Capacity Planning in the Healthcare Environment

At the Outpatient Clinic for Oncology of the University Medical Center Groningen

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Preface

When writing this thesis, a lot of people have supported me of which I want to thank a few especially. First of all my supervisors: dr. J.T. van der Vaart, G. Bosma and A. Gotink for all their helpful critiques and for thinking along. Second I would like to thank F. van Hilten, dr. T.J.N. Hiltermann and the care administration for all the background information they provided which enabled me to accurately map the problem. At last I want to thank J. Pols and A. Muurman for their guidance along the whole process.

Agaath Hermsen

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Abstract

This research is conducted at the University Medical Center Groningen at the outpatient clinic for oncology. In the current situation consultation rooms are used by different specialists who often feel there is a lack of rooms. This leads to discussions which affect the work atmosphere and to dissatisfaction amongst specialists and administrators. Therefore, the following goal statement was formulated: "*to analyze the current planning of room capacity at the outpatient clinic for oncology focusing on the amount, the spread and the real use, to formulate the consequences of this planning on the utilization and availability of capacity and to provide recommendations to improve this utilization and availability of capacity.*"

To reach this goal, the current situation was researched on three levels: the master level (room reservations), the operational level (patient appointments) and the level of actual use. In November 2010 a new Ambulant Oncology Center (AOC) will be opened to centralize all activities for the patient. Therefore, the future situation was taken into account as far as possible. The research focused on three specialties namely the lung oncology, hematology and the medical oncology.

It was remarkable that no waiting lists for patients existed, 20% of the consultation rooms at the master level were not reserved, and still specialists would complain about a shortage of rooms. This was mainly caused by the unleveled situation where reservations would fluctuate between 3 and 12 rooms per consultation period. When specialists requested an extra room at peak moments, it was not available. When the reservations would be leveled, only 7 rooms would be needed to accommodate the three specialties. In the future situation the room reservations will still fluctuate and 38% of the rooms will still be available. However, the overload of capacity did not only exist on the master level. When researching the current operational level, only 56% of the reserved capacity was scheduled to be used for appointments. This low efficiency is mainly explained by a lack of patients due to the fact that there are no waiting lists, consultation rooms being reserved for specialists running late, and cancelled consultation rounds.

When researching the actual use, it came forward that consultation rounds always started late. This was often caused by blood results which were not available yet. Nothing could be said about real consultation times compared to scheduled consultation times since the measurements were not extensive enough.

The variability at the master level and the operational level has several consequences. The fluctuating reservations at the master level lead to a fluctuating patient flow. Since most patients visit the blood laboratory, it can often not process the sudden increase in tests which leads to delays in the results and thus the starting time of consults. This again leads to patients arriving late at their following appointment at for example the daycare center. The daycare center is under high pressure to anticipate to the large variability in the patient flow just as the care administration and the pharmacy. For the future situation a few recommendations are given to improve the utilization and availability of capacity. Below some of the main recommendations are given:

- Level the reservations at the master level and the scheduled appointments at the operational level.
- Link the master- and the operational schedule to create more insight in the availability of consultation rooms.
- Create a better insight in the duration of consults and other activities.

In the end, all research questions were answered for as far as this was possible. Unfortunately not all researched specialties wanted to participate in the measurements at the level of actual use. Therefore, on this level the created insight was limited. This is a limitation of this research and at the same time a recommendation for future research.

1 Research design

1.1 Introduction

Research is looking for answers to questions in a systematic way. Thus, research needs to provide knowledge and the search process should be conducted in a systematic way (De Leeuw, 2003). To meet these requirements a research design is developed. This research design is set up according to the overview described in the book of Verschuren and Doorewaard (2003). This overview can be found in appendix A.
This chapter provides the structure of this research. After reading this chapter, the reader will understand the goal, scope and the design of this research. Paragraph 1.2 covers the conceptual design comprising the goal of the research and the research questions. In paragraph 1.3 the technical design of the research will be addressed. Next, in paragraph 1.4, the constraints will be discussed. Finally, paragraph 1.5 will show the structure of the report.

1.2 Conceptual design

Since this research covers only part of a much bigger topic, it will be put in perspective first. According to Verschuren and Doorewaard (2003) a research design needs to address the following two objectives: a project frame and a goal extracted from this frame. This paragraph will address these requirements describing the context and the objective of this research. Subsequently, a research model will be presented with the research questions derived from it.

1.2.1 Research objective

This research is conducted at the outpatient clinic for oncology of the University Medical Center Groningen.

The University Medical Center Groningen
The University Medical Center Groningen (UMCG) is a center for highly specialized medical treatment for the more than 3 million residents living in the north of the Netherlands. Their mission is to build on the future of health in three ways: pioneering in research, testing and sharing knowledge and caring for people.
With 9000 employees and over 1300 beds, it is a large employer and an economic engine in the region. Besides this, the UMCG is the only university medical center in the north. This means that patients from the whole region will be sent to the UMCG when they have a rare disease that is hard to diagnose and treat. The UMCG is also a center for education and research.
The structure of the organization is shown in appendix B.

The outpatient clinic for oncology
As shown in appendix B, sector D is the sector for oncology. Currently the hematology, lung oncology and the medical oncology are established at the internal outpatient clinic for oncology. The head-neck oncology and the clinical genetics are established elsewhere.

The new Ambulant Oncology Center (AOC)
In November 2010 the new AOC will be opened, see appendix C. In this center, more oncology specialties will work together in one place to centralize the activities for the patient. Figure 1 shows the specialties that will move to the new AOC.

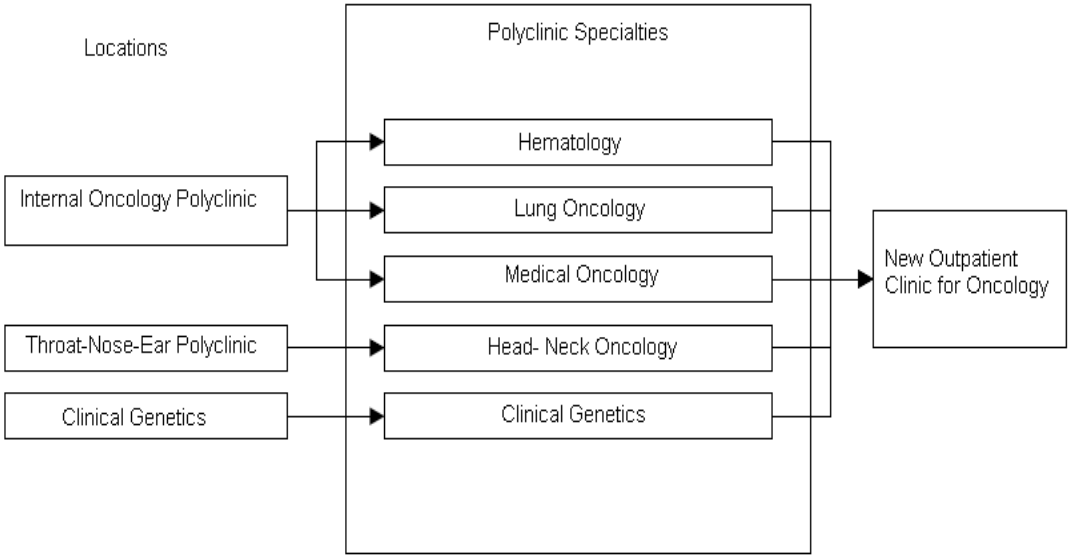


Figure 1 specialties in the new AOC

Research goal

In the current outpatient clinic consultation rooms are used by different specialties. Specialists often feel there is a lack of rooms. This leads to discussions which affect the work atmosphere and to dissatisfaction amongst specialists and administrators. Specialists request more consultation rooms which, according to the administration, are often not available. Therefore, the need is felt to have a clear analysis of the current use of the rooms. Even though more consultation rooms will be available at the new AOC, an effective planning is desired since additional services will be offered which will utilize the rooms as well.

The sector oncology has two wishes:

- An analysis on the utilization and availability of capacity taking into account the demand of patients.
- Recommendations to improve the utilization and availability of capacity

Now the desires of the sector are identified, the following goal statement is formulated.

The main goal of this research is to analyze the current planning of room capacity at the outpatient clinic for oncology focusing on the amount, the spread and the real use, to formulate the consequences of this planning on the utilization and availability of capacity and to provide recommendations to improve this utilization and availability of capacity.

This research is directed at operations in the health care sector with a focus on the utilization and availability of room capacity. Therefore, in the next part a general insight is provided in factors influencing operations in health care.

Introduction to operations in health care

Given the pressure to contain costs, it is critical for hospitals to develop systems that ensure the best possible patient care with limited resources. An important aspect of this objective is to develop procedures to improve the patient flow, to provide timely treatment and maximum utilization of available resources (Hall, 2006). This all involves operations management. Operations management can be defined as 'the analysis, the design, the planning and control of al steps needed to deliver a service to a client' (Vissers & de Vries, 2005). However, a hospital is not a manufacturing organization but more a special kind of service organization which cannot stock its commodities (Vissers & Beech, 2005). Production guidance and capacity management are therefore important to offer a good service which is accessible with short waiting times through efficient use of capacity. Planning in hospitals is mostly scattered between departments. The connection between several stations in the logistic chain needs guidance. However, managers are often too busy with their day-to-day activities to develop such an instrument. (de Vries & van Tuijl, 2006). The need is felt to better coordinate and organize the care processes and to optimize the capacity planning with quality improvement as a result (De Vries & Beijers, 1999).

To put this research in perspective; several levels of logistics in health care will be discussed. Vissers and Beech (2005) make a distinction between unit logistics, chain logistics and network logistics. Units execute one type of activity for several products. Examples of a unit are an outpatient clinic or an X-ray department. Unit logistics concerns the optimization of the efficiency at a department. Chain logistics concerns the optimization of the process a patient goes through. Network logistics combines unit- and chain logistics. Figure 2 shows an overview of the various types of logistics.

At the level of unit logistics decisions are taken involving resource utilization. The unit logistics is less focused on the total process since it only deals with one department.

This thesis will focus on the use of capacity at the outpatient clinic for oncology. Therefore the unit logistics is at the center of attention. However, care processes are part of a logistic chain. Therefore, the chain logistics will sometimes be addressed to show the consequences of decisions made by the unit logistics on other departments. Now the research is put in perspective and the research goal is formulated, the research model will be discussed.

Perspective item	Unit logistics approach	Chain logistics approach	Network logistics approach
Focus points	Resource utilization; workload control	Service level	Trade off between service level and resource utilization
Strong point	Capacity management	Process management	Combination
Weak point	Not process oriented	Not related to the use of resources	More effort
Suitable for	Efficiency analysis	(re)design of a process	Redesign and efficiency

Figure 2 Differences between the unit, chain and network logistics approaches (Vissers & Beech, 2005).

1.2.2 Research model

To get a better understanding of the time horizon in this research, the framework for directing production in hospitals will be described. Subsequently, the research model will be discussed.

