operative process and defining what actions and capacity-decisions are linked to possible outcomes of the indicators. This will be described in paragraph 6.4 and 6.5.

6.1 Dashboard

Before deciding upon the content of the dashboard and the data that are to be included, the general dashboard recommendations as described in paragraph 5.2 were considered.

First, the dashboard should be seen as a tool that is developed to support the decision-making process, and not to dominate or lead the decision-making process. Especially in the starting period, the dashboard should be used to see what its effects are on the process of coming to a decision, and how it can be used to supply the tactical decision-makers with additional information on the situation in the operative process. Since most indicators were not fully realizable yet, see paragraph 6.2, the dashboard is still incomplete and often has incorrect data. Therefore, it was important to inform all users properly about the context of used data and their shortcomings. The context of the data includes the (in)completeness of the data, the assumptions made when calculating indicators and the indicators that require additional or different registration to be calculated.

Secondly, repeated measurement should be a main consideration when developing the dashboard, since it delivers useful insights in re-occurring situations. Users of the dashboard can recognize re-occurring situations and remember capacity choices that were successful, and which should be avoided. The dashboard should save the outcome of an indicator to enable comparing it with the outcome of the indicator the next time of usage; this will also give insight into which actions are successful in changing indicator scores and which are not.

Thirdly, the results and underlying calculations should be open to all direct and indirect stakeholders, to enable the stakeholders to check them and thus create support for decisions. When certain actions are taken, based upon dashboard results, this transparency can create support and understanding within the organization, since staff and stakeholders understand why decisions are made (Weiner et al., 2015). This conflicts with a recommendation that is given in paragraph 6.2, that certain indicators should only be used by people that have knowledge of the context. A possible solution for this is to clearly indicate in the dashboard that certain indicators are work-in-progress, or that incorrect and incomplete data-sets are used. Then, the dashboard can be put into action, while indicating at the same time that some indicators cannot be fully relied upon yet.

However, this should not be a reason for not using a concept version of the dashboard and/or its indicator(s), since the fourth recommendation is to start developing and using the dashboard, even if only one or two indicators are available. In that way the users can get used to it and can experience how data are presented. This is expected to have positive effects on the successful future use of a dashboard in the planning of the operative process.

6.2 KPIs

The aim of the literature study was to identify KPIs that can be used to measure all phases of the operative process, so that the dashboard is a valid representation of the state of the process. Along with that, literature on the use of tools within the planning process of hospitals was studied, to identify important factors which can support proper use of the dashboard.

The goal of the dashboard in the current project is not to represent the organization, but the effects of decision-making within the planning of the operative process, and therefore that should be considered as the strategic objective when selecting KPIs rather than selecting KPIs based on the opinion of decision-makers or the availability of data. So, the goal of the dashboard (or the goal of the indicators) should always be a key consideration when selecting KPIs.

The KPIs should be a set of between 4 and 8 leading and lagging indicators, with target values for every indicator whenever possible. When this is not possible from start for specific indicators, documentation should be provided on how to set targets soon. This is done by the developer of the dashboard, the writer of this thesis, and is available for all users of the dashboard in the same folder as the rest of the dashboard documents. A performance management system, in this case the dashboard, should link activities to indicators in case of over- or underperforming. The easiest way to do this, is to build this into the processes when designing them. However, in GHZ, as in most organizations, processes are already in place, and therefore it should be well documented how the indicator fits in the already existing processes and what the consequences of certain decisions or activities are. Process indicators that focus on efficiency are a good match for the objective of this dashboard, because the dashboard will be used to make changes in the process to optimize efficiency within the entire operative process.

Since the dashboard and KPIs will be used by a specific group of decision makers that know the context of numbers and processes, internal indicators will be used. The difference between internal and external indicators is explained in paragraph 5.3.1. These internal indicators should be documented in detail to avoid miscommunication or misconceptions about what they mean, it is very important that all users have the same meaning in mind when using the dashboard. Also, it is important to realize that processes will not be changed immediately in order to supply data that is needed to calculate all indicators. Therefore, the development process should be pragmatic, i.e. starting with the indicators that can already be calculated and make a first version of the dashboard.

In the literature examples of KPIs are given, however there are differences between the specific

context/processes of the different hospitals that were studied and those of GHZ. Therefore, indicators cannot simply be copied from the literature, but the idea behind selecting indicators can. Therefore, the indicators about lead time, efficiency, utilization and performance that can be used in the dashboard are of the following types:

- Throughput indicators (from department 1 to department 2)
- Indicators on efficiency and/or delay (on-time starts)
- Length of stay indicators
- Structural indicators on the availability: waiting queue, hospitalization (bed utilization), surgery
- Process indicators on capacity level: compare waiting queue to available capacity of beds and/or operating rooms

However, as mentioned above, the selection of indicators cannot only be based on literature, but also on experiences in other hospitals, expert opinions and data availability.

All these recommendations lead to a set of lagging and leading indicators, where the lagging indicators are sufficient (give a full image of the state of the operative process) to represent the performance of the operative process in a given period of time, and the leading indicators are used to forecast the performance of the operative process in a given period of time.

The first step to get to the desired situation wherein a tool supports the tactical level of planning of the operative process is that each specialty should make agreements on which term patients have surgery. These agreements should be made centrally, in a meeting where all specialties have representatives. An example:
For GYN there are pregnant patients that see a doctor and get the diagnosis that they should get a cesarean section. These patients should be helped within a short period (2 weeks), this should be the standard for this category of patients. However, there are also GYN patients that need to go for surgery, but are less urgent, and should be helped within 12 weeks. Every specialty should categorize their patients into sub-specialties, with terms in which this patient-category needs to be treated. The doctors in GHZ know what the maximum waiting time for a patient is, but since GHZ has insufficient insight in the waiting list, capacity is not re-distributed when this is needed. When there are hospital-wide agreements on what the maximum waiting time is per sub-specialty of patients, it is possible on a tactical level to see whether these goals are met, and what the backlog is per sub-specialty. A final note is that some specialties (NCH) are too small to divide their patients into sub-specialties, if this is the case, sub-specialty can be read as specialty. To each sub-specialty an urgency is assigned, that decides what is the final date that a patient should go for surgery., Along with this final date for surgery, a final date is given for a patient to go to the POPS to get a POPS-agreement. Medical specialists should decide whether the sub-specialty has healthy patients (that on average receive their POPS-agreement on the first visit) or patients that have a higher chance to need additional examination before receiving a POPS-agreement. When each new patient receives a maximum date for POPS visit and for surgery, this enables the GHZ to make capacity decisions based on how well these targets are met.

6.2.1 Lagging indicators

Based on the recommendations drawn from the literature study, the decision is made that the lagging indicators are used to represent the state of the operative process, with each indicator assessing the performance of the entire operative process, or the performance of a specific part of the operative process.

Since the lagging indicators should give a representation of the state of the entire operative process, in Figure 6.1 the placement of these indicators is shown when using the simplified view of the

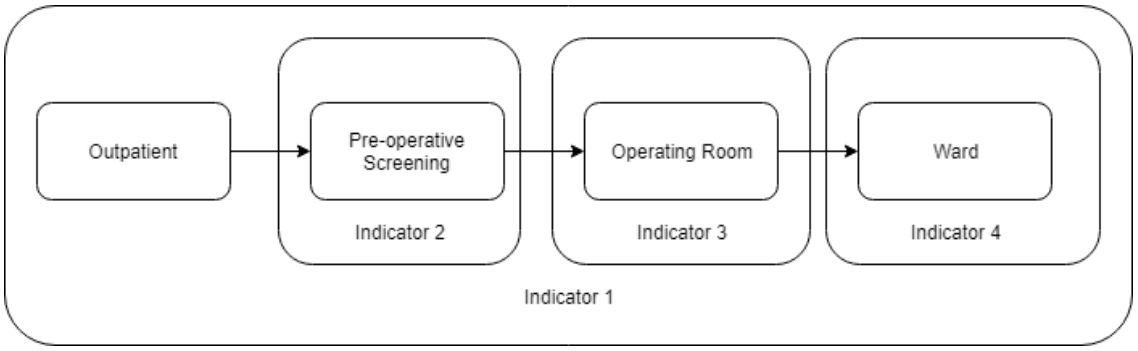

Figure 6.1: Lagging indicators in operative process

operative process. There is no indicator for the first step (the different specialties), since this is an inflow which GHZ cannot control, and therefore no performance assessment is possible. The first indicator should assess the process as a whole, while the three following indicators each assess the performance of a part of the process.

An outcome of the literature study was that it is not possible to have a perfect set of indicators, therefore, it is also not possible that there is a perfect indicator for each of the 4 lagging indicators as shown in Figure 6.1. Therefore, in consultation with the capacity manager and the direct stakeholders (paragraph 5.4) it was decided to start with the following set of indicators, so that there is a starting point. However, every stakeholder had the possibility to suggest other indicators that would be better for the purpose of the indicator as shown in Figure 6.1. This is also a recommendation from the literature study, to build a prototype of a dashboard without getting too deep in conceptualization discussions but just using what is available instead. An example: Indicator 3, which measures the OR performance, is now the walk-in and run-out of the OR on schedule. However, the manager of the OR gets the opportunity to suggest an alternative indicator, when (s)he thinks that this indicator fits better for the goal of this project.
All stakeholders agreed on this procedure, since the nominated indicators, which follow hereinafter, are in their eyes good representatives of the operative process and the results will be awaited.

- **Throughput times through the operative process (Outpatient → First POPS → POPS-agreement → OR → Discharge)**:
  This indicator is chosen as it combines all parts of the operative process in one indicator and the results are also easy to compare with targets. Since the underlying data of this indicator are the dates that patients have been helped in the past in a chosen period of time, this indicator resembles the operative process perfect in terms of throughput times, independent of the choices that will be made on a tactical level. This is the advantage of using a lagging indicator. In Figure 6.2 an example of the indicator is given with made-up values.
  This indicator should make a distinction between ASA 1-2 & 3-4 patients, since the POPS-agreement should take a longer time for the latter category.

- POPS-indicator: **The percentage of appointments per sub-specialty that are handled within the agreed horizon.** This indicator is chosen, since it fits well in the operative process and is a (possible) delay-indicator. The agreements on POPS-visits that are being made per sub-specialty are evaluated. This indicator is chosen for the POPS, the other option was a utilization-indicator of available POPS-places. This indicator evaluates how well patients are being helped in the period that is agreed upon, and if it under-performs it is clear that additional capacity should be assigned to this sub-specialty. For the utilization indicator over- or under-performing could also arise from other reasons (extra or absent staff, change in time per patient). This indicator clearly measures the flow of the operative process, by which is meant that one of the goals of the ICM-project was to have a more stable pattern of patients moving through the operative process.

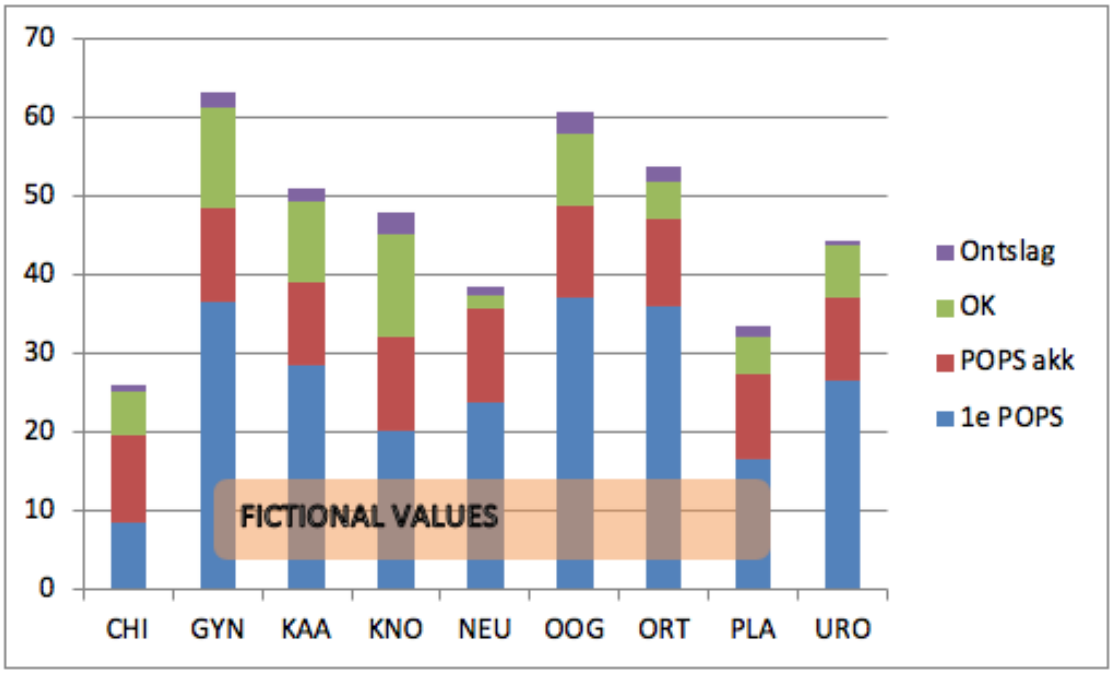

Figure 6.2: Example of the throughput-times indicator with fictional values

- OR-indicator: **Walk-in and run-out on schedule**: This indicator gives the end-time of the operation per Operating Room per day, and also which specialty this was and whether it was a first-aid patient. For the OR there are many indicators among which can be chosen (utilization per room, net/gross cutting time etc.), these should be bundled into a dashboard that is specifically aimed for the OR-manager. Since the goal of this dashboard is to give insight in the state of the entire operative process and to support decision-making on capacity choices, this indicator shows how well the planning is (in terms of comparing the planning with the realized schedule). The indicator should also give the main reason of walk-ins and run-outs per specialty. A walk-in is when the end-time of the OR is earlier than 16.00 (or the planned time), and a run-out is an end-time after 16.00 (or the planned time). When there is too much run-out this might come since the specialty has insufficient OR-sessions, or the planning is too positive. This indicator complements the leading indicator: waiting list versus capacity, since the leading indicator compares the expected inflow to the OR with the available capacity. When there is unavailable capacity this should be visible in the lagging indicator, namely, more run-outs.

- Ward-indicator: **Pattern of bed occupancy**: The pattern of the bed occupancy is measured through means of the variation coefficient. The variation coefficient is the ratio of the standard deviation to the mean. In other words, it describes the variance (fluctuations) of bed occupation on the wards. One of the changes that the ICM-project aims to realize is that the flow of patients through the process is more even as stated in paragraph 2.1: Currently, there is an unpredictable outflow of patients to the clinics, which results in difficulties with beds and staff planning and eventually in some extremely busy days for the nurses, and days that they have 'nothing to do'.
  This indicator indicates this well per ward (C1/D3 etc.), it translates one of the goals of the project to a measurable number. The alternative for this indicator was the utilization of the beds per department, which is always an absolute number, but since the chosen indicator fits so well to the project goals (it measures the flow, since it uses the mean and standard deviation, thus it is a relative number), the pattern of bed occupancy is chosen.

6.2.2 Leading indicators

Two leading indicators are chosen, both of them compare available capacity with needed capacity. The first indicator does this for the OR-capacity (available capacity) and compares this with the in-flow of patients from the waiting list (needed capacity). The second indicator compares the number of beds per ward department (available capacity) with the expected outflow of patients from the OR (needed capacity).

- **Waiting list versus OR-capacity**: This indicator compares the available versus the needed capacity for a specific time range (even number of weeks because the OR-scheme is divided into even and odd weeks) the expected OR-duration of the patients that are coming in according to the waiting list with the available OR-time per specialty. This indicator has a good fit with the operative process, since the inflow of patients is compared to the capacity of the OR, and shows what decisions and actions are needed to balance this needed and available capacity by the assignment of OR-sessions.
  Optionally, this leading indicator can be extended with the inflow of first-aid patients and patients that are not on the waiting list, but can still be expected to come in based on historical data (seasonal trends).
- **The expected number of bed-days per ward**: This indicator uses the information from the first indicator to determine the number of patients that will arrive at each ward, and the expected total length of stay. This is compared with the available number of bed-days. This indicator also has a good fit with the operative process, since it forecasts highs and lows in the outflow of patients, which gives the wards the possibility to use this information, for example by asking the rearranging of OR-sessions, planning extra personnel or moving beds from one ward to another.

6.3 Requirements for dashboard and KPIs in desired situation

In this paragraph, it will be described what the future situation should look like in order to successfully start using this KPIs in the decision-making process regarding the distribution of capacity in the operative process. First, the required data and registration methods that are needed should be described, to have sufficient data to develop the KPIs. In Chapter 7 on implementation, recommendations are given how to create support for this new method of working among the staff (the indirect stakeholders), to successfully sustain the new data registration methods.

As described earlier in paragraph 6.2, all specialties should categorize their surgeries into sub-specialties and give each sub-specialty an urgency. This urgency assigns to each new patient that is registered in the system a maximum date for the POPS-visit and a maximum date for surgery. This is the first step that GHZ should make before it is possible to allocate capacity based on the in- and outflow of patients.
In Table 6.1, urgencies are presented with example dates, in the example wherein the registration date (the date the patient is registered for surgery, e.g. diagnosis for surgery is made) is 01-03-2019. These urgencies are already used in the CHI and ORT specialty, where the planners - following initial doubts about the usefulness - got used to registering the urgency of each patient, because they acknowledged the support in planning surgeries and POPS-appointments. Since the planners and managers are now able to sort the waiting list on the urgencies of patients (largest exceedance of maximum date), it is immediately clear where capacity is mostly needed. In Chapter 7, more details on the implementation of this method is presented.

For the KPIs the following data is needed:

Lagging indicators

Table 6.1: Urgency with maximum dates on 1-3-2019

Urgency	POPS-visit before	OR-visit before
2 weeks	5-3-2019	15-03-2019
4 weeks	11-3-2019	29-03-2019
3 months	14-5-2019	1-6-2019
6 months	14-8-2019	1-9-2019
1 year	14-2-2020	1-3-2020

- Throughput times: All specialties should use the same system to register their patients (xCare), since uniformity is essential when comparing numbers. In the system the following dates should be saved:
  - Date of outpatient visit (the visit during which the diagnosis is made that indicates the need for surgery)
  - Date of POPS-visit (not the maximum-date as shown in Table 6, but the realized date)
  - Date of POPS-agreement (usually the same as the POPS-visit-date)
  - Date of surgery
  - Date of discharge

  Most of these dates are already saved, and for the planners this does not require any extra work, since xCare already takes care of these dates in the standard settings. However, in the xCare system data often gets overwritten, which is a known bug of the old system. The cause for this overwriting should be identified and tackled, however in 2022 the hospital aims to have one system across the entire hospital that will ease the gathering of data.
- The percentage of appointments per sub-specialty that are handled within the agreed horizon: For this indicator each registration in the waiting list should have a maximum date for POPS, and the dashboard should compare for a given period in the past, with what percentage these dates are met.
  The difference with the current situation is the registration of the urgency, with automatically gives the patient a maximum POPS-date. GHZ already started the registration of the urgency, for more details see Chapter 7 on implementation.
- Walk-in and run-out on schedule: For this indicator each surgery should be recorded with starting and closing time, and for each OR per day the last surgery should be identified and whether or not this was a first-aid surgery.
  All this data is already available in production files, therefore for this indicator nothing should be changed in the current system.
- Pattern of bed occupancy: For this indicator all hospital admissions should be registered, the starting and discharge date for each bed. Then from all this data per ward (C1/D3 etc.) an average and standard deviation can be calculated, which leads to the variation coefficient. For this indicator all data is already available too, it can be developed without changing any processes.

Leading indicators

- The waiting list versus capacity-indicator. This indicator has similarities in its requirements with the lagging indicators. At first, it is important that the maximum date of surgery is correct, this is done by giving the patient the right urgency when registering in xCare, this urgency should be determined by the doctor that made the diagnosis for surgery. If this is not done, the system automatically assigns a date, which makes the scores of the indicator, not reliable at least, and possibly wrong. This registration of the urgency is the first step

that will be discussed in chapter 7. Another requirement is that the waiting list gets cleaned, so that it gives a complete image of the situation. Currently, the waiting list is incorrect. There are patients on the list that went to another hospital, or even have died. It should be verified that all patients on the list are really waiting for surgery at GHZ.
When this indicator gets extended with the inflow of first-aid patients and patients that are not on the waiting list but can still be expected to come based on historical data (seasonal trends), the data that is needed for the lagging throughput indicator can be used, since it has the history of the last years, which can be used to forecast expected patients with their OR-duration and bed-stay duration.

- The expected number of bed-days per ward. The other leading indicator uses the waiting list to forecast the expected amount of beds per ward that is needed in a given period in the future. Therefore, each type of surgery should have an expected number of bed-days, and this should also be added in the waiting list. When the planners from a specialty register a surgery and a patient, xCare should automatically add the expected number of bed-days.

Summarized, to answer the sub-question on which data should be considered in the design and implementation of a dashboard to support the tactical level of planning of the operative process at GHZ, the following can be concluded:

- Start assigning an urgency to every surgery, this urgency gives the patient a dead-line for having the first POPS-visit, and a dead-line for surgery. Although these dates will not always be met, it gives GHZ a perfect insight in the status of the operative process: The specialty that is most behind on its goals as well as the specialty that has been assigned too much capacity, and therefore reaches its goals too easy.
- The cleaning of waiting lists per specialty and the standardization of waiting lists for all specialties to increase the ease of use in a dashboard, and to enable comparing all specialties with the same criteria (e.g. not that every specialty uses its own waiting list method). The waiting list should also be periodically checked on whether it is still complete, and if all patients on the list are still waiting for surgery at GHZ
- The registration of the dates that are required to calculate the flow of a patient through the process, and to forecast expected patients regarding the leading indicators.

6.4 Linking the indicators to the process

A main outcome of the literature study was that all the indicators should be mapped in the operative process, such that it is clear what exactly they measure, and that the scores on the indicators could be linked with possible actions. This is mandatory to make the use of the dashboard successful and to build and keep support in the organization, since it will give the stakeholders the impression that the scores on the indicators are a good representation of the actual situation.

In Table 6.2, each indicator is assigned an abbreviation. In Figure 6.3 the placement of the lagging indicators in the operative process is shown and in Figure 6.4 the placement of the leading indicators in the operative process is shown.

As described in paragraph 6.2.1, the lagging indicators aim to be a good representation of the operative process wherein the LAGG1 indicator gives information for the entire operative process, and the other three lagging indicators each focus on specific parts of the operative process: LAGG2: Outpatient + POPS, LAGG3: OR, LAGG4: Wards.

Both of the leading indicators compare two parts of the operative process in terms of expected/needed and available capacity. The LEAD1-indicator compares the expected inflow in the operative process with the available OR-capacity, whereas the LEAD2-indicator does this for the outflow of the OR (expected/needed) with the available bed capacity.