To fulfill the demands of delivering high quality care, health care institutions need to make choices concerning the use of capacity. To create more insight in the steering and planning of the needed capacity, a framework for directing production is developed by Vissers, De Vries and Bertrand (2001). This framework addresses decisions taken at

	Level	Time horizon	Decision function
1.	Strategic planning	2 to 5 year	Plan for future capacities
2.	Patient volume planning & control	1 to 2 year	Available and needed capacity at year level
3.	Capacity planning & control	1 year to 3 months	Allocate capacity, mainly allocating personnel to locations/departments
4.	Patient group planning & control	3 months to weeks	Planning rules per patient group based on available specialist capacity
5.	Patient planning & control	weeks to days	Planning for individual patients

Table 1 framework for directing production (Vissers, De Vries & Bertrand, 2001)

various levels within the organization. Summarized, the framework consists of the parts shown in table 1.
The planning at the outpatient clinic occurs at all levels. For example, at the first level the decision is taken to build a

new AOC. At the second level it is decided how many specialties will be able to make use of the consultation rooms at the outpatient clinic. The third level plans what specialties get assigned what rooms. The fourth level makes sure that for example a patient group that needs to be seen early in the morning, gets early appointments. Lastly, the fifth level plans individual appointments for patients.
This research focuses on the third, the fourth and the fifth level since the outpatient clinic wishes more insight in the

possibilities to improve the utilization and availability of capacity at these levels. Therefore, the research can be subdivided in three parts which are modeled in figure 3. The master plan discusses the level of capacity planning & control, the operational schedule discusses the patient group planning & control and the patient planning & control, and the actual use discusses what happens with this planning in a real situation on the work floor.

Master level – the master plan (see appendix D) is the schedule that shows when specialists have a room reserved for their consultation round (i.e. a block of 3,5 hours wherein consults take place). This schedule has been the same for years. Only slight changes are made when a specialist leaves the hospital or when a new specialist starts.

Operational level – the operational schedule is a more detailed schedule with patient appointments. The consultation round of each specialist is subdivided in different time slots for appointments.

Level of actual use – the actual use shows how the consultation rooms are used in reality. This may deviate from the planning in the operational schedule and the master plan.

This research will be conducted in the same order as figure 3 shows. In every following phase, the relation to previous phases will be taken into consideration.

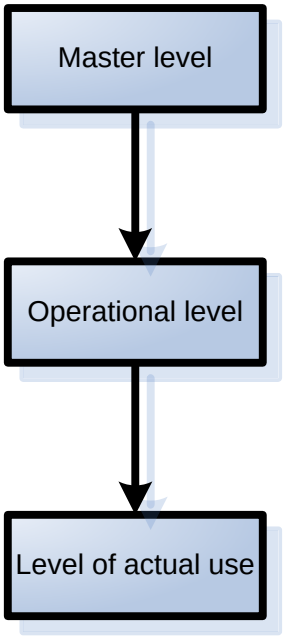


Figure 3 levels of analysis

1.2.3 Research questions

The main research question following from the research goal and model is:

How is the room capacity planned at the outpatient clinic for oncology focusing on the amount, the spread and the real use, what are the consequences of this planning on the utilization and availability of capacity and what recommendations can be provided to improve this utilization and availability of capacity?

To be able to answer this question, several sub questions are formulated.

Master level
- *What is the planned use of capacity according to the* master plan?
- What are the fluctuations in the planned use of capacity according to the master plan?
- What are the consequences of the fluctuations in the planned use at the level of the master plan?
- What is the amount and spread of capacity planned to be used in the future AOC according to the future master plan?

Operational level
- What is the efficiency of the reserved consultation rooms?
- What are the fluctuations in the scheduled use of capacity according to the operational schedule?
- What causes the fluctuations in the scheduled use of capacity at the operational level?
- What are the consequences of the fluctuations in the scheduled use of capacity at the operational level?

Level of actual use
- What prevented consultation rooms from being used *efficiently while observing the consultation rounds?*
- *What is the actual use of capacity for the lung oncology* and how can it be compared to the scheduled use?
- *What is the actual use of the hematology and how can it be compared to the scheduled use?*

Definitions

Health care organizations have different kinds of capacity like space, personnel, specialist time and machines. This research mainly focuses on the efficient use of the capacity space. However, other capacities need to be taken into consideration as well. After all, to optimize the use of space, unlimited specialists and patients with blood results should be available to prevent a consultation room from staying empty, which is of course not possible.
When discussing capacity, a division can be made.

According to Waters (2002), two types of capacity exist:
- Designed capacity: the maximum output that can be achieved in ideal circumstances
- Effective capacity: the maximum output that can be expected under normal conditions.

In case of the master level, the designed capacity per week would be 20 rooms * 7 consultation hours a day * 5 days a week = 700 hours of designed capacity per week. The effective capacity however would be 160 reserved consultation rounds per week * 3,5 hours per consultation round = 560 hours of effective capacity per week.
These different types of capacity are linked to the utilization and efficiency ratio.
- Utilization : the ratio of actual output to designed capacity
- Efficiency: the ratio of actual output to effective capacity

This research discusses the use of capacity as well. However, due to the fact that the research is conducted at three levels, a division will be made between three types of use.
- Planned use: the number of reserved rooms at the master level
- Scheduled use: the scheduled consult time at the operational level
- Actual use: the time a consultation room is occupied in reality

Lastly, this research uses several terms to indicate the time blocks in which specialists see patients. Below, explanations will be given for these terms.
- Consult: a specialist seeing a patients
- Consultation round: a block of 3,5 hours wherein consults take place
- Consultation period: a weekly time period in which consultation rounds take place. For example, Monday morning.

The most important definitions are addressed above. However, since this research uses an extensive amount of definitions, a vocabulary is added in appendix E.

1.3 Research technical design

This paragraph first grounds the research material used in section 1.3.1. Subsequently, in section 1.3.2 a short overview will be given of how the report is structured and the structure of the analysis will be elaborated on together with a more extensive explanation on how the research material was used.

1.3.1 Research material

Several types of research material will be addressed to create this thesis. Overall the research material can be subdivided in four groups namely persons, documents, literature and observation.

Persons
Informants provided information in several stages. In the beginning discussions were organized as orientation. In later stages informants gave explanations for symptoms. The main persons involved in this research were: the care administrators, specialists from the three main specialties and staff members.

Documents
Several documents were used in this research. In the beginning they mainly provided background information on the subject. Examples are the year report and the development plan. The websites of other University Medical Centers were visited to see whether they had conducted similar research in this field. When the research proposal was approved the analysis on the three levels began starting with the master level. The master plan was immediately available through the administration of the outpatient clinic for oncology. Second, the operational level was analyzed. Data for this level could be subtracted from OMAF (order management and appointments) which is an

application of X/Care, the planning system of the clinic. For the third level of analysis, no documents were needed.

Literature
To get an overview of the existing literature, a research was conducted through the database of the university: PurpleSearch. Main search terms were: appointment, scheduling, hospital, health care, (shared) capacity, capacity utilization, efficiency, patient flow, operations management, logistics, and consultation rooms. When useful articles were found, articles from their reference list were looked up for more information.

Observation
With digital pens, measurements were taken during consultation rounds to get an insight in the actual use of the consultation rooms and to gather more information on the activities of specialists during a consultation round. Besides the measurements, the daily business was observed during a longer period without involvement in the activities. This was done several times during different stages of the research. Observing a consultation round by sitting in the waiting room without a specialist being aware of it, gave more insight in the situation.

1.3.2 Research strategy

First, the structure of the total report will be introduced briefly. Subsequently, the structure of the analysis will be addressed since the analysis is quite extensive.
The report is structured as follows. After this research design, a more extensive background on the outpatient clinic will be provided. Next, the analysis will answer the sub questions. Subsequently, the conclusion will answer the main question and lastly in the discussion the limitations and possibilities for future research will be discussed.
Now the structure of the analysis will be addressed. Figure 4 provides an overview of this analysis to put everything into perspective.

The overview will shortly be discussed together with the research steps taken at each level. Figure 4 shows the three levels in which the research is divided. Every level has several focus areas. The information for these areas was pertained in different ways. The research started off with a preparation to get more insight in the processes of the outpatient clinic. Informal talks with specialists, the administration and management provided a better understanding of the current situation and the future plans. This information was completed with information from other sources such as year reports and intranet. Through time a good insight was created in the outpatient clinic. This enabled us to form a research proposal which suited the needs of the situation. This lead to the division into three layers as discussed earlier.

The research was conducted level by level starting off with the master level. This level is divided in two parts: the current situation at the outpatient clinic and the expected future situation at the new AOC. The current master plan was analyzed to map the planned use (i.e. the number of reserved rooms at the master level) and the fluctuations in this use. Lower levels such as the operational level were not taken into account. To be able to formulate the consequences of this planned use, theory was consulted and directed informal talks were held.

The future planned use was analyzed by using the future master plan of the new AOC. Here again the main focus was on the fluctuations in the planned use.

After the master level, the second level was researched: the operational level. Data from OMAF was researched for this analysis. First the efficiency of the consultation rooms was analyzed. Fluctuations in this efficiency are caused by the scheduled use (i.e. the scheduled consult time at the operational level). Therefore, fluctuations in the scheduled use are mapped followed by an analysis to explain these fluctuations and to determine the influence the outpatient clinic can have on these fluctuations.

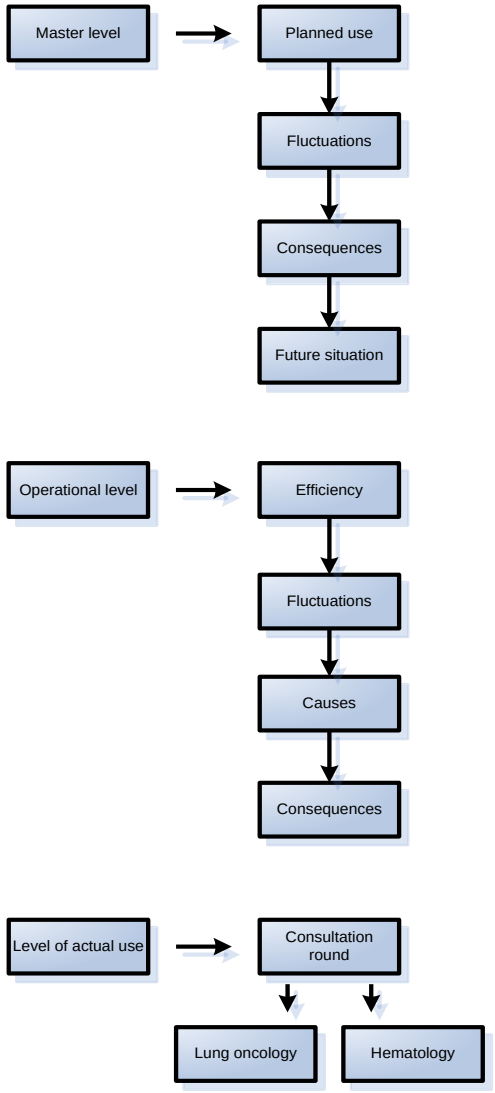


Figure 4 structure of the analysis

Finally, the consequences of the fluctuations are formulated by consulting theory and having directed informal talks with specialists, the care administration and managers.