Table 6.2: Overview lagging and leading indicators

	Lagging indicators
LAGG1	Throughput times through the operative process
LAGG2	Percentage of POPS-deadlines met per sub-specialty
LAGG3	Walk-in and run-out on schedule
LAGG4	Pattern of bed occupancy
	Leading indicators
LEAD1	Expected inflow (waiting list, first-aid) versus OR-capacity
LEAD2	Expected number of bed-days per ward

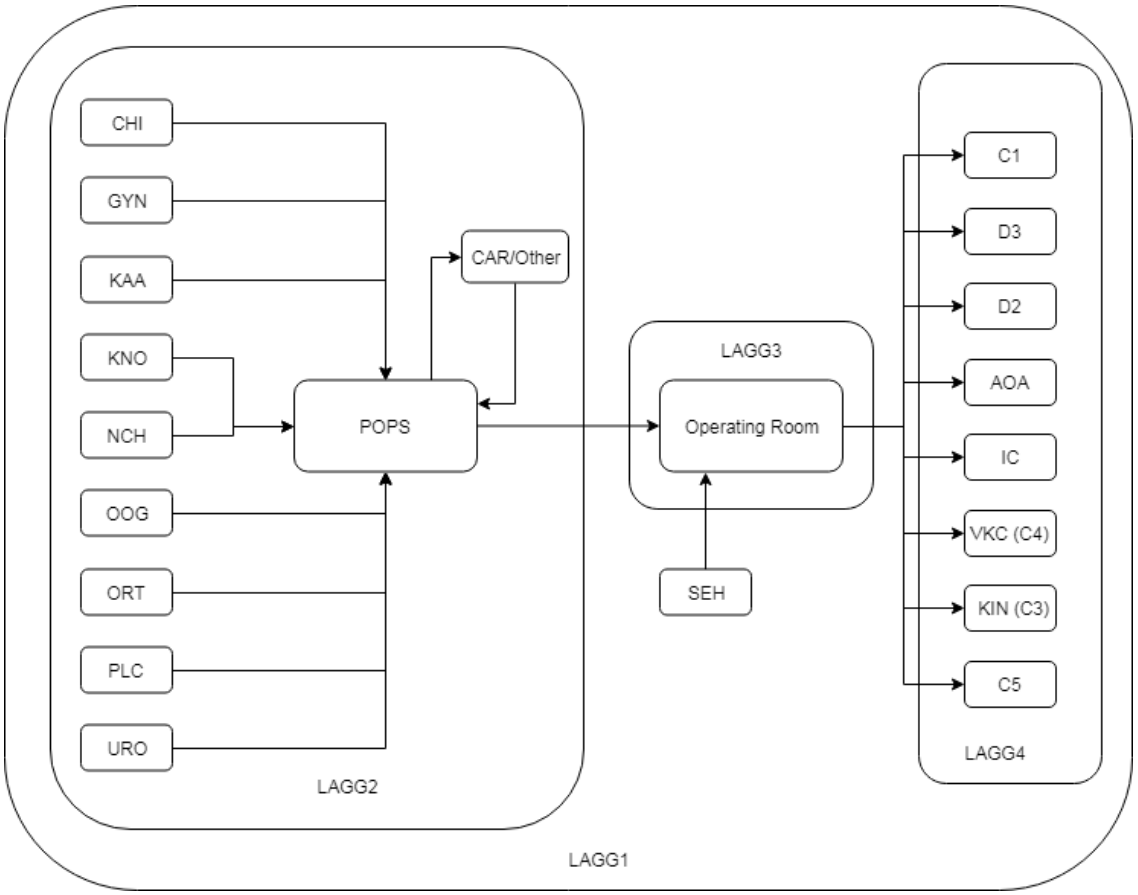

Figure 6.3: Placement of the lagging indicators in the operative process

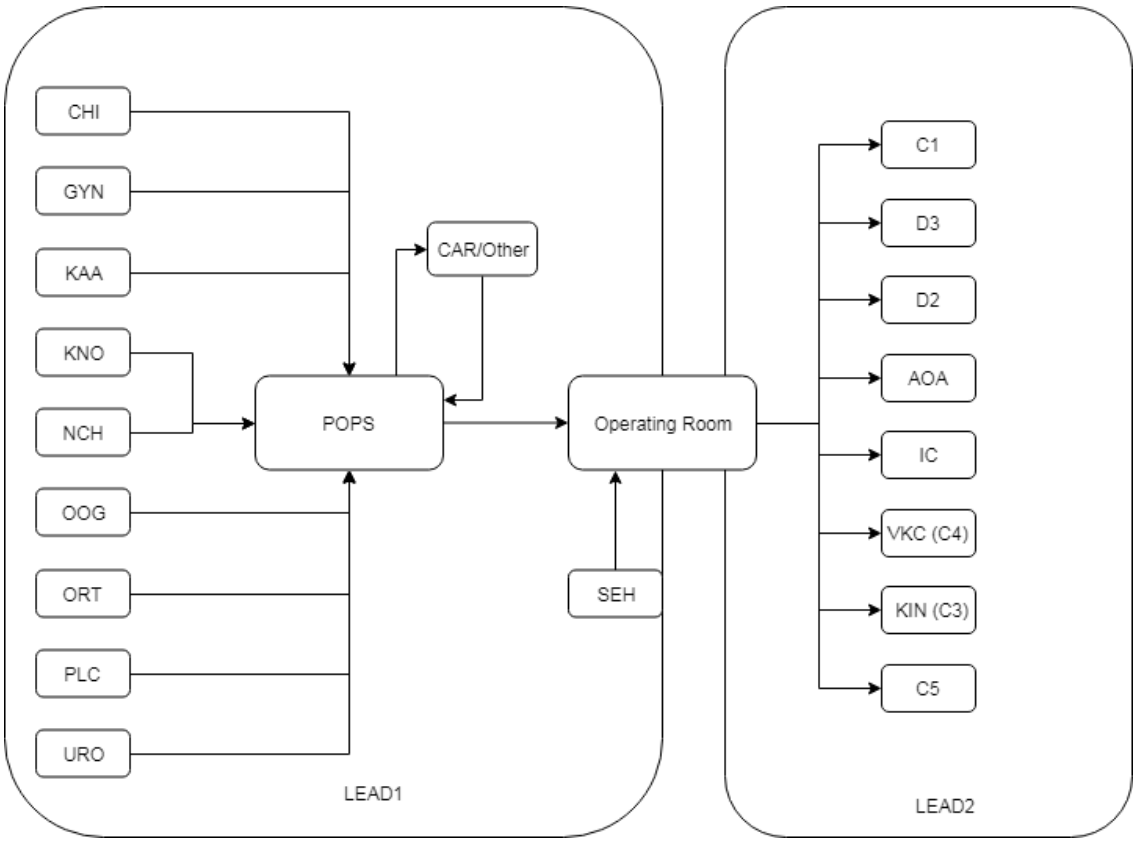

Figure 6.4: Placement of the leading indicators in the operative process

6.5 Outcome of indicators

Since the lagging indicators are used to evaluate how the process performed in the past, the lagging indicators give the decision-makers an insight in how capacity could be assigned better (if necessary). The effects of these new assignment of capacity is shown in the scores on the leading indicators.

6.5.1 Lagging indicators

- The throughput times per specialty: This indicator shows the throughput times of patients through the operative process, and these throughput times are categorized per ASA-score of patients. After dividing the specialties into sub-specialties with urgencies, this indicator can compare the realized outcome of sub-specialties with the required dates.
  If the decision-makers find out that the outcomes of a sub-specialty are below target, this sub-specialty should have extra capacity assigned. The consequences of these decisions can be forecasted with the leading indicators.
  Therefore, it is not possible to give upper- and lower limits for this indicator, but this should be done by comparing the results of the indicator to the agreements per sub-specialty.
- The percentage of POPS-deadlines met per sub-specialty: For this indicator the same procedure applies as for the previous one.
- Walk-in and run-out on schedule: This indicator gives the average walk-in and run-out of the OR per day for a given period. With this outcome also the number of emergency run-outs is given and insight into which specialty had the most delay is gained, compared to the relative number of sessions each specialty has.
  When a specialty has more delay than could be based on the amount of first-aid patients that they treated, the cause should be found, which can be: a shortage of OR-sessions to do surgery on the incoming patients or inaccurate planning (the expected OR-duration is too short or the number of extra first-aid patients is underestimated). When the specialty has insufficient sessions to treat all the incoming patients, extra sessions should be assigned in one of the ways that is discussed later in this paragraph, and when the expected OR-duration is underestimated these durations should be updated.
- Pattern of bed occupancy: The outcome of this indicator is a variation coefficient that compares the standard deviation with the mean number of patients on a ward. When the variation coefficient is higher than agreed, this means that there are high fluctuations on a department, which make it difficult to plan the staff and other caregivers for this ward. For each ward maximum variation numbers should be agreed upon, since some wards can handle higher fluctuations than other wards (first-aid wards have a higher number of flexible staff than a regular post-surgery ward).

6.5.2 Leading indicators

The first leading indicator, the comparison of expected incoming patients with the available capacity of the OR, is shown in Figure 6.5.

This indicator compares for each specialty (since the OR-scheme divides sessions per specialty and not per sub-specialty) if there is enough capacity to handle the expected duration of all incoming patients. There are 3 options in outcome with the following possible actions:

- The specialty has too much sessions (there is OR-capacity left): In this case the specialty should release the number of sessions that they have too much, to help other specialties get the amount of capacity that they need.

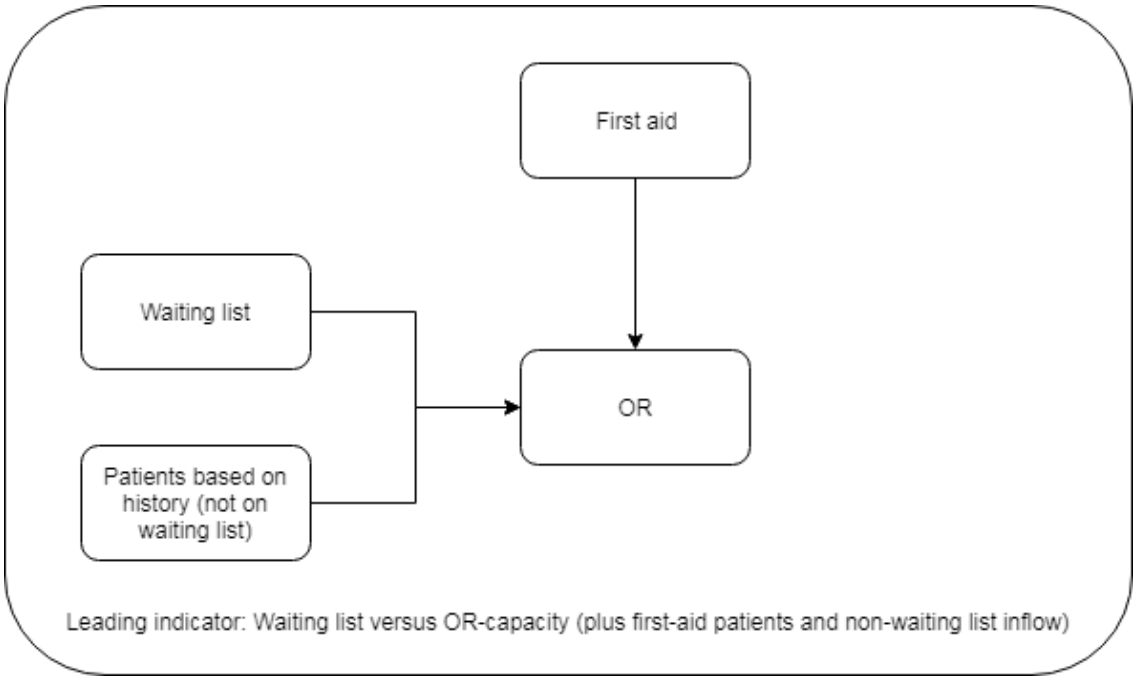

Figure 6.5: The leading indicator: Incoming patients vs. OR-capacity

- The specialty has enough sessions (needed and available capacity is about the same): No actions needed.
- The specialty needs more sessions (there is not enough OR-capacity): In this case the available sessions should be assigned to this specialty, there are 3 possible options:
  - The allocation of the so-called 'flex' session to this specialty
  - The allocation of sessions that come available (for example due to drop-out of patients, or doctors)
  - Making changes in the OR-scheme (this is unusual, and should be done on strategic level)

Since the GHZ already deals with a shortage of OR-capacity, there will be more specialties that need more sessions than there are available sessions. This is where the new registration method with urgencies comes in useful, since it gives the decision-making team the insight in which specialty has the highest urgency to receive the available OR-sessions.