Finally, the level of actual use was analyzed using measurements and observations. Lung oncologists measured all their activities themselves while parts of the activities of hematologists were measured by the researcher. During all the measured consultation rounds and during random consultation rounds in other weeks, the progress of the consultation rounds was observed. This provided a lot of background information and confirmed situations described in the directed informal talks. The level of actual use first discusses remarkable observations in the consultation round section. Subsequently, the results from the measurements at the lung oncology are discussed. Lastly, the results from the measurements at the hematology are discussed.

Now the research strategy is discussed, the constraints of the research will be elaborated on.

1.4 Constraints

Before starting with the outline of the situation, some constraints will be discussed.

Constraints
This research has a few constraints. First of all, the head-neck oncology and the clinical genetics were not measured even though they will be established at the new AOC. This leads to the constraint that no exact prediction can be made about effective capacity (i.e. the maximum output that can be expected under normal conditions) at the new clinic, on the operational level and the level of actual use, when the five specialties will be established there. The reason for not including these two specialties is twofold. First, the research was set up in name of the oncology department which does not include these two specialties. Second, there is a time constraint for this research and

including these two specialties would make the research too extensive.
Another constraint of this research was the fact that the medical oncology and the hematology did not want to participate in the measurements for the actual use. Even though measurements were taken outside the consultation rooms of the hematology, a total insight was not created. Therefore, the insight in what the reasons could be for possible waste of effective capacity was impeded. Also, since only a few consultation rounds were measured, it was not possible to make statistically justified statements which would be applicable to future situations as well. The measurements just provided some ideas on the pastime of a specialist during a consultation round.
No information was available on the number of urgent patients or on the lead times of the blood laboratory. Therefore the impact of these factors could not be fully mapped.
Since specialists could see their consultation rounds being measured, biases might have occurred here. Also, since specialists measured their own consultation rounds and were not used to marking off all their activities, they might have forgotten to mark off some of them.
A last constraint is the fact that only one master plan is used in the analysis on the master level even though this plan may have had some slight changes over the measured year. This is caused by the fact that not all old plannings are available and it is not registered when a new master plan is taken into use. However, since the changes to the master plan are very limited the impact on the main findings should be limited as well.

1.5 Conclusion

As the conceptual design, technical design and the constraints are clear, the first chapter is concluded. Before the main deliverables can be established, an outline of the situation will be provided. This will be done in chapter two.

2 Outline of the situation

2.1 Introduction

In this chapter, background information regarding the outpatient clinic for oncology will be provided. In order to understand the analysis in chapter three, the reader should first understand how the outpatient clinic works and the situation it is in. Paragraph 2.2 will address these issues.

2.2 Outline of the situation

In this paragraph a short outline of the situation at the outpatient clinic will be provided using several subheadings.

Three specialties
This research focuses on the three main specialties that will move to the new AOC. These specialties are hematology, lung oncology and medical oncology. In the current situation and in the new situation, other specialties occupy consultation rooms as well. However, these specialties will not be extensively researched and therefore only mentioned shortly.

Consultation periods
There are two consultation rounds each day. The morning round is from 8.30 am until noon. The afternoon round starts at 12.30 pm until 4.00 pm. Both consultation rounds are thus 3,5 hours. In the morning, the outpatient clinic opens at 8.00 am for patients with an early appointment who need to get their blood tested before that. The outpatient clinic is open only on workdays.

Blood testing
Most patients need to get their blood tested before seeing a specialist. When patients get their blood tested it is planned to take 30 minutes before the results are available. However, this is not always the case. At the lung oncology more extensive tests are often needed which take more time, generally 60 minutes. When the blood laboratory has a peak moment the blood results may take longer as well. Unfortunately, no exact information is available on the delivery times of the blood laboratory.

Rooms
In the current situation, 20 consultation rooms are available. However, these need to be shared with other specialties such as dietetics and rheumatology. Therefore, only part of these 20 rooms are reserved by the three specialties this research measures. In the future situation, 17 rooms are available. Here, fewer other specialties reserved rooms. When reserving a room, one always books it for the whole consultation round. Thus, when a specialist only needs to see a few patients, the room is marked occupied for the whole consultation round, which is 3.5 hours.

Appointments
Several types of consults are planned in a consultation round requiring different timeslots. The administration subdivides all appointments into four different types.

- New patients 20-45 minutes
- Check-up patients 10-20 minutes
- Treatment patients 10-20 minutes
- Conversation 10-20 minutes

The timeslots planned for an appointment vary depending on the specialist. Some specialists are able to consult patients faster than others and thus have shorter timeslots.

Planning
The planning is made in the digital planning system X/Care which is used for the analysis on the operational level. The

administration is able to book more patients in one timeslot. These are called double bookings and are tried to be avoided. Numbers about urgent patients cannot be subtracted from the system since they are spread over different departments and often poorly registered.

Waiting list
The outpatient clinic does not have a waiting list. When a patient needs to be seen, an appointment can be made. However, there is still a delay between calling for an appointment and seeing a specialist. This is mainly caused by the fact that patients need to be available and specialists only work certain days of the week. Therefore it is not always possible to plan an appointment right the same or the next day.

Process chain
The outpatient clinic is part of a chain of processes. Before visiting the clinic patients may get their blood tested and afterwards the daycare center or the radiotherapy department can be visited. Therefore, when the flow of patients fluctuates, other departments are affected by these fluctuations.

Now the outline of the situation is provided, the next chapter will provide the analysis.

3 Analysis

3.1 Introduction

This chapter provides an analysis of the three levels discussed in section 1.2.2. Every level will answer the sub questions related to that level. First the master level will be discussed in paragraph 3.2. Paragraph 3.3 will discuss the operational schedule. Finally, paragraph 3.4 concludes this chapter with the measurements of the actual use. The master plan will be discussed next.

3.2 Master level

This paragraph will discuss the master plan. At the end of this paragraph the following sub questions will be answered:

- What is the planned use of capacity according to the master plan?
- What are the fluctuations in the planned use of capacity according to the master plan?
- What are the consequences of the fluctuations in the planned use at the level of the master plan?
- What is the amount and spread of capacity planned to be used in the future AOC according to the future master plan?

The master plan is an Excel-sheet which shows the 20 rooms of the outpatient clinic as shown in appendix D. Each room gets assigned to a specialist for a consultation round (i.e. a block of 3,5 hours wherein consults take place). The grey areas are rooms assigned to the three specialties hematology, lung oncology and medical oncology. Some grey areas are empty and not assigned to a certain specialist. These rooms are reserved precautionary for the three specialties in case they ask for extra rooms. These rooms are not utilized at this time and therefore will be treated as empty in the measurements. The master plan has been enforced for over 15 years and only slight adjustments have been made. The rationale behind the current plan is unknown. It is not clear why the plan was ever made this way.

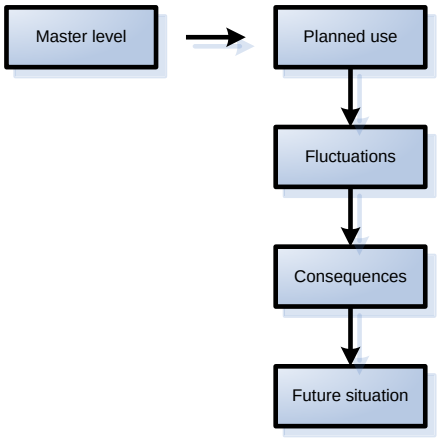


Figure 5 structure of analysis, master level

The structure of this paragraph is shown in figure 5. In the following section we will discuss the planned use (i.e. the number of reserved rooms at the master level) to see whether, according to the master plan, there is indeed a lack of rooms. The fluctuations in planned use will be addressed in section 3.2.2. In section 3.2.3 the effects of these fluctuations will be clarified. Section 3.2.4 will discuss the capacity planned to be used at the new AOC.

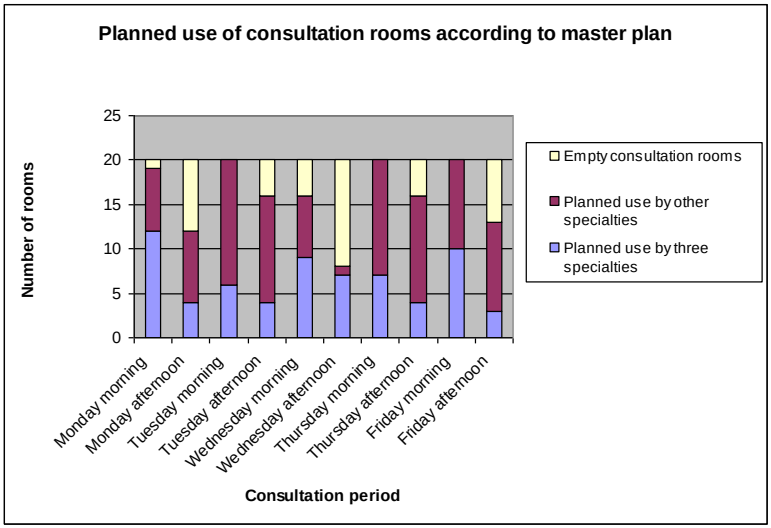


Figure 6 planned use of consultation rooms according to master plan

3.2.1 Planned use

This section will answer the following sub question: *What is the planned use of capacity according to the master plan?*

A separation will be made. The three main specialties, hematology, lung oncology and medical oncology, will be separated from the other specialties. The reason for this is twofold. First, the research was set up in name of the oncology department which does not include these two specialties. Second, there is a time constraint for this research and including these two specialties would make the research too extensive.

Figure 6 shows the planned use of the rooms. The first thing to note is that 40 consultation rounds, out of 200, are still available, which is 20% of the designed capacity (i.e. the maximum output that can be achieved in ideal circumstances). Remarkable is that, as noted earlier, there

are no waiting lists for patients, enough consultation rooms are available, and there are still complaints about having too little designed capacity. The main cause of this complaint is the fact that the planned use is not leveled. Therefore, the following section will discuss the fluctuations in the planned use.

3.2.2 Fluctuations

This section will answer the following sub question: *What are the fluctuations in the planned use of capacity according to the master plan?*
Based on figure 6, one can clearly conclude that large fluctuations exist in the planned use of the rooms.

Especially Tuesday morning, Thursday morning and Friday morning are very busy. All consultation rooms are reserved and when specialists want to reserve an extra room on these days, their request is denied. However, Monday afternoon, Wednesday afternoon and Friday afternoon are quiet. When specialists would request extra rooms during these consultation periods (i.e. a weekly time period in which consultation rounds take place), there would be enough designed capacity available. The highly occupied

mornings are caused by the fact that treatment patients need to be seen in the morning since they need to go to the daycare center after visiting the outpatient clinic. Therefore, doctors prefer consultation rounds in the morning even though most other patients are not bound to the mornings. The three main specialties all have an unleveled planned use and thus influence the total unleveled situation as can be seen in figure 7.