In Figure 6.6 the second leading indicator is shown in how it compares the expected out-flow from the OR with the available capacity at the wards. Ward 1, ward 2, etc. are the different departments as shown in Figure 5.3 (C1/D3 etc.) The expected outflow from OR is the same as the first indicator uses as input, but instead of expected duration this indicator looks at the expected length of stay at the hospital. Since it is known in advance to which ward a patient goes after surgery, and how long the patient is expected to stay, the expected/needed capacity can be compared to the available capacity at this ward. Again, there are three possible outcomes, which can be reacted upon as follows:

- The ward has enough capacity to handle the incoming patients
- The ward has too much capacity: The ward-manager can decide that flexible staff is not needed, or the ward can communicate to the other wards that there are empty beds available, and that wards with shortcomings can move their patients to this ward. However, this is

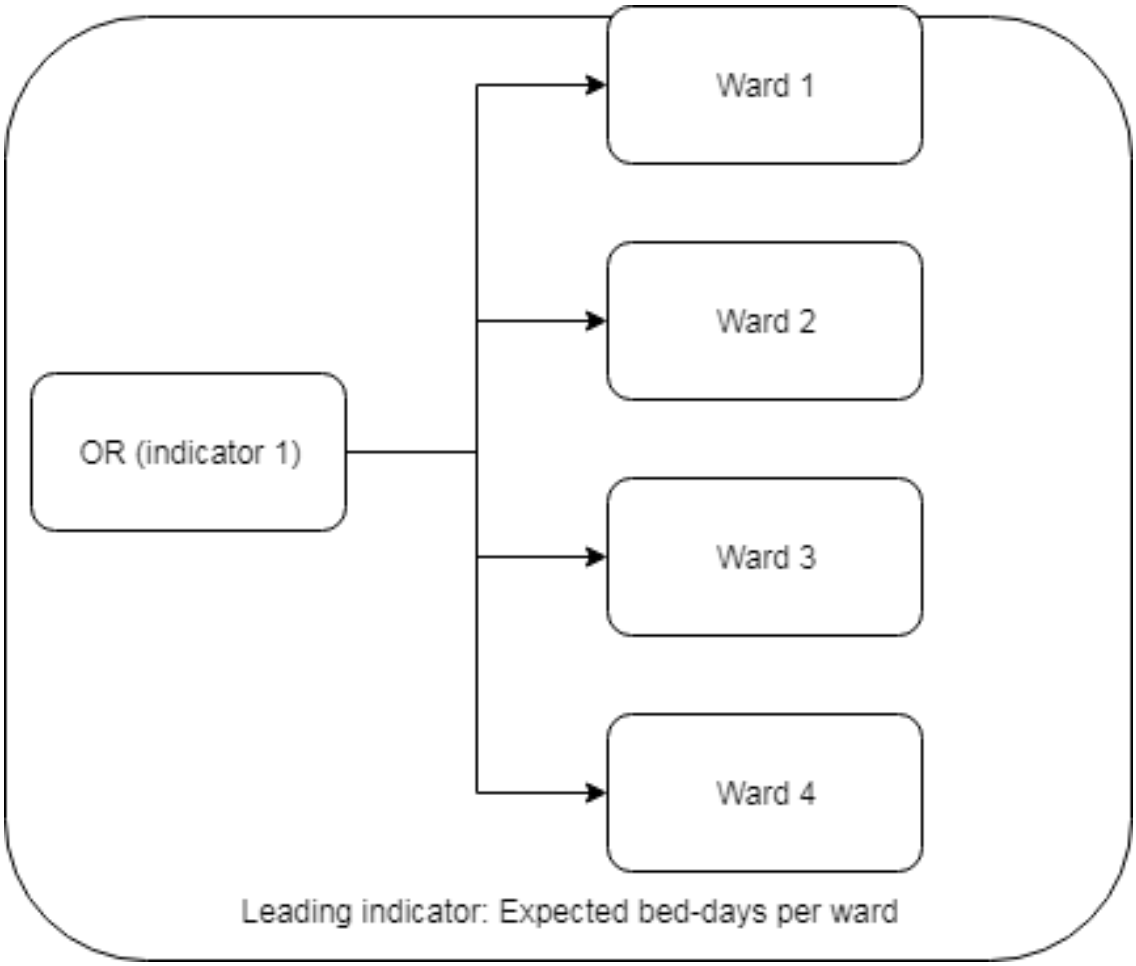

Figure 6.6: Leading indicator: The expected bed-days per ward

not always possible since certain wards are specialized in specific kinds of care-giving, and this cannot be done on other wards.

- The ward has not enough capacity: When there are other wards that have capacity left, the patients should go to that ward if the patients can be treated at that ward, otherwise the patient can go to the ward of the diagnostic specialties.

The indicator is not only useful to determine whether the ward has sufficient capacity, but also to determine the expected number of bed-days per ward, which can be used to decide on the number of nurses that is needed. Most of the time, there is enough capacity in the hospital to handle the outflow of patients, but there is insufficient knowledge on the expected amount of used beds per ward, see paragraph 5.1.2.

Summarizing, the outcome of the indicators gives the decision-makers clarity on the available options in the distribution of POPS, OR and ward capacity. Ideally, the lagging indicators show how the systems performance was in a given period in the past (time period should be entered in the dashboard) and indicate that certain specialties have a higher need for extra capacity than other; while some specialties may even have too much capacity. The leading indicators show the decision-makers what the effects are of certain capacity decisions. Therefore, it is not necessary to assign weights to the indicators, since they complement each other.

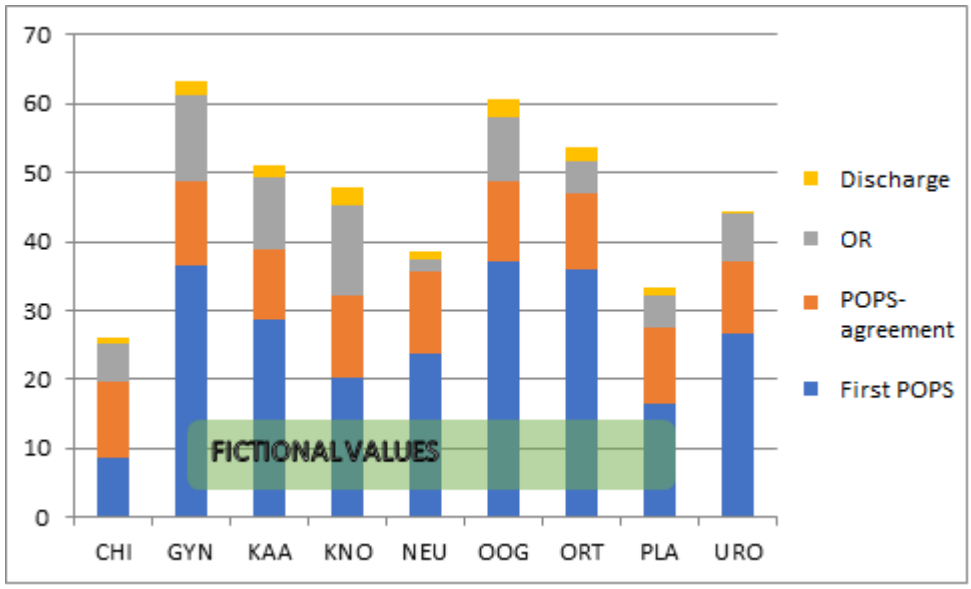

Figure 6.7: Lagging indicator: Throughput times through the operative process

OK- In/Uitloop	Van	Tot	Ivm. onbeschikbare data	
	01-10-2018	01-12-2018		
Gem. eindtijd	16:27:25		Spoed:	Niet beschikbaar
Aantal OK's open	378		Per specialisme:	Niet beschikbaar
Aantal > 16.00	190			
Aantal <= 16.00	188			

Figure 6.8: Lagging indicator: Walk-in and run-out on schedule

6.6 Prototype dashboard

In Figure E.1 and Figure E.2 the main screen of the prototype that has been built is shown, where some numbers have been removed due to privacy reasons. This is not how the final version of the dashboard will look, but it has been built with Excel to show the possibilities with the available data, and what the final KPIs might look like. The 4 KPIs that are shown in this example will be briefly described, since the aim of this research is not to build a working dashboard, but to make a design that suits the needs of the organization and write an implementation plan. Also, the used data is not correct and sometimes made-up, with the only reason to show what an indicator might look like.

Throughput times through the operative process

In 6.7 an example of what the throughput times might look like is shown. It is divided into phases of the operative process: From the outpatient visit in which a surgery is chosen as treatment till the first POPS-visit, POPS-visit till agreement, agreement till OR, and from OR until discharge. In the final version of the dashboard there should be a distinction between elective and first-aid patients, day-care and long-stay and other optional parameters.

Walk-in and run-out on schedule

In Figure 6.8 a preview is shown of the third lagging indicator, which shows the average closing time of each OR, and whether this is before or after the official closing time (which is 16.00). Meaningful extra information would be the reason for delay (first-aid/elective patients) and how

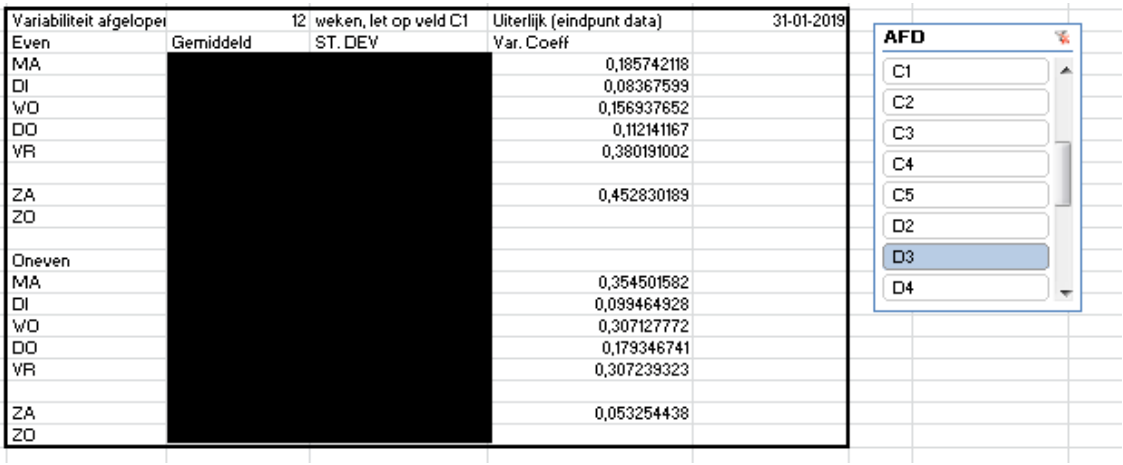

Figure 6.9: Lagging indicator: Pattern of bed occupancy

each different specialism scores.

Pattern of bed occupancy

In Figure 6.9 the fourth lagging indicator is shown, which shows the variation coefficient per day for the even and odd weeks, since the OR has a different scheme in the even and odd weeks. The indicator can show this variation coefficient for each department (AFD). In a more advanced version of the dashboard the system should be able to compare this coefficient with comparable time periods in earlier years.

Waiting list versus OR-capacity

The leading indicator that compares the inflow to the operative process with the available OR capacity is shown in Figure 6.10 with fictional numbers. An important recommendation for GHZ is to build a model of the operative process, instead of using the leading indicators. When building a model of the entire operative process the expected status of POPS, OR and wards can be forecasted more specifically, for example on a daily or hourly level. The principle however stays the same, comparing the needed capacity with the available capacity.

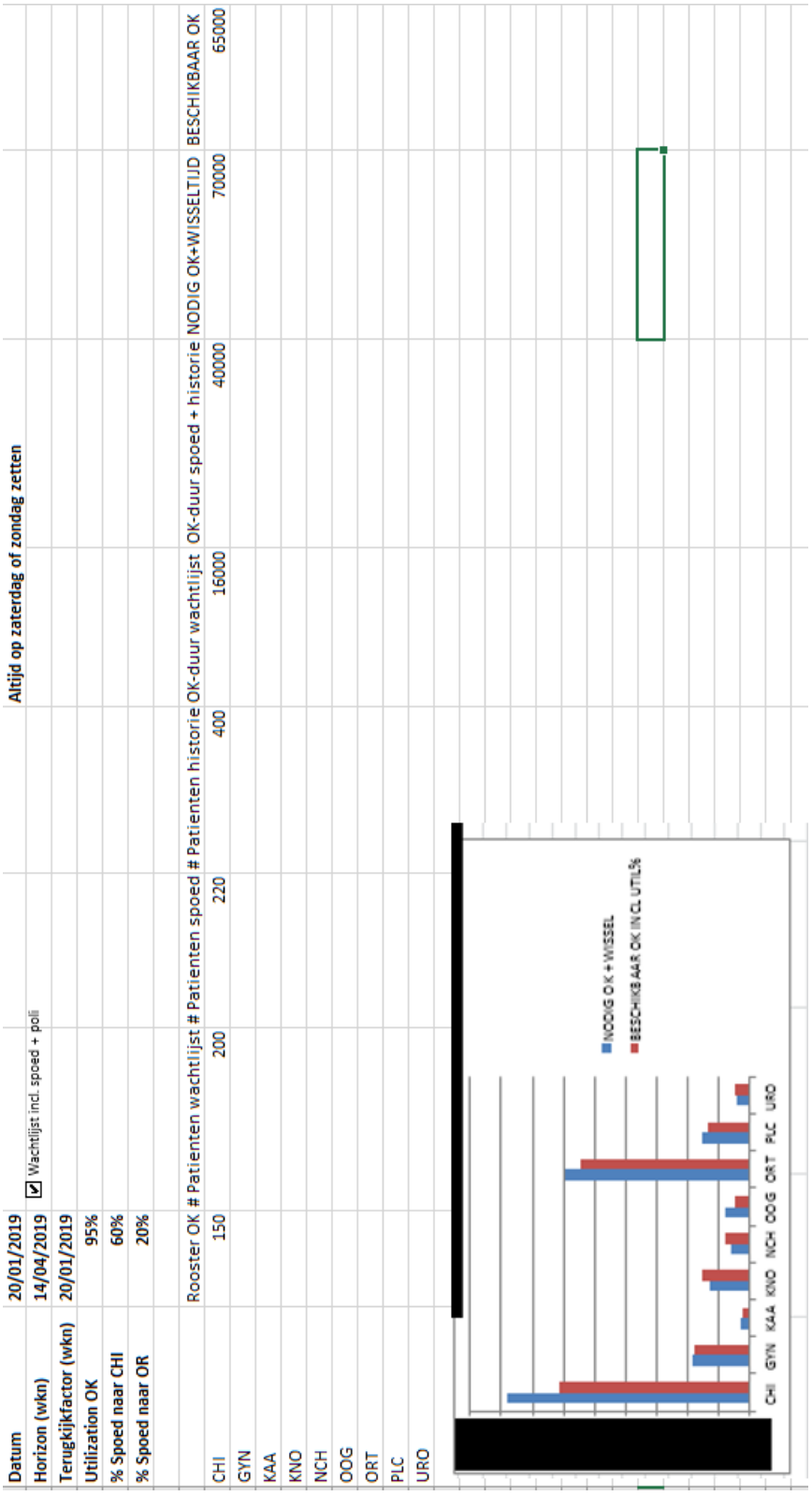

Figure 6.10: Leading indicator: Waiting list versus OR-capacity

6.7 Answer to sub-question 3

The sub-question discussed in this chapter was: What data should be considered in the design and implementation of a dashboard to support the tactical level of planning of the operative process at GHZ?

The dashboard should exist of four lagging and two leading indicators:

Lagging:

- Throughput times
- Percentage of deadlines met per sub-specialty (POPS)
- Walk-in and run-out on schedule (OR)
- Pattern of bed occupancy (Wards)

Leading:

- Inflow (expected capacity) versus OR (available capacity)
- Outflow of OR (expected capacity) versus bed-days per ward (available capacity)

Each specialty should divide its patients into sub-specialties categorized per urgency of patients, with dead-lines linked to it for POPS visit and surgery on the OR. The dates of all patient contacts should be registered in the system, and the waiting list should be standardized for all specialties.

This will help the tactical decision-making in the operative process, since the lagging indicators provide a useful insight in the state of the operative process, where the leading indicators complement this view by forecasting the results of possible capacity-decisions for the state of the operative process in the near future. This will help the decision-makers since the dashboard gives them the data they need, so that they can focus on the assigning of capacity.

Chapter 7

Implementation

In this chapter sub question 4 will be answered: What will the tactical level of OR-planning look like in practice, regarding decision-makers involved, frequency of meetings, grounds to change capacity distribution?

This will be done for the stakeholders that were identified in the stakeholder analysis that was described in paragraph 5.4.
The implementation of the dashboard will be described using the following steps:

- The translation of the needed registration (of urgency) to a new way of working for the planners and how to realize this change in the organization
- The use of the dashboard in practice, looking at decision-makers involved in the capacity-meetings (based on the stakeholder analysis done in paragraph 5.4), and the further set-up (frequency etc.)
- Recommendations to make the implementation of the dashboard successful on the long-term, derived from scientific literature on organizational change management

7.1 Registration of urgency

An important requirement for successful implementation is the assignment of an urgency to every surgery, this urgency gives the patient a dead-line for having the first POPS-visit, and a dead-line for surgery. Even when these dates are not met, it gives GHZ a perfect insight in the status of the operative process in terms of the specialty that is most behind on its goals, and the specialty that had too much capacity, and therefore reaches its goals too easy.

Some specialties already started with this method of registration, since they had a need to have more insight in the state of the waiting list. Planners of other specialties are still used to their own method of planning - with different systems or paper agendas - but in none of these cases the urgency of a patient is registered (or a random option is chosen in xCare). Since it is a requirement for the dashboard and KPIs that the urgency is registered and a dead-line for POPS and OR is assigned to a patient, these planners should start registering the urgency too.

Based on the article of Choi (2011), willingness to change is a requisite for a change in the organization to be successful on the long-term. Choi (2011) performed a literature review on the attitudes toward organizational change, and state that the attitude exists of four constructs, a person has a position/score on each of these 4 constructs, which represent his/her attitude towards organizational change:

- Readiness for change
- Commitment to change
- Openness to change
- Cynicism about organizational change (has a negative influence on willingness to change)

Since GHZ expects the planners to change their way of working, willingness to change from their side is required. Therefore, these four constructs can help GHZ to achieve high willingness to change among their employees. In GHZ a workgroup was set up, which existed of at least one planner from each concerned specialty, that should help to improve the four constructs to achieve a more positive attitude towards organizational change.

The main aim was to give the planners insight into their role in the entire operative process, and how their work contributed to decisions that were made on a tactical and strategic level. To show the planners how big the differences were between specialties, the information that a patient receives from each specialty was collected (Appendix D - Figure D.1). The planners of the specialties that already started working with urgencies for patients (CHI/ORT) shared their experiences with this new registration method and with other changes, such as different communication methods, paperless working. The planners told that they were at first skeptical about changing the process, but after one year all of them were positive, because of the: paperless working, a more fair planning (based on the real urgency of the patient), and a correct insight in the waiting list per sub-specialty and outflow to the wards.
Another goal of the workgroup was the creation of a guidebook for planners, this was done to identify the different ways of working that were practiced in order to give them insight into the differences. Most planners did not know that the differences were this big, and after seeing how the new system could help them with their work, the majority of the planners voluntarily proposed to start registering new patients with urgency, which in turn supported them with planning these patients at the POPS and the OR. An example on how the workgroup changed their opinion on the change in their working methods:
The CHI planner showed how the planning of patients was possible by only using xCare, without the use of other tool and systems: the system sorted the patients based on their urgency (sort on time to dead-line for POPS and OR), and how the planner thus gained insight into the available OR-capacity for CHI, and the wards where CHI-patients went after surgery. The other planners never realized this possibility of the system that they had been using for 15 years and started to use the options without GHZ having to formally impose this.

The expectation is that this will improve the score on the 4 constructs as given by Choi (2011) in the following way:

- Readiness for change: By understanding the reason for change the staff will see the reason behind the change and prepare to make changes in their own way of working.
- Commitment to change: The involvement of staff in the change process will generate commitment to change since their opinion and contribution is valued and taken into account.
- Openness to change: The involvement of staff in the change process, combined with the understanding of the need for change, gives an open attitude towards the needed changes.
- Cynicism about change: By understanding the need for change and how it improves their work activities, and not only the operative process as a whole, cynicism will disappear.

For GHZ, this method of involving a workgroup with planners to reach a new situation was new compared to earlier strategies of change management in the organization which were mainly top-down. This usually resulted in resistance from the workplace, which is a major difference with the current, voluntary initiative of the planners themselves to change their work process.

7.2 Practical use of the dashboard

In this paragraph sub question 4 will be answered: What will the tactical level of OR-planning look like in practice, regarding decision-makers involved, frequency of meetings, and grounds to change capacity distribution?

The goal of the dashboard is to support decision-making within the operative process, and this was the main focus when selecting KPIs. Now that the selected KPIs give a representation of the operative process that is as complete as possible, the practical use of the dashboard in GHZ should be described. In paragraph 5.4 the different stakeholders were already described.

Since all management information and reports in GHZ are issued monthly (in the beginning of each month the reports come out on last month) the dashboard should be used in the beginning of a month. The data that is needed for the dashboard to calculate the indicators is available and can be uploaded to the dashboard, and the dashboard can 'look forward' to the next weeks. The scope of the dashboard should be an even number of weeks, because of the division of the OR-scheme into even and odd weeks. The dashboard can be set-up in horizons of 2, 4 and 6 weeks. Therefore, the members of the capacity-division group are not bound to a specific date to meet, but the availability of data for the dashboard should be considered because using a dashboard with incomplete data gives an incomplete, or even worse, an incorrect view of the state of the operative process. Therefore, it is recommended to have a meeting frequency of the capacity allocation group of once a month, in the beginning of each month. Possibly, when the use of the dashboard will be successful, budget will be made available to deliver the needed data constantly, which requires implementing the tool in the Data Warehouse of the hospital.

The composition of the capacity allocation group should be as follows, to ensure a good representation of all parts of the operative process, with influence of all of the direct stakeholders, and context experts:

- A doctor on behalf of the specialties
- The ORmanager, which in GHZ also functions as POPS-manager
- A ward manager
- The capacity manager
- A representative on behalf of the financial department
- A data analyst, for the context of the used data in the dashboard; this is especially important in the starting phase, since a lot of data is not correct, as described in paragraph 6.3.

For each of above-mentioned members there is a candidate that has already been involved in the ICM project since its beginning. It is recommendable that this person takes place in the capacity allocation group.

In paragraph 7.3 some guidelines will be given, based on scientific literature on organizational change management, to make the use of the dashboard as a planning tool successful both at the beginning and in the long term.

7.3 Recommendations and factors for successful implementation

In addition to the recommendations drawn from the literature review on the use of a dashboard in paragraphs 5.2 and 6.1, in this chapter some additional recommendations will be given on the implementation of the dashboard as a tool to support the capacity decisions on a tactical level. These recommendations are derived from scientific literature on organizational change management.