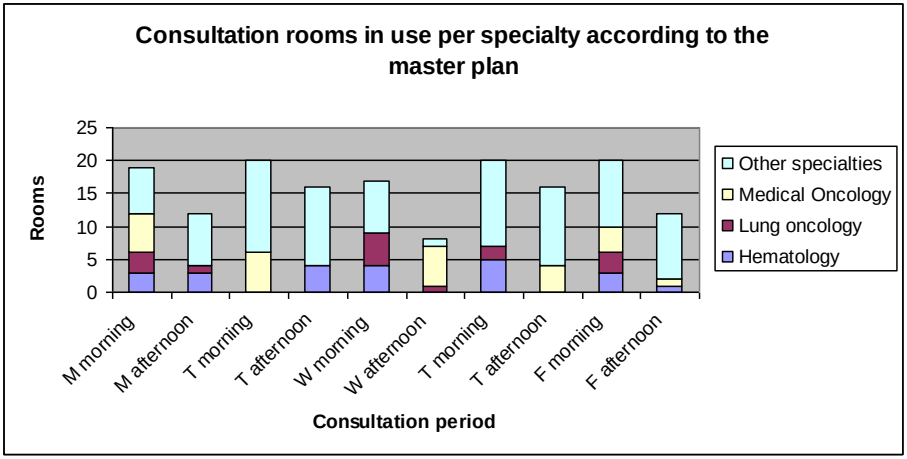


Figure 7 Consultation rooms in use per specialty according to the master plan

The frustration of specialists about room capacity being too low is not grounded based on the master plan. Extra rooms might not be available at the exact times specialists prefer, but if they are willing to shift their consultation rounds there are still rooms available.
One striking point in the master plan is the fact that at two points in time, on Tuesday morning and on Thursday morning, rooms are booked double as can be seen in appendix D. It seldom causes problems since there are often specialists absent and the operational schedule shows that it rarely ever happens that both specialists have a patient planned at the same time. However, it is still something one wants to prevent.

In a leveled situation where the planned use would be evenly spread over the week, the number of rooms that should be reserved each day would be 6.6 (66 reserved consultation rounds per week divided by 10 consultation periods per week). Therefore, with the availability of only 7 rooms, in theory there would be enough effective capacity according to the master plan. However, on Monday morning 12 rooms are reserved while on Friday afternoon only 3 rooms are reserved. In the following section the effects of these fluctuations are researched.

3.2.3 Effects

This section will answer the following sub question: *What are the consequences of the fluctuations in the planned use at the level of the master plan?*
An unleveled situation at the master level has an effect on the flexibility of the rooms. At peak moments all rooms are occupied. When at such a moment a sudden change in the planning arises, when for example a specialist needs to see an urgent patient, there is no extra capacity available. Stretching the planning to the limits, as is done at some points according to the master plan, takes away any chance

of flexibility. At other times when it is quiet at the clinic there is an overload of available rooms and thus there is excess flexibility. This is the only effect that can be detected when solely taking the master plan in consideration.
In the following section the future master plan will be discussed to see how this compares to the current master plan.

3.2.4 Future situation

This section will answer the following sub question: *What is the amount and spread of capacity planned to be used in the future AOC according to the future master plan?*
Since the new AOC will open soon, it is interesting to discuss the planned use of that outpatient clinic as well. The planned use is based on rooms that were pre-assigned during the development phase of the new AOC. The planned use of rooms at the new outpatient clinic will look as shown in figure 8.

Figure 8 clearly shows there are enough rooms available according to the future master plan when taking into account the extra requested rooms of all specialties at the new clinic. Even during the morning consultation periods extra rooms are available. To create a margin at the level of actual use, for example when specialists are running late, one consultation room is always booked empty at the new AOC. The other available rooms can be used to accommodate psychosocial care, the oncology nurse, social work or other specialties which are involved in a patient's case.
Based on figure 8 we can conclude that great fluctuations in the planned use of the rooms will still exist in the future situation. It is clear that there are still a lot of rooms available. In the future situation 64 consultation rounds out of 170 are still available, which is 38%. All specialties have their share in causing the fluctuations. However, even though most specialists are aware of this situation, they do

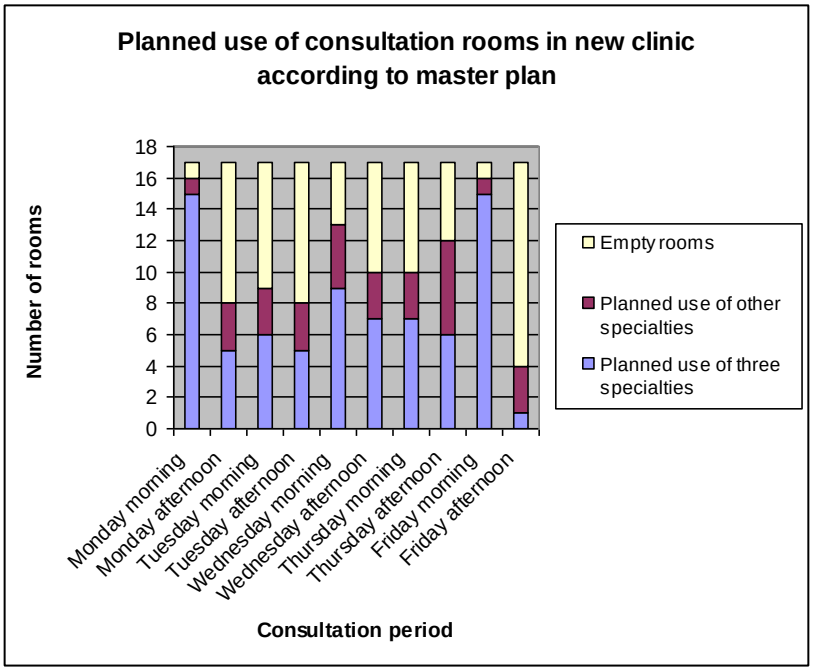


Figure 8 planned use of consultation rooms in new clinic according to master plan

not switch their consultation rounds partly because they have other obligations and their full agendas make changes difficult. When the schedule of the outpatient clinic changes, other schedules in the hospital have to change as well. Since this would have a large impact, most doctors are not willing to put in all the effort or do not know how to.

3.2.5 Conclusion

In paragraph 3.2 the first set of sub questions as defined in section 1.2.3 has been answered:

- What is the planned use of capacity according to the master plan?
- What are the fluctuations in the planned use of capacity according to the master plan?
- What are the consequences of the fluctuations in the planned use at the level of the master plan?
- What is the amount and spread of capacity planned to be used in the future AOC according to the future master plan?

The conclusions are divided in these four sub questions. The main conclusions coming forward from the analysis are:

Planned use

- In the current situation, 20% of the designed capacity is still available and the complaint of too little available capacity is therefore not grounded. This complaint stems from the fact that specialists request extra capacity at peak moments in the mornings.

Fluctuations

- The current planned use is not leveled.
- The three main specialties all have an unleveled planned use and thus influence the total unleveled situation
- When the current reservations would be leveled, the clinic would only need 7 rooms to accommodate the three specialties.
-

Effects

- The large fluctuations in the master plan lead to inflexible capacity.

Future situation

- In the future situation 62% of the designed capacity is reserved in the master plan, thus 38% of the designed capacity is still available.
- In the future situation, the planned capacity for the three specialties is unleveled and thus influences the total unleveled situation.

The following paragraph will discuss the scheduled use at the operational level.

3.3 Operational schedule

This paragraph will discuss the operational schedule. At the end of this paragraph the following set of sub questions will be answered:

- What is the efficiency of the reserved consultation rooms?
- What are the fluctuations in the scheduled use of capacity according to the operational schedule?
- What causes the fluctuations in the scheduled use of capacity at the operational level?
- What are the consequences of the fluctuations in the scheduled use of capacity at the operational level?

The operational schedule is a planning system which contains the appointments a specialist has during a consultation round (i.e. a block of 3,5 hours wherein consults take place). Sometimes timeslots are left open when there are no patients that need to be seen. This occurs since there is no waiting list. On the other hand, sometimes timeslots get double booked when there are more patients than there are available timeslots.

Again, a division will be made between the three specialties and the other ones. Only the three main specialties will be

taken into account when measuring the scheduled use (i.e. the scheduled consult time at the operational level) of the rooms.
To get a good overview of how the consultation rooms are scheduled, the operational schedule is analyzed for a period of one year. This provides a large sample of consult appointments and creates the opportunity to take into account seasonal fluctuations. To make the measurements as recent as possible all appointment information from the operational schedule was taken from 1/4/2009 until 31/3/2010.

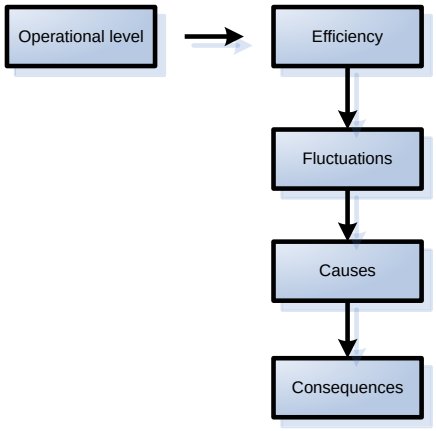


Figure 9 structure of analysis, operational level

The operational level is divided in four parts which are linked to the sub questions. Figure 9 maps the structure of the analysis of the operational level. First, in section 3.3.1 the efficiency will be discussed. Subsequently, section 3.3.2 will discuss the fluctuations in scheduled use followed by section 3.3.3 which will discuss the causes of these fluctuations. Finally, section 3.3.4 discusses the consequences of the fluctuations

3.3.1 Efficiency

This section will address the following sub question: *What is the efficiency of the reserved consultation rooms?*
The ratio of scheduled use of capacity (i.e. the scheduled consult time at the operational level) to the planned use of capacity (i.e. the total time consultation rooms are reserved in the master plan) is the efficiency. Figure 10 shows the efficiency of every day. The measured year consists of 253 working days when not taking into account weekends and national holidays. The total efficiency for the three specialties is 56% (st. dev.=12, min=26, max=104) which is remarkably low. The efficiency is calculated using the planned use of capacity. However, when also taking into consideration the consultation rounds which are not reserved, the utilization is calculated. The utilization is only 37% (st. dev.=11, min=13, max=74) and thus even lower than the efficiency. However, since the outpatient clinic is not only used by the three specialties, the available consultation rounds are not all to be used by them. Therefore, in the following part we will only discuss the efficiency since the planned use is known.
The efficiency fluctuates per day with large differences between the minimum and maximum.

The efficiency shows some large dips around July which are caused by cancelled consultation rounds due to summer vacations. These peaks of cancellations in July are confirmed by the data on cancelled consultation rounds. On April 14th there is a peak in the efficiency (104 %). This is most likely caused by the fact that the day before was a national holiday. Therefore, specialists miss a consultation round while they need to see the same amount of patients as usual. This leads to full consultation rounds at other

times and thus high efficiency rates. This is confirmed by the total appointments per day which is high on April 14th. Now the efficiency over the year is known, it is interesting to map the efficiency per consultation period (i.e. a weekly time period in which consultation round take place).