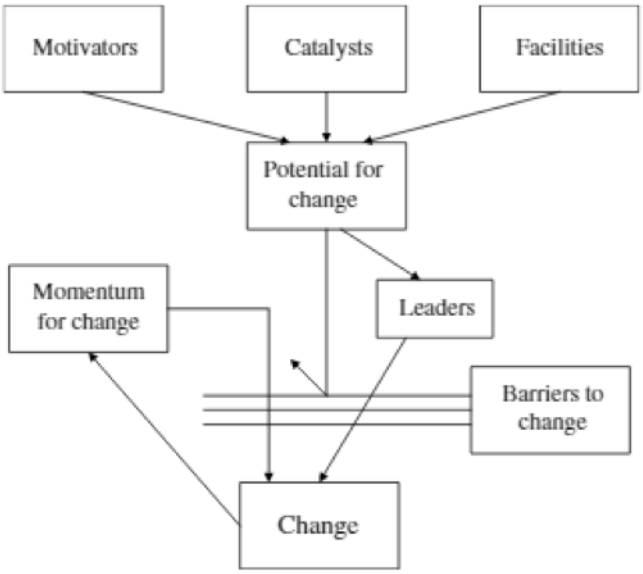

Figure 7.1: Accounting change model (Cobb et al., 1995)

Kasurinen (2002) wrote an article on the implementation of a balanced scorecard in an organization, and identified barriers that may hinder, delay or even prevent the process of its implementation. Since a balanced scorecard is a performance management tool, just as the dashboard, these recommendations can also be applied to the implementation of the dashboard in the operative process in GHZ. Kasurinen (2002) uses the accounting change model of Cobb et al. (1995) which is presented in Figure 7.1.

Potential barriers to change that Kasurinen (2002) mentions, and which should be avoided in GHZ are:

- Inadequate internal commitment on creation process: Could be avoided by motivating individuals to implement the new ideas and to act. For GHZ this means that individuals in the organization that are skeptical or not committed to change particular ways of working, since they do not see the usefulness, can be motivated by showing them the benefits of the new method of working, and why their contribution is important for this change to be successful. GHZ already used this method with the planners, as described in paragraph 7.1.
- Organizational culture and power distribution: Since the culture in GHZ always has been management-oriented (decisions are made top-down, procedures should be followed), there is a danger that especially the indirect decision-makers get the feeling that their opinion does not matter. This should be avoided by, the involvement of the indirect stakeholders in the evaluation of the dashboard and its decisions, particularly in the early phase of implementation. GHZ has taken its first steps in this direction by updating all the stakeholders on the status of the ICM-project, and what changes could be expected the coming years.

Another article on organizational culture, that supplements the previous article, is the article of Rad (2006) on the impact of organizational culture on the successful implementation of Total Quality Management (TQM). A part of TQM is the measurement and management of performance; therefore the findings of this research can help GHZ to make the implementation of the dashboard as successful as possible. Rad (2006) performed an investigation among 40 different hospitals to identify the barriers and the facilitators for successful implementation of TQM. An important finding for GHZ is that long-term strategic planning is essential for the dashboard and the ICM-project to be successful. Fortunately, this is well organized in GHZ, with the appoint-

ment of a capacity manager, and a long-term plan for the implementation of new methods of planning on strategic, tactical and operational level. This contributes also to another factor that is important for successful implementation: the commitment of involved managers. In GHZ the relevant managers from the operative process and the capacity manager all have the same opinions on which way to go.

The last recommendation that GHZ should keep an eye on is sharing knowledge of all indirect stakeholders on what is going on, and on how their colleagues work. When starting the workgroup with planners, a common remark was that the planners - besides not knowing each other - also had no idea about the problems each of them encountered. A recommendation is that GHZ should try to keep connecting all staff in the operative process (planners, staff at POPS, OR and wards), to generate shared knowledge, recognition and understanding. This is important for the implementation phase, since the indirect stakeholders will or might experience changes in their way of working, and also notice capacity decisions that they are not familiar with. When there are possibilities to communicate about these changes, the underlying reasoning can be explained, and their opinion can be taken into account. This is also valid for the direct stakeholders, as described in paragraph 6.2, that the indicators might be changed or compared to other indicators, which can be suggested during such communication moments.

7.4 Answer to sub-question 4

The sub-question discussed in this chapter was: What will the tactical level of OR-planning look like in practice, regarding decision-makers involved, frequency of meetings, grounds to change capacity distribution?

The implementation of the dashboard requires extra data registration, amongst others the registration of the urgency of a patient. This change is brought into the organization by creating willingness for change, which is done by the creation of workgroups. Showing the benefits of more extensive registration in their work process caused voluntary changes.

The dashboard itself should be used in the organization on a monthly basis in order to analyze the last period in the operative process, while looking forward to what is coming. The lagging indicators are used to report on the performance of the operative process during the last period to the members of the capacity allocation group and gives them an idea about which capacity choices to make; while the leading indicators show the expected results of these choices.

The group of users of the dashboard that meet monthly should consist of all direct stakeholders (representatives of all parts of the operative process) including a data analyst, to provide context to the numbers.

To foster the successful implementation of the dashboard all stakeholders should be involved in the process and be informed on results and decisions. Firstly, by informing the (in)direct stakeholders during capacity-meetings and workgroups, secondly, by making the dashboard as open as possible, while keeping an eye on the possible misunderstanding of indicator results.

Another important factor, wherein GHZ excels, is the long-term strategic planning. It is clear how the dashboard fits in the tactical level of planning, and how this tactical level of planning fits in the vision that GHZ has on how the operative process should be managed in the future. This also requires commitment of managers, and the connection of all staff in the operative process, by means of capacity meetings, and workgroups.

Chapter 8

Conclusion and Discussion

The aim of this thesis was to assist GHZ with the design and implementation of a tool that could support them with planning decisions in the operative process on a tactical level. The main research question was **How to design and implement a tool to support the tactical level of planning of the operative process at GHZ considering the relevant data and the perspectives of the stakeholders involved?** and this question was divided into sub-questions on the needed data, gap between the current and desired situation, the stakeholders involved and the use of this dashboard in practice. An extensive literature study has been performed on the subject of using a dashboard to make capacity decisions and the contents (indicators) of such a dashboard. The results of this literature study were translated to the situation in for GHZ, with its specific stakeholders and their view on the future planning of the operative process.

This chapter presents the main conclusions of the current project, answers to the research questions, recommendations for GHZ and directions for future research.

8.1 Conclusions

The main research question can be answered by combining the answers to the four sub-questions. The project consisted of three different phases: an **analysis** phase, **design** phase and **implementation** phase.

The **analysis** phase consisted of the literature review, and a process-, gap- and stakeholder analysis. The **design** phase consisted of the translation of the results of the analyses into a dashboard with indicators, the placement of the indicators in the operative process and describing the possible outcomes of these indicators. The **implementation** phase consisted of the needed changes in the operative process to obtain the data required for calculating the indicators, a practical action plan for using the dashboard including the set-up of the meetings and the stakeholders involved, and additional recommendations which should lead towards a successful implementation of the dashboard.

8.1.1 Analysis phase

In the analysis phase, sub-question 1 and 2 have been answered and the literature review has been performed.

When comparing the desired situation with the current situation, the main differences were:

- Different way of working per specialty (especially registration of patient)

- Insufficient insight in inflow of patients to POPS and OR
- Insufficient insight in utilization and planning of beds at wards
- Different communication for the patient per specialty
- Fluctuations for POPS

The conclusion of the gap analysis was that these points should be improved with the use of a dashboard with indicators, which gives insight into the entire flow of the operative process, with uniform working standards per specialties, for the planners and for the patients. This dashboard should be filled with indicators, which represent the state of the operative process and forecast the effect of capacity-decisions that can be made. Since each indicator requires data, registration of patients into the different systems should be changed into a uniform registration in one system. The aim of the dashboard world be to enable users of the dashboard to make capacity-decisions on the allocation of OR-sessions, the focus on certain specialties or urgency groups or the calling in or cancelling of staff. This dashboard should provide sufficient insight in the inflow and outflow of the operative process and in the utilization and planning of beds at wards.

The stakeholder analysis shows that there are stakeholders of this project among the entire operative process, which can be categorized into direct and indirect stakeholders. The direct stakeholders are closely involved in the development and evaluation of the dashboard and the indirect stakeholders are regularly informed on the project and asked to share their opinion. Special workgroups have been set-up to involve these individuals.

The literature analysis showed that it is impossible to select indicators that are a perfect match; therefore, the advice was to start with selecting indicators and building a prototype of the dashboard, to show what it would look like, how it could be used and to determine requirements for a complete implementation.

To conclude, during the further development and implementation of the dashboard, both direct and indirect stakeholders should be updated on the process and results of indicators, what this means for capacity decision-making in the operative process, and how this affects their work.

The interviews among the indirect stakeholders revealed that they had no specific wishes for information on the state of the operative process. This gave the decision-makers and managers a certain freedom when it came to selecting indicators, however, it was important that the indirect stakeholders recognize the relevance of those indicators for their daily work.

8.1.2 Design phase

Based on the results of the analysis (process and literature analysis), the dashboard should exist of lagging and leading indicators, which represented the operative process (lagging) and showed the effects of capacity decisions in the near future (leading). Combining the analysis of the operative process and this recommendation (Figure 6.1), lead to the selection of the following set of indicators:
Lagging: Throughput times, Percentage of deadlines met per sub-specialty (POPS), Walk-in and run-out on schedule (OR), Pattern of bed occupancy (Wards).
Leading: Inflow (expected capacity) versus OR (available capacity), Outflow of OR (expected capacity) versus bed-days per ward (available capacity).

Each specialty should categorize its patients into sub-specialties categorized per urgency, with dead-lines linked to it for POPS visit and surgery on the OR. The dates of all patient contacts should be registered in the system, and the waiting list should be standardized for all specialties.

These lagging indicators were not the only set that could represent the operative process, thus the hospital should be aware that these indicators might be exchanged for other indicators that measure the same part of the operative process. This can happen when the capacity allocation

group notices that the lagging indicators do not correspond with the state of the operative process, e.g. the indicators give an incorrect representation of the state of the operative process. For the leading indicators, the main conclusion is that their purpose, comparing the expected inflow with the available capacity, is right, however, a simulation model is a better fit for this purpose, since it gives the hospital the possibility to see the effects of changes on the expected usage of capacity in detail.

8.1.3 Implementation phase

The conclusion, following from the design of the dashboard, was that the indicators require extra data registration, among others the registration of the urgency of a patient. This change was brought into the organization by creating willingness for change via the creation of workgroups consisting of the staff from the operative process (planners from each specialty, POPS-staff, OR program coordinators and nurses). Showing the benefits of more extensive registration in their work process caused voluntary changes.

A conclusion, based on the internal issuing of data and reports in GHZ, was that the dashboard itself should be used in the organization on a monthly basis to analyze the last period in the operative process, while looking forward in what is coming. The lagging indicators are used to give the members of the capacity-division group a report on the performance of the operative process during the last period and give an idea about which capacity choices to make; while the leading indicators show the expected results of these choices.

The users-group of the dashboard that meets monthly should consist of all direct stakeholders (representatives of all parts of the operative process) including a data analyst, to provide context of the numbers.

To foster the successful implementation of the dashboard, a recommendation derived from change management literature was that all stakeholders should be involved in the process and be informed on results and decisions based on these results.
Another important factor, wherein GHZ in excels, is the long-term strategic planning. It is clear how the dashboard fits in the tactical level of planning, and how this tactical level of planning fits in the vision that GHZ has how the operative process should be managed in the future. This also requires commitment of managers, and the collaboration of all staff involved in the operative process.

Ultimately, the use of a tool to support capacity decisions, a dashboard, should help the GHZ on a tactical level, but there is no specific right way to do it. The lagging and leading indicators should complement each other in providing an image on the state of the operative process, but the underlying requirements to calculate the indicators and the way of implementing the dashboard are also essential for its success. Therefore, it is crucial that the direct and indirect stakeholders keep being updated on the situation, and that the recommendation that their evaluation is important for the use of the dashboard is not only an advice but stays true.
This has been prepared in the setting-up of workgroups, involvement of all stakeholders and writing documentation for the dashboard, so the pre-requisites are available.

8.2 Discussions and further research

The goal of this thesis was to design and implement a tool that supported GHZ to make capacity decisions in the operative process on a tactical level. Therefore, it was necessary to investigate which stakeholders are involved in this process, and what GHZ exactly expected from this tool. The first part of this study consisted of a broad exploration of the operative process at GHZ,

which provided insight in the process and available data, to provide a foundation for the indicator selection.