As already noticed in figure 10, the efficiency highly fluctuates which is confirmed by figure 11. However, since this figure only provides averages, table 2 puts the efficiency rates in perspective by showing the standard deviation, the minimum and the maximum.

Large differences in efficiency rates come forward. These differences implicate fluctuations in scheduled use and reserved capacity (i.e. rooms reserved in the master plan) which is not scheduled to be used.
Some factors need to be taken into consideration when addressing the efficiency. On Monday and Wednesday afternoon a room is reserved for lung oncologists running late. Since no patients are planned during these consultation rounds, the efficiency becomes lower. On Friday afternoon a room is reserved for the three specialties for extra consuls. However, this room is never fully booked which lowers the efficiency as well.
All specialties have their share in the low efficiency. The medical oncology has an efficiency of 49% , the hematology 59% and the lung oncology 34% or 51% when not taking into account their reserved rooms for running late.
We can conclude that the efficiency is low and fluctuates. All specialties have their share in causing this.
Efficiency looks at the total scheduled appointment time. However, as will be shown in the following section, the total scheduled appointment time and the number of appointments are closely related. Since the number of appointments influences the patient flow, the following section will focus on the fluctuations in the number of appointments.

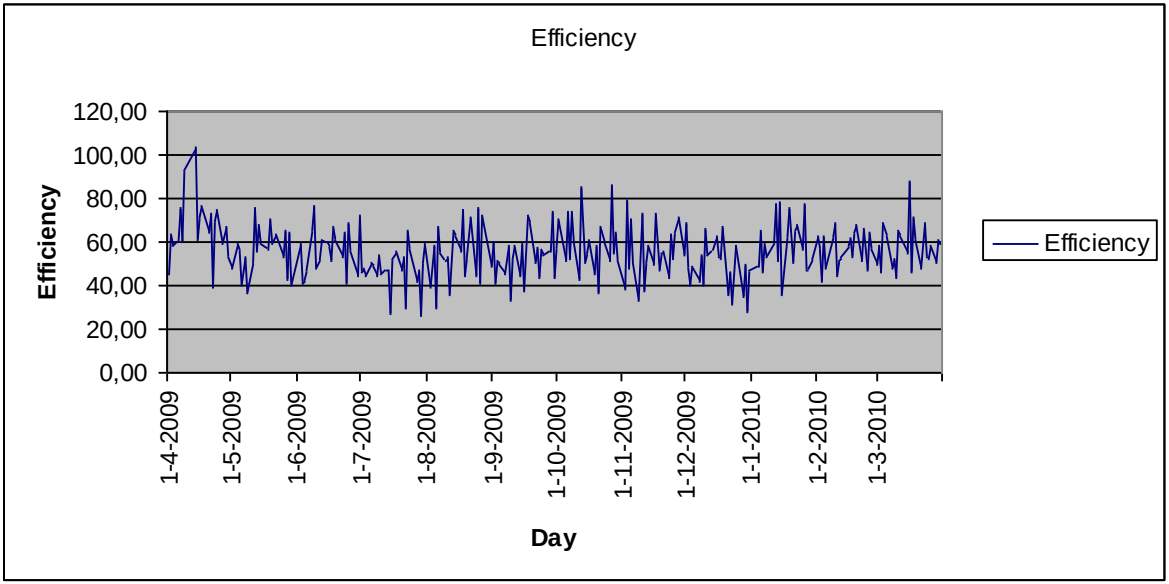


Figure 10 efficiency per day for the three specialties

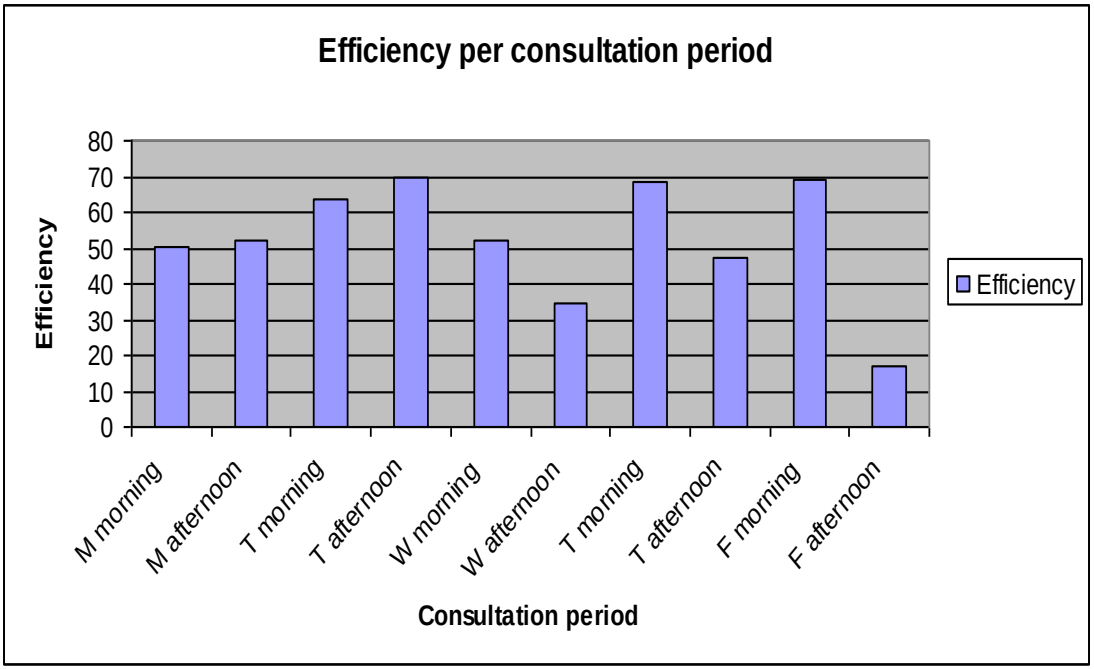


Figure 11 Efficiency per consultation period for the three specialties

	St. dev.	Min.	Max.
M morning	7	30	65
M afternoon	18	29	88
T morning	13	35	92
T afternoon	17	25	121
W morning	11	22	74
W afternoon	10	19	52
T morning	14	33	94
T afternoon	16	16	93
F morning	11	42	89
F afternoon	12	14	53

Table 2 standard deviation, minimum and maximum efficiency per consultation period for the three specialties

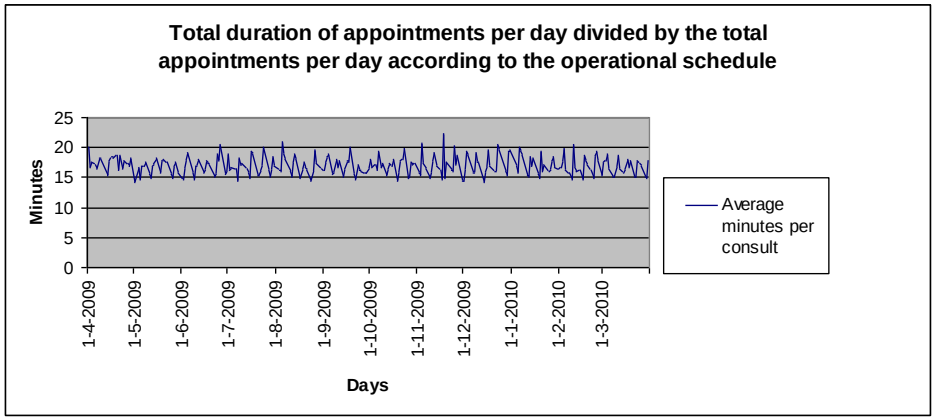
3.3.2 Fluctuations in scheduled use

This section will address the following sub question: What are the fluctuations in the scheduled use of capacity according to the operational schedule?

The scheduled use tells us more about the appointments scheduled. One can address appointments in two ways: the number of appointments or the duration of appointments. As will be shown below, these two are closely related. A high number of appointments leads to a high total duration of appointments. This is confirmed by the fact that the average time per consult per day barely fluctuates.

The duration of appointments has an effect on the efficiency as discussed in the previous section. The number of appointments influences the patient flow. Since the efficiency is already discussed, figure 13 will only discuss the number of appointments.
The first thing to note is the fact that during the mornings more appointments are scheduled than during the afternoons. Large fluctuations exist in the patient flow, not only between consultation periods but also between consultation rounds. For example, on Tuesday afternoon the average number of patients is 39 with a standard deviation of 10. This is not extreme, but with a minimum of 13 appointments and a maximum of 61, the peaks in the patient flow can be large.

We can conclude that large fluctuations exist in the scheduled use of capacity. The following section will discuss the causes of these fluctuations.



Average	16,99
Standard deviation	1,54
Min	14,24
Max	22,33

Figure 12 average minutes per consult per consultation day

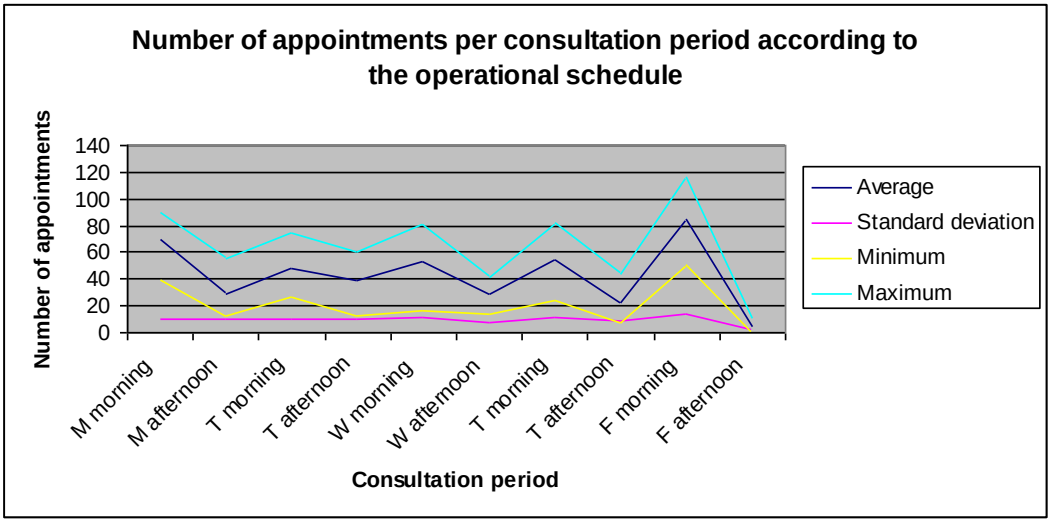


Figure 13 number of appointments per consultation period according to the operational schedule

3.3.3 Causes of fluctuations in scheduled use

This section will address the following sub question: *What causes the fluctuations in the scheduled use of capacity at the operational level?*

From a logistics point of view, in a perfect situation patients would be buffered at the gate to enable the outpatient clinic to create a smooth patient flow. Unfortunately, this is not possible since patients with cancer cannot wait very long to be seen. Since the demand fluctuates, the outpatient clinic has to deal with these incoming fluctuations. For new patients there is an access time of 8 days on average (st. dev.=12) which includes weekends and national holidays. Urgent patients are always seen the same day. Because the average access time is 8 days, there may seem to be a short waiting list. However, according to the care administrators this is not the case. When patients do not require an urgent consult, the appointment date is dependent of the availability of the patient and the consultation days of the treating specialist which leads to an average access time of 8 days. This access time enables the outpatient clinic to filter the patient flow to try to reduce the fluctuations since there apparently is some flexibility in scheduling appointments. Appointments are dependent on the availability of a specialist. Therefore, changing the consultation period of a specialist for example, would influence the patient flow during that period. First, a comparison will be made between the fluctuations in requested appointments and the fluctuations in scheduled appointments to see what impact the outpatient clinic has on fluctuations in the patient flow. Subsequently, several causes influencing the patient flow will be elaborated on.

The requested appointments have an average of 80 patients per day (st. dev.=15, min=53, max=154) and the scheduled appointments have an average of 89 patients per day (st. dev.=19, min=47, max=141). As can be seen in

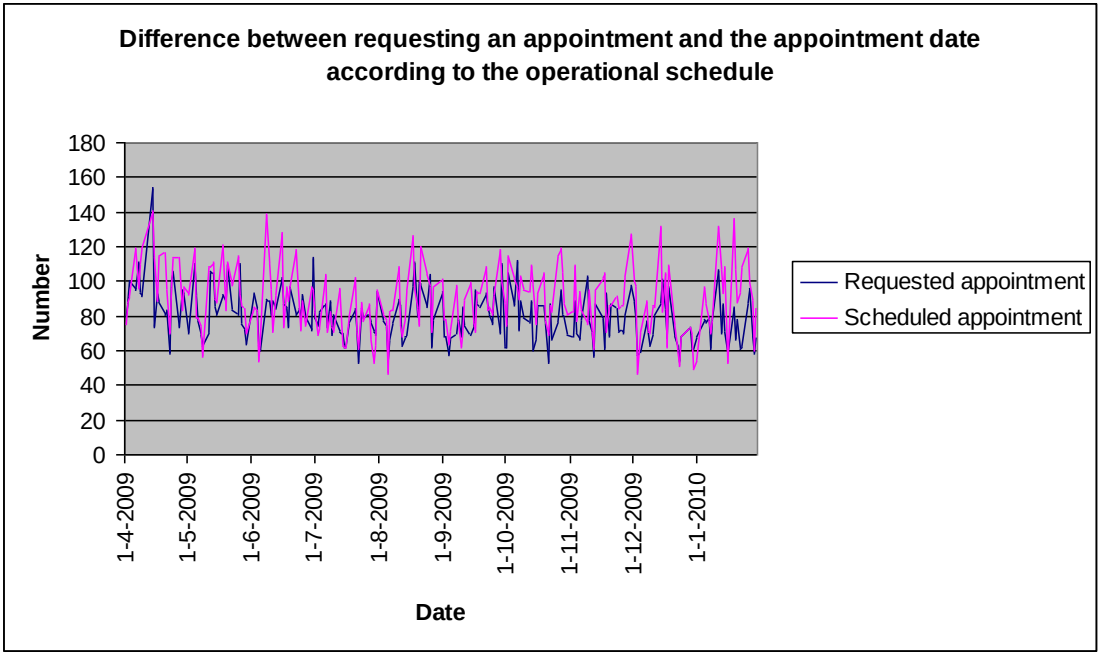


Figure 14 difference between requested appointment and scheduled appointment

figure 14 and in the numbers, the fluctuations in requested appointments compare to the fluctuations in scheduled appointments. Therefore, it can be concluded that the outpatient clinic does not lower the variability when scheduling appointments even though they have possibilities to do so, as will be discussed later in this section. The difference in average can partly be explained by the fact that scheduled appointments are sometimes requested before April 2009 or requested before February 2010 but scheduled afterwards. In these cases, the appointments are not involved in the measurements which lowers the average requested appointments.

The reason for not including February and March 2010 in figure 14 is the fact that the requested appointments which were scheduled after March 2010 could not be measured. Therefore, the measurements would not be representative including these months.

Fluctuations in the scheduled use of capacity are influenced by fluctuations in the requests for appointments. However, the outpatient clinic has some influence on the fluctuations in scheduled use as well. Below several factors will be discussed which influence the scheduled use of capacity and which can be influenced by the outpatient clinic. These factors are: the master plan, the planning, double bookings and extra or cancelled consultation rounds.

Master plan

Figure 15 a and b show the rooms reserved in the master plan and the total number of appointments per

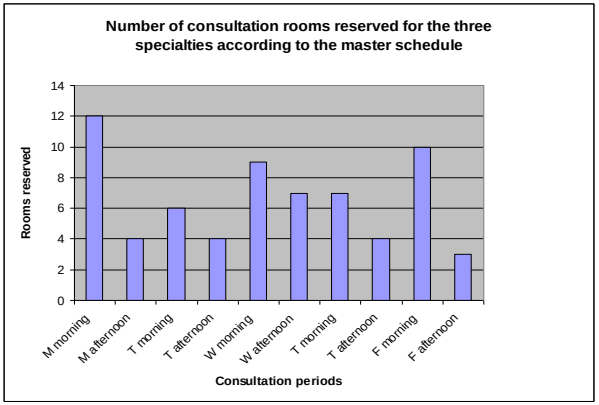


Figure 15a reserved consultation rooms

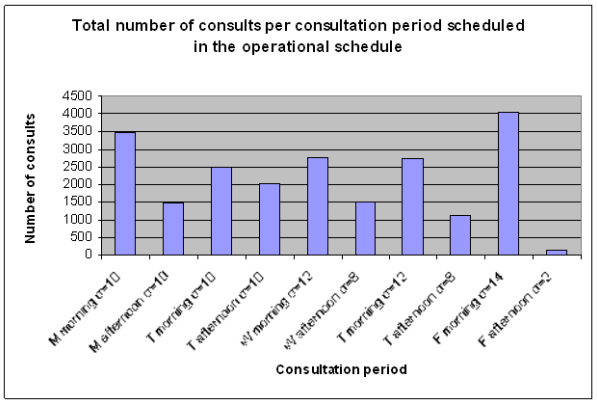


Figure 15b total number of consults

consultation period. When comparing these figures, one can see that they look similar. If in the master plan a lot of rooms are reserved during a consultation period, often a lot of consults are scheduled during that consultation period in the operational schedule. This shows that the planning at the master level has an influence on the scheduled appointments and thus the patient flow. The fact that on average the access time for new patients is 8 days makes this possible as it provides some flexibility when scheduling. Therefore, the outpatient clinic should not underestimate the influence of the master plan on the patient flows within a week.

Now it is clear that the master plan influences the patient flow, it is interesting to see whether the planning at the outpatient clinic increases the variability in the patient flow or not.

Planning

This part will investigate whether or not the planning increases the fluctuations in the scheduled appointments caused by the master plan. This is done by mapping the average number of patients per consultation period when this would be fully linked to the master plan (total number of appointments over the measured year/total number of consultation rounds over the measured year*rooms reserved per consultation period) and compare this to the average number of patients per consultation period in reality. Figure 16 a through c, shows the results of these measurements. When compared to the master plan, the figure clearly shows that at peak consultation periods in the master plan (Tuesday morning, Thursday morning and Friday morning) the average number of patients in reality is higher than would be expected according to the master plan. This means that when there is a peak in the master plan, this peak becomes even larger when appointments are scheduled. Thus, when the master plan would be leveled, the patient flow would still fluctuate caused by the planning.

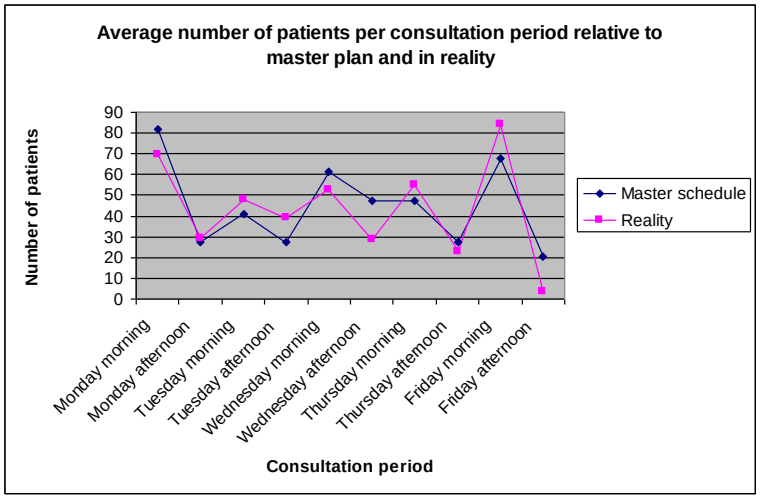


Figure 16a average number of patients per consultation period, master plan compared to reality

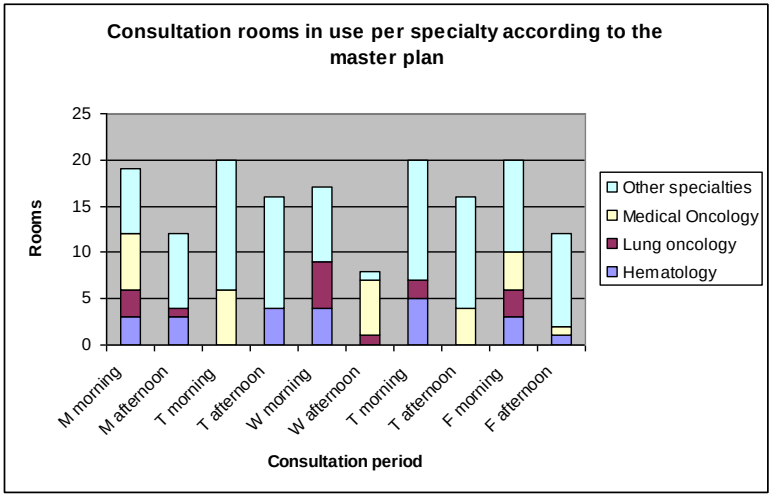


Figure 16 b consultation rooms in use per specialty according to the master plan

	Standard deviation reality
M morning	10
M afternoon	10
T morning	10
T afternoon	10
W morning	12
W afternoon	8
T morning	12
T afternoon	8
F morning	14
F afternoon	2

Figure 16 c standard deviation reality

However, when the average number of patients per consultation period is compared to the master plan which only takes into consideration the reservations of the three specialties (figure 15a), the conclusions are different. At peak consultation periods in the master plan of the three specialties (Monday morning, Wednesday Morning and Friday morning), the average number of patients in reality is only higher than would be expected according to the master plan on Friday morning. On Monday and Wednesday morning, the average number of patients in reality is lower than would be expected according to the master plan. Therefore, the three specialties do most of the time not increase their peak moments when appointments are scheduled. However, peak moments for the polyclinic are increased by the three specialties once appointments are scheduled.