This research can be used by other organizations (health-care or non-health-care) as a guideline in the development-process of a dashboard. The steps that have been taken show the route to a prototype dashboard, and which steps are needed in the finalization of such a project. Starting from scratch, the gap-, process- and stakeholder- analysis combined with the theoretical research give direction towards the selection process for indicators. This analysis phase is also useful during the rest of the project, since it helps with describing and documenting the requirements for the indicators itself. Additional recommendations given in this thesis will support the implementation of the tool in an organization. Therefore, the power of this research lies in the bridge between the theoretical scientific literature and the daily practice in a complex organization, such as a hospital.

A literature study has been performed to verify whether using a dashboard as a performance management tool could help the GHZ to make capacity decisions in the operative process, which is slightly different then using it in corporate environments. However, the dashboard is a great tool to support in these choices. After that, an extended literature study has been performed on the selection of indicators to fill this dashboard, which was twofold: the approach to indicator selection and the use of indicators in other comparable environments. This literature study provided a solid base to select the indicators upon.

The final set of indicators is not perfect, since there are dozens of options to use; these indicators have been chosen since they are a complete representation of the operative process but also based on pragmatic deliberations, which was an advice based on the literature study. Further research should verify if this indicator set is indeed a good representation of the operative process, not only in GHZ, but also in other hospitals, since the operative process is the same in The Netherlands. GHZ should also evaluate after about 3 months of usage whether the indicators live up to the expectations.

The first main change in the operative process is that each specialty should divide its patients into sub-specialties categorized per urgency of patients, with dead-lines linked to it for POPS visit and surgery on the OR. The dates of all patient contacts should be registered in the system, and the waiting list should be standardized for all specialties. This might seem a major change but requires discussion between all specialties on what acceptable care dead-lines are, considering that differences between specialties should be small. This step was not in the scope of this research but is worth an investigation on its own. Therefore, the recommendation for the hospital is to start internal discussion on which standards of healthcare they want to deliver, while scientific research should be done on how to fairly make such agreements between specialisms, and how to guard these agreements.

Another important recommendation for GHZ is to build a model of the operative process, instead of using the leading indicators. The leading indicators are only able to compare the available capacity for a given period with the incoming capacity for that same period. When building a model of the entire operative process the expected status of POPS, OR and wards can be forecasted more specifically, for example on a daily or hourly level.

Also, the assumption has been made when selecting the indicators that in order to calculate the expected inflow, waiting list data can be supplemented with historical data on the inflow of patients from first-aid and outpatient. This is an interesting research for an industrial engineering student with a more statistical background, which can be combined with the modeling of the operative process. In this aspect the health-care world falls behind on comparable processes in the business world, where all logistic processes are already modelled.

When tools come into play to support decision making based on data, thus replacing human analysis, this can cause obstruction by the involved employees in the organization or concerning process. In this research this aspect of change management is included in the scope and recommendations (paragraph 7.1 and 7.3), by describing the ways to involve all stakeholders in the

change process, however, this is worth a more extensive look, since it can be an important factor influencing the failure or success of a dashboard, irrespective of the quality of the dashboard. Kasurinen (2002) recommended specific ways to avoid barriers that are often found in hospitals when implementing performance management tools, it would be interesting to see in which extend the dashboard changes the impact of these often-found barriers. Also, it is worth further research to verify not only how often these recommendations are being followed, but also what the effects of following those recommendations are.

Abelson et al. (2017) and Persaud and Nestman (2006) state that each indicator should be linked to a specific part of the process it aims to measure. In this research this is done in detail, in the design phase the development of indicators is based on the operative process. Also, possible outcomes of the indicators have been described with actions that can be taken in case of these outcomes. It would be interesting to investigate the effects of this steps, compared to the design and implementation of tools where these steps have not been taken, or less extensively. It is expected that this linking and describing the possible outcomes will positively influence the successful long-term use of the dashboard, since the users know more precisely what is being measured and what it means.

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Appendix A

Tables used in literature research

Table A.1: KPIs in perioperative process according to Ryan et al. (2017)

Pre-assessment KPIs	**Category**	**Target**
% of patients seen	Q	100%
% of patient walk-ins	F	5% or less
% of no shows	F	1% or less
Missing documentation	Q	0
PACT Length of Stay	S	45 min
Pre-operative KPIs		
Patient arrival to admission	Q	2 to 3 hours
% Patients without Evaluation	F	5% or less
PRE-OP delays	Q	5 minutes or less
PRE-OP length of stay	S	35 minutes
Intra-operative KPIs		
Prime time room utilization	F	80%
First Case of the day On-time starts	S	90% +- 5 min 95% in 15 min
Subsequent on-time starts	S	80% in 15 min
OR turnaround time	F	25-30 min
In Room to Cut time	Q	20-30 min
Close to out of room time	Q	12-17 min
Accurate Case Duration estimate	Q	80%
Day of Surgery cancel rate	F	<2 %
Day of Surgery add-ons	Q	<10 %
% of cases with delays	S	<5 %
Average minutes per delay	S	5 15 min
Total minutes lost to delay	F	None
Post-operative KPIs		
Bed-assigned to ready-to-move	Q	15 min
Ready-to-move to occupy bed	Q	15 min
Ready-to-sign-out to sign-out	Q	5 min
# of patient holds (# of patients that had no bed available when needed)	F	None
PACU length of stay	S	60 min

Table A.2: Frequently used structure indicators in systematic review of Chazapis et al. (2018)

F	Pre-operative stage	E	D
13	There is a designated area suitable for private communication with patients. Patients are given adequate information	1a	P
9	There are multidisciplinary team clinics to discuss patients preoperatively	3b	EC
5	There are agreed local policies for preoperative preparation as listed: preoperative fasting, investigations, blood cross-match, thromboprophylaxis, diabetes management, latex allergy, and antacid prophylaxis	5	EC, S
2	Up to date, clear, and complete information about operating lists is immediately available. Any changes are agreed by all relevant parties	3b	EN
	Intra-operative stage		
8	Availability of anesthetic equipment in the operating room: measurement of inspired gas concentrations, saturations, tidal volumes, temperature, non-invasive blood pressure equipment available	NA	
6	The recovery room staff are appropriately trained in all relevant aspects of postoperative care and are present in appropriate numbers	NA	S, EN
3	Fully resourced, dedicated daytime emergency and trauma lists are available	NA	S, T, EN
	Post-operative stage		
6	There is regular (at least bimonthly) review of all deaths following emergency general surgery	NA	S
4	PACU bed area, capacity, and equipment are all maintained to national standards	5	S, EN
4	Regular education and training of PACU staff to national standards	5	S, EN
4	Transfer from operating room to PACU is with a formal handover process	5	S
4	There is a policy for the post-procedural review of all patients: surgical and anesthetic	3b	S, EC, T
	All stages		
33	Hospital annual case volume	1a	EN
21	Protocols exist for the perioperative management of: venous thromboembolism prophylaxis, avoidance of hypothermia, management of diabetes mellitus, handover, anesthetic emergencies, morbidly obese patients, handling of complaints, elderly patients, remote site anesthesia, end of life care, and critical care referral	1b	S
19	Surgical monthly/annual case volume by surgical specialty	1a	S, EC

Table A.3: Frequently used process indicators in systematic review of Chazapis et al. (2018)

F	**Pre-operative stage**	E	D
27	Percentage of patients who have received an anesthetic assessment before the day of surgery	1b	EN, EC, T
24	Each patient should have his or her expected risk of death estimated and documented prior to intervention and due adjustments made in urgency of care and seniority of staff involved	1b	EC, EN, S
24	The following medical history should be documented in the medical record prior to the operation: past medical history, past surgical history, drug history, allergies	2a	EC, EN, S
14	Elapsed time between admission and entry into operating theatre is measured	3b	T
10	Adequate preoperative fasting: clear fluids up to 2 h prior to surgery, solids up to 6 h prior to surgery	1b	EC
8	Time from diagnosis/referral to operation should be <2 months	3b	T
	Intra-operative stage		
41	Prophylactic antibiotics are administered within 60 min before start of surgery	1a	EC
32	Adults having surgery under general or regional anesthesia have normothermia (temperature >36.0C) maintained before, during, and after surgery	1a	EC
24	Proportion of patients who have had appropriate prophylactic antibiotic selection for surgical patients	1a	EC
5	Percentage of 1st cases starting on time measured and recorded	3b	T
	Post-operative stage		
25	Proportion of surgical patients who had an order for venous thromboembolism prophylaxis to be given within 24 h before incision/after surgery end	1a	S, EC
22	Proportion of patients whose prophylactic antibiotics were discontinued within 24 h after surgery end time	1a	T, EC
21	Patients should be encouraged to sit out of bed and begin mobilizing the day after surgery, within 24 h or as determined by the surgeon	1a	EC
2	PACU length of stay measured	3b	T
	All stages		
19	Chronic beta blocker use is continued in perioperative period (24 h before incision to first 2 postoperative days)	1a	EC
6	Percentage of surgery patients who received appropriate venous thromboembolism prophylaxis within 24 h prior to surgery to 24 h after surgery	1a	S, EC
3	Surgery takes place during standard daytime working hours (including weekends) except in exceptional circumstances	3b	EN, S

Appendix B

Per-article summary of the literature review

B.1 Literature on the implementation and use of a dashboard

Van den Berg et al. (2014) 7 recommendations based on the development of the Dutch Health Care Performance Report (Zorgbalans). The optimal way to select indicators is by balancing the top-down and bottom-up approach.

1. Conceptualize: which aspects and what dimensions
2. Repeated measurement is more important than highly qualified studies
3. Added value is the combination of perspectives
4. Include patient experiences, and integrate within the concerned subject
5. Signalize data caveats
6. Use already existing performance measurement networks
7. Continuous exchange between researchers and policy makers The researchers also stated that when developing such a performance report, pragmatic choices should be made between indicators and available data.

Weiner et al. (2015) When implementing a dashboard, state-of-the-art requirements are not needed. The dashboard should be open to everyone in the organization, except for sensitive and/or clinical data.

Weir et al. (2009) The study investigated the implementation of a balanced scorecard for an entire hospital (finance, quality, efficiency etc.), and have 5 tips:

1. Involve management and front-line staff in the development
2. Start with many indicators, to reduce the chance of overlooking
3. Target the initial scorecard at the governing board
4. Indicators become more informative over time

B.2 Literature on the selection of KPI's

Chambers (2002) 1. When selecting KPIs start by defining the following subjects in this order:

- Mission
- Vision
- Core values
- Key Success Factors
- Performance Indicators

2. Differentiate between leading and lagging indicators.
3. A performance management system should contain between 12 and 20 indicators.
4. Every indicator should have a target value

Giltenane et al. (2016) Indicators can be categorized into: structure, process and outcome indicators.

Mainz (2003) Indicators can be categorized into: structure, process and outcome indicators.

- Process and outcome indicators should be verified with outcome indicators.
- Process indicators are useful when a goal is to improve quality
- Process indicators are easier to interpret than outcome
- The broader the perspective required, the greater the relevance of outcome indicators.

Finally, the study concludes that in all choices, feasibility should always be a key consideration.

Persaud and Nestman (2006) There are process and outcome indicators. A good performance management tool should link the criteria (accessibility, effectiveness, efficiency) with the processes from the start of development. The fundament of a performance system lies in the development phase. The strategic goal of the performance management system should constantly be reflected.

Abelson et al. (2017) An indicator chaos has been created, there is unclarity what indicators really indicate. Every indicator should have a target value, and actions and processes that are linked to the indicator is case of over- or underperforming.

Berg et al. (2005) Performance indicators can be used internal and external. It is impossible to find a set that perfectly represent the process or the organization. Therefore, feasibility is key.

B.3 Literature with specific KPI's

Ryan et al. (2017) Example KPIs to measure the perioperative process, which is divided in 5 sub-processes:

- Pre-assessment
- Pre-operative
- Intra-operative
- Post-operative

- Central sterile supply

3 categories of KPI: Financial, quality and satisfaction. For each KPI a best-practice target is given. The KPIs are shown in Table A.1.