These peak moments should be taken into consideration when scheduling appointments. Patients are somewhat flexible in the date and time of their appointment since the access time for new patients is 8 days on average. Therefore, flexibility exists to lower the variability in scheduled use within a week by planning patients during quiet consultation rounds. This can be done even more easily by patients who are very flexible such as yearly checkups. Another factor which should be taken into consideration when scheduling appointments is treatment patients. Since treatment patients need to be seen (early) in the mornings because they will visit the daycare center afterwards, it would be best to plan the other patients later during the day. When other patients are scheduled in the mornings as well, the mornings become very busy.
Now it is clear that the planning can increase peaks in the scheduled use created by the master plan, the following factor influencing the fluctuations in scheduled use will be discussed: double bookings.

Double bookings
Double bookings have an influence on the patient flow in a sense that they increase peak moments. When there is a peak in reserved rooms and scheduled consults, and at the same time a lot of double bookings are planned, it increases the peak in the patient flow. This again will have an influence on other sectors as will be shown in the next section. Besides this, a consultation round is more likely to run late when there are a lot of double bookings. Consequently, patients have to wait longer and the next specialist waiting for the room cannot start his consultation round because his scheduled room is still occupied.
In total 12.49% of all bookings are double bookings. At the Medical oncology 13.06% of all their consults are double bookings. At the Hematology this is 13.87% and at the Lung oncology it is 6.72%. What immediately stands out is the low percentage of double bookings at the lung oncology. This is the result of earlier research which indicated that their high amount of double bookings caused a lot of problems. This was researched at the beginning of 2009 (Bouterse & Joostens, 2009) after which measures were taken. The administration actively put a stop on double bookings. This seems to have somewhat worked since the double bookings at the lung oncology went down, from 317 in 2008 (Bouterse & Joostens, 2009) to 227 in these measurements, compared to the other two specialties where double bookings went way up since the research in 2008. However, the effect of the stop on double bookings is not very large.
When mapping the double bookings from the measured year, figure 17 comes forward.

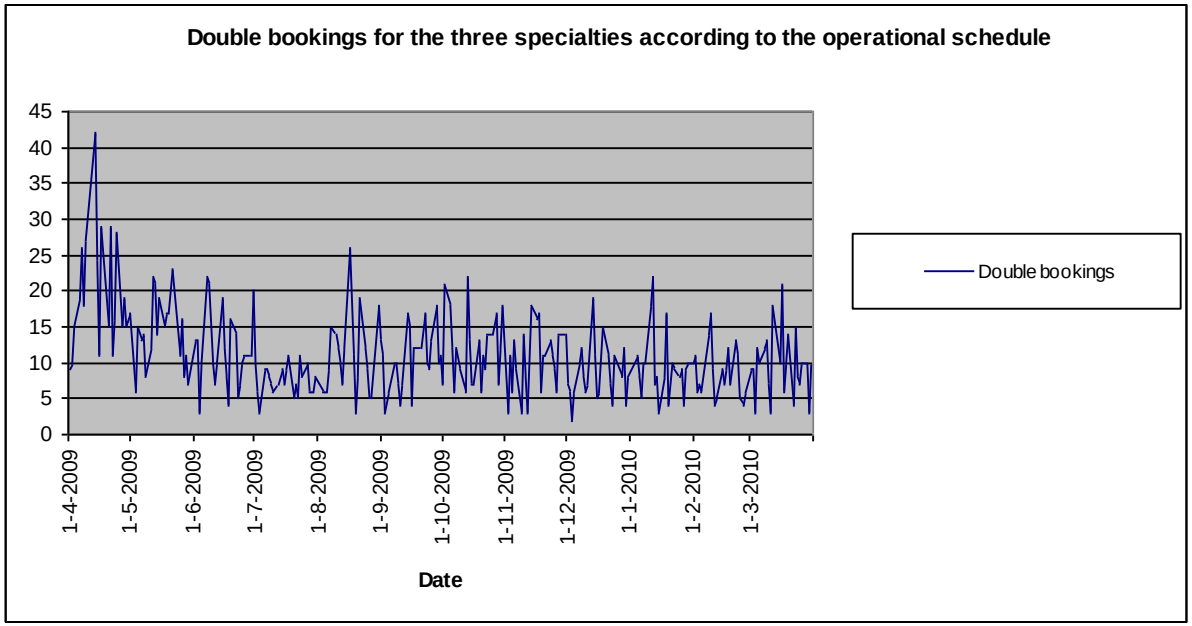


Figure 17 Double bookings for the three specialties

The average number of double bookings per day is 11 (st. dev.=6) and at the peak in April 42 double bookings are planned on one day. This is extreme and is most likely caused by the fact that the day before that peak was Easter. Since no appointments were planned during Easter and patients still needed to be seen and treated, the appointments were moved to the next day.
The reasons for all these double bookings are not completely clear. However, it seems that the patient flow and national holidays have a large impact. Fact is that this high number of double bookings should be lowered since it has unfavorable effects.
The following factor influencing the fluctuations in scheduled use is cancelled consultation rounds.

Cancelled consultation rounds
Cancelling a consultation round when there is a peak in demand, leads to an even larger peak during the next consultation round. Therefore, consultation rounds can best be cancelled at quiet moments. This prevents peaks in scheduled use from growing and it prevents consultation rounds from having a low efficiency due to a lack of patients. The total percentage of cancelled consultation rounds over the measured year is 12%. On average 1.6 consultation round is cancelled daily (st. dev.=1,3, min=0, max=7). Both in the mornings and in the afternoons consultation rounds are cancelled where the morning cancellations are especially interesting since they create available capacity when the rooms are often fully booked. When a consultation round is cancelled it should be

communicated well in order to enable another specialist to make use of the room.
At the outpatient clinic consultation rounds are cancelled when a specialist is absent due to vacation, a congress or other activities. Cancellations are thus known ahead of time. When a specialist is present, a consultation round is never cancelled, not even if only a few appointments are scheduled. The patient flow is thus not taken into consideration when cancelling consultation rounds.
The following factor influencing the fluctuations in scheduled use is extra consultation time.

Extra consultation time
The extra planned consultation time is 2.25% of the total scheduled consultation time over the measured year. The extra consultation time thus only forms a small part of the total consultation time. Extra consultation time can be scheduled when there is an increase in demand, when a patient needs to be seen on a day that the specialist does not have a consultation round, or when cancelled consultation rounds need to be rescheduled. With planning extra consultation time the demand is thus taken into consideration. However, since the extra time forms 2.25% of the total consultation time, it only has a small impact on fluctuations in the scheduled use.
We can conclude that the scheduled use is influenced by the requests for appointments. However, the outpatient clinic has a share in the fluctuating scheduled use as well with the master plan, the planning, double bookings and extra or cancelled consultation rounds.
Now all factors influencing the fluctuations in scheduled use are addressed, the consequences of these fluctuations will be discussed next.

3.3.4 Consequences of fluctuations in scheduled use

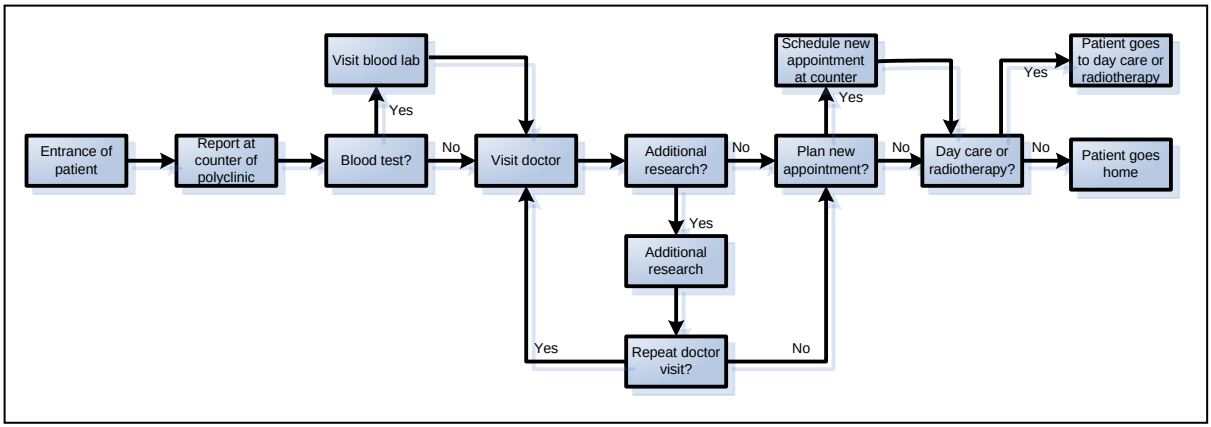
This section will address the following sub question: *What are the consequences of the fluctuations in the scheduled use of capacity at the operational level?*
There are several consequences of fluctuations in the scheduled use. Below the consequences at the operational level will be discussed.

To minimize the risk of capacity problems caused by unexpected events like longer procedure time, consultation room schedules should be developed that lead to smooth resource occupancies without peaks (Cardoen, Demeulemeester, & Beliën, 2009). This can be explained by the "Theory of Swift, Even Flow". In this article by Schmenner (2001) it is argued that the productivity of a process rises with the speed by which materials flow through the process and falls with increases in the variability associated either with the demand on the process or with the steps in the process itself. This is called the Theory of Swift, Even Flow. The more swift and even the flow of materials (or customers) through a process, the more productive is that process (Schmenner, 2004).
In case of the three specialties, the fluctuations in planned use (i.e. the number of reserved rooms at the master level) lead to unfavorable fluctuations in their scheduled use and thus their patient flow as shown in figure 15 a and b. According to the Theory of Swift, Even Flow this lowers the productivity and leads to unwanted effects. After all, variability in combination with overcapacity can lead to a quick flow. However, when one does not have the overcapacity, less variability should be created to remain a quick flow. First the effect of variability on capacity will be discussed, followed by the effect on the patient flow.
One effect of fluctuations in the scheduled use is unused reserved capacity (i.e. rooms which are reserved in the master plan). As could be seen earlier, there is never a point at which the efficiency is 100%. In theory this would mean that every day specialists have the chance to see more patients than eventually planned for, or that less consultation rounds are needed. Several reasons could be mentioned for not fully occupying a consultation round. For example, a lack of patients to fill a whole consultation round. Since, in most cases, rooms are reserved for a whole consultation round for one specialist, another specialist does not have the chance to make use of the left over capacity. It is a negative side of the rigid planning system that rooms can only be reserved for a whole consultation round. However, it is also partly caused by the fact that theory and practice widely differ. When a new planning system would allow specialists to share the use of a

consultation room during a consultation round, the planning would need to be very accurate to prevent overlap.
Another effect of fluctuations in the scheduled use is the fluctuating patient flow. First of all, it is good to get a clear overview of the processes a patient goes through to get an idea of what sectors are influenced by the fluctuating patient flow.

Figure 18 shows the different steps a patient takes when visiting the outpatient clinic. It should be apparent that medical care is delivered through a network of service stations, and that there is a potential for delay in multiple locations (Hall, 2006). When there is a high efficiency, it affects more elements than just the specialists consult. For example, when there is a sudden increase in patient arrivals, it means the blood laboratory rapidly has to run more tests. Since their effective capacity (i.e. the maximum output that can be expected under normal conditions) stays equal, it will take more time for the laboratory to deliver the test. This was confirmed by staff of the blood laboratory. Since 97.5% of all patients visit the blood laboratory, a temporary increase in this patient flow has immediate effects. Often the blood laboratory cannot process the large amount of patients and thus their results are delayed. This again has an effect on the consultation round since specialists cannot start their consults before the results are available. No exact numbers on the duration of the arrival of blood results are available. However, observations and informal talks all confirmed problems to occur which were caused by delays from the blood laboratory.
During the fully booked consultation rounds, the counter at the outpatient clinic is very busy as well. The administration can barely help all patients and when patients need to wait to report themselves before they can go the blood laboratory, a delay is already starting to build up. Also behind the scenes the administration has to deal with the large fluctuations in work pressure.
Besides the blood laboratory, more departments are influenced by the fluctuating patient flows such as the daycare center and the radiotherapy department. After their doctor's appointment, a lot of patients need to go to the daycare center or the radiotherapy department for medical treatment. When the consultation rounds are not leveled over the week, these departments have to deal with the fluctuations coming from the outpatient clinic. Also, when patients are seen late by specialists because blood results are not available, they will be late for their next appointment as well. Earlier research at the UMCG has

Figure 18 process chain



shown that this has a great impact on the occupation degree of the daycare center which highly fluctuates and is

hard to anticipate to. These fluctuations again influence other departments such as the pharmacy which needs to prepare all the chemos for these patients.
Figure 19 shows from each consultation period, how many patients needed to go to the daycare center over the measured year.

Especially Monday morning and Friday morning are very busy. When one compares figure 19 to figure 15b, it is clear that the total number of consults for the three specialties according to the operational schedule relatively corresponds to the number of treatments at the daycare center.

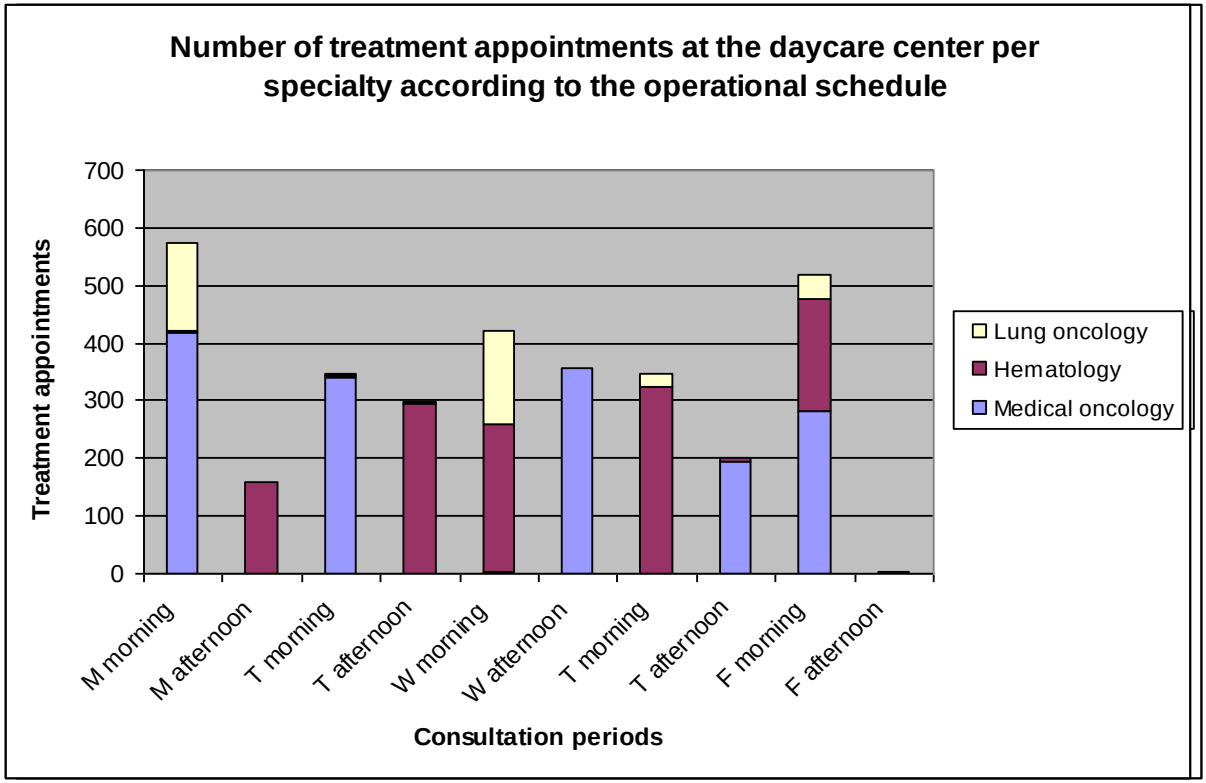


Figure 19 division of treatments appointments at the daycare center

Therefore, when the fluctuations in the scheduled use would be leveled, most likely the peak moments at the daycare center would be leveled as well.
Figure 20 shows the number of treatment appointment throughout the year to not only provide total amounts but to take into account seasonal fluctuations as well.

The average number of treatment appointments per day is 13 (stand. dev.=4). Even though the standard deviation is not extremely high, based on the minimum and maximum number of patients on a day the differences can be large

(min=3;max=28). 28 patients on a day only from the outpatient clinic, puts a very high pressure on the available effective capacity at the daycare center. The seasonal fluctuations in the number of treatment appointments look a lot like the fluctuations in the total number of appointments. This again shows that the number of treatment appointments is closely linked to the total number of appointments.No information is available on the number of patients that visit the radiotherapy department after visiting the outpatient clinic. According to specialists and the administrators, the pressure on this department is comparable to the pressure on the daycare center.
To conclude, a fluctuating scheduled use has large consequences. First of all, it leads to unused effective capacity. Second, it leads to problems at different steps in The blood laboratory can often not process the sudden increase in tests which leads to delays
in the results and thus the starting time of consults. This again leads to patients arriving late at their following appointment at for example the daycare center. This department is under high pressure to anticipate to the large fluctuations in patient flows just as the care administration and the pharmacy.

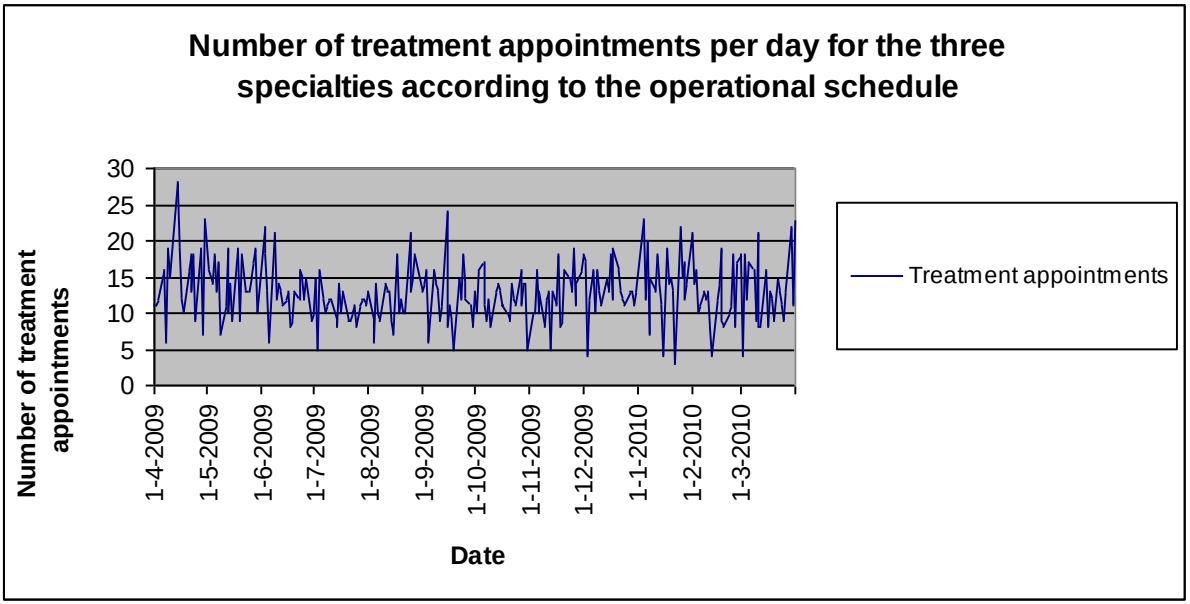


Figure 20 number of treatment appointments at per day for the three specialties

3.3.5 Conclusion

In paragraph 3.3 the second set of sub questions as defined in section 1.2.3 has been answered:

What is the efficiency of the reserved consultation rooms?
- What are the fluctuations in the scheduled use of capacity according to the operational schedule?
- What causes the fluctuations in the scheduled use of capacity at the operational level?
- What are the consequences of the fluctuations in the scheduled use of capacity at the operational level?

The conclusions are divided in the four sub questions. The main conclusions coming forward from the analysis are:

Efficiency
- The total efficiency for the consultation rooms scheduled to be used by the three specialties is 56% (st. dev.=12, min=26, max=104) which is remarkably low and fluctuates. All three specialties have their share in causing this. The utilization is only 37% (st. dev.=11, min=13, max=74) and thus even lower than the efficiency.
- There are some seasonal fluctuations in the efficiency influenced by cancelled consultation rounds and national holidays. In July there are some dips in efficiency due to the summer vacation and in April there is a large peak (104%) after Easter.
- The low efficiency on Monday and Wednesday afternoon is influenced by a room reserved for specialists running late.

Fluctuations in scheduled use
- During the mornings more consults are scheduled compared to the afternoons due to treatment patients.
- Large fluctuations exist in the scheduled use with averages between 3 (st. dev.=2) and 84 (st. dev.=14) patients per consultation period.

Causes of fluctuations in scheduled use
- The fluctuations in requested appointments compare to the fluctuations in scheduled appointments. Therefore, it can be concluded that the outpatient clinic does not lower the variability when scheduling appointments even though they have possibilities to do so.
- Several factors influence the scheduled use of capacity which can be influenced by the outpatient clinic: the master plan, the planning, double bookings and extra or cancelled consultation rounds. All factors will shortly be discussed below.
- The master plan has an influence on the scheduled appointments. The more rooms reserved in the master plan, the more appointments scheduled in the operational schedule.
- The three specialties do most of the time not increase their peak moments created by the master plan once appointments are scheduled. However, peak moments in the master plan for the polyclinic are increased by the three specialties once appointments are scheduled.
- Double bookings increase peak moments in the scheduled use. In total 12.49% of all bookings are double bookings.
- The total percentage of cancelled consultation rounds over the measured year is 12%. The demand is not taken into consideration when cancelling consultation rounds.
- The extra planned consultation time is 2.25% of the total consultation time over the measured year. The extra consultation time thus only forms a small part of the total consultation time.

Consequences of fluctuations in scheduled use
- Fluctuations in scheduled use lead to unused effective capacity
- A fluctuating scheduled use leads to problems at different steps in the patient flow. The blood laboratory can often not process the sudden increase in tests which leads