Chazapis et al. (2018) A systematic review on perioperative structural and process indicators. The most frequently used and/or relevant indicators are given in Table A.2 and Table A.3.

Haller et al. (2009) A systematic review on quality and safety indicators in anesthesia. 57% were outcome indicators, 42% process and 1% structure indicators. There is limited academic interest in clinical indicators. When implementing new indicators, it is important that the indicators are linked to processes, and not unthinkingly copied from literature. For an overview see Table 5.3.

Hassanain et al. (2017) When implementing Lean in a hospital, 5 indicators were used to assess whether it was a success. These indicators are shown in Table 5.4. The on-time start of OR is important, since it causes further delay the rest of the day.

Stoop et al. (2005) Waiting time data should only be used as an indicator, since expertise is needed for the context of the numbers. 4 reasons why waiting time data is difficult to deal with:

1. The patient behind the number
2. The treatment behind the number
3. The strategy behind the number
4. The validity of waiting times

When using internally the users know about the complexities and context and know where the indicators can be used for.

Appendix C

Interview in Dutch

Vraag 1 is algemeen.
Uitleggen dat de verdere vragen gaan over het planproces, dit omdat genterviewde meerdere rollen kan vervullen.

1. Wat is jouw/uw rol binnen het planproces?
2. Hoe zien je werkzaamheden eruit?
3. Wie hebben er directe invloed op je werkzaamheden? En wat is die invloed precies?
4. Wat is hun rol binnen het planproces?
5. Waar ben je tevreden over tijdens je werkzaamheden in het planproces?
6. Waar loop je tegenaan tijdens je werkzaamheden in het planproces?
7. Wat zou je zelf aandragen als mogelijke oplossing?
8. Wie zouden daarbij betrokken zijn, en wat is hun rol hierbij?
9. Wat denk je dat hun mening over een dergelijke oplossing/verandering is? Verwacht je dat ze hieraan willen meewerken? Waarom (niet)?
10. Wat zou jij het liefst verbeterd of veranderd zien binnen het planproces?
11. Wat zijn voor jou belangrijke succesfactoren/criteria om te weten of het planproces succesvol verloopt?
12. Welke informatie zou jij graag willen hebben om het plannen (nog) beter te laten verlopen?
13. Hoe zou je die informatie gebruiken?

Table C.1: Questions per sub-question

Deelvraag	**Vragen**
1 (KPI)	11,12,13
2	5,6,7
3	8,9,10
4	3,4

Appendix D

Different information per specialty

	Algemeen	NEU	OOG	KAAK	KNO	GYN	CHI	ORT	URO
Buiten scope opnameplanning (door Poli)									
Op poli	Planformulier (zelfgemaakt door poli)	X			X				
	MRSA-form				X				
Opnameplanning									
Opname	02.07.054 Rechten Plichten	jun-18		jun-13	jun-18	jun-18	jun-18		jun-18
	Opname magazine	18.04	17.03	18.03	18.03		18.02		
	04.04.010 10 meestgestelde vragen						mei-16		
Info over spec/afd	Contact info van poli					jun-18		X	
	Vakgroep (namen zorgverleners)					X			X
Informatie via app	02.08.018 GHZ App behandelwijzer				apr-17				
	02.07.113 GHZ App				okt-15		okt-15		okt-15
POPS									
POPS	Geel POPS formulier	X	X	X	X	X		X	
	Formulier proces operatie					X			
	04.01.036 POPS spreekuur Anesthesiologie	apr-18	apr-18		apr-18	apr-18	apr-18	apr-18	aug-15
Kliniek									
Informatie over opnameafdeling	08.01.074 Dagbehandeling Alg		feb-17		feb-17	feb-17	feb-17	feb-17	
	04.06.020 KVA			mei-16	mei-16		mei-16		
	08.03.006 IC						sep-16		
	02.07.111 Reanimeren						okt-17		okt-17
Buiten scope opnameplanning									
	04.04.146 Roken				feb-18				
	04.01.037 Algehele anesthesie			jul-14	feb-18				
	04.01.022 Pijnbehandeling					okt-18			
	goedkeuringsformulier USB							X	
	02.07.082 Geloof								mei-17

Figure D.1: The differences between the provided information to the patient per specialty

Appendix E

Dashboard prototype

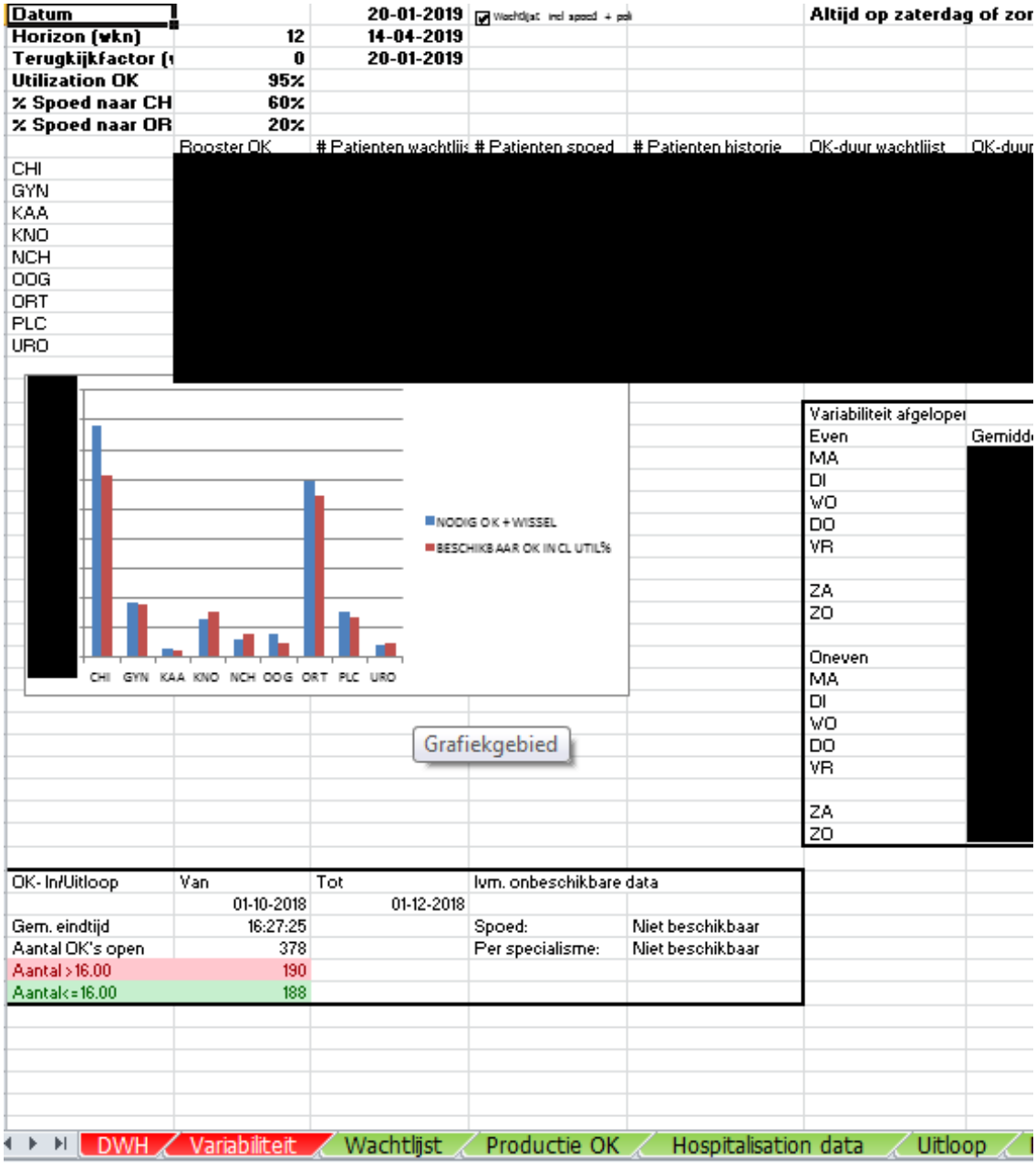

Figure E.1: A screenshot of a prototype of the dashboard (1/2)

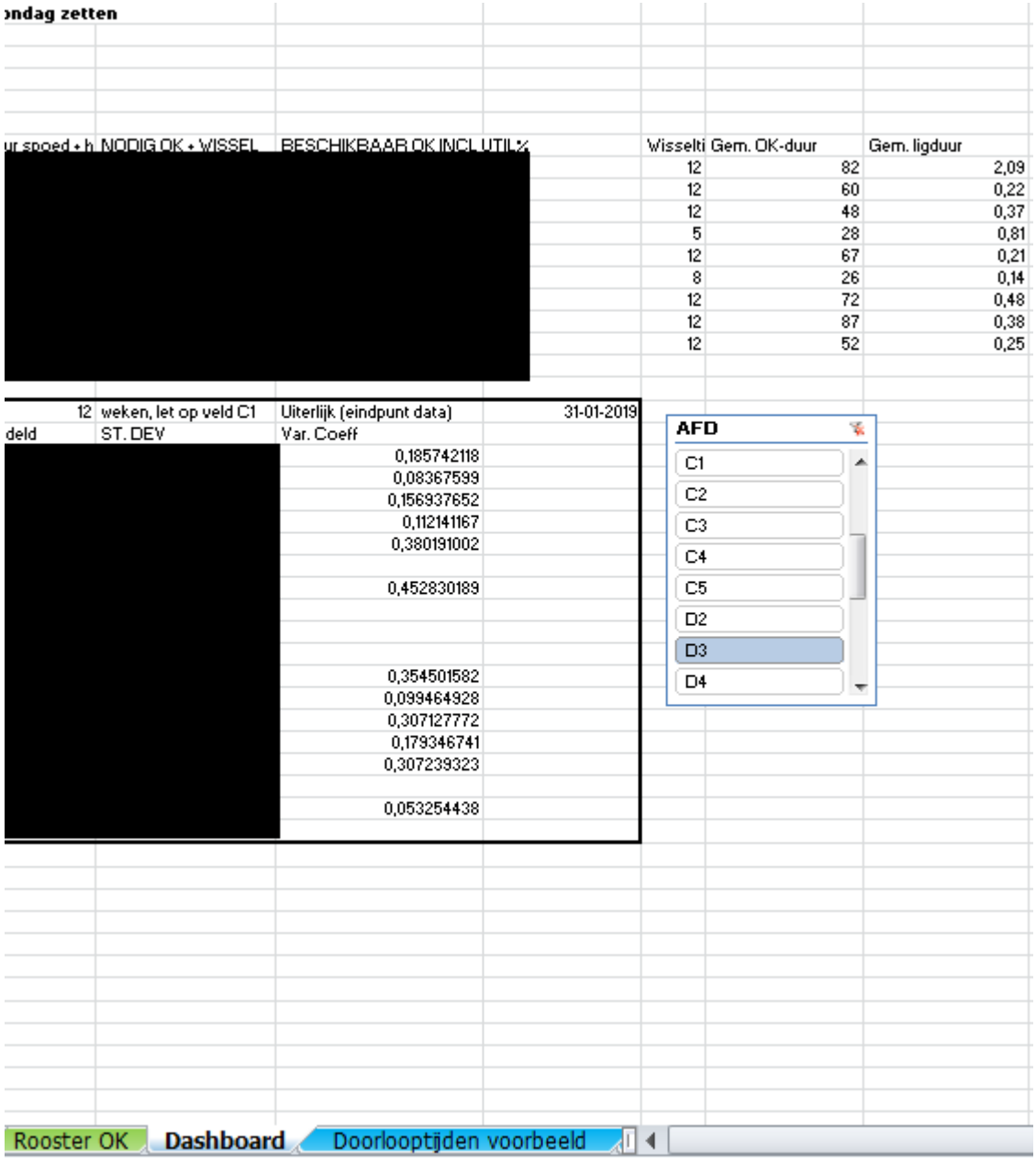

Figure E.2: A screenshot of a prototype of the dashboard (2/2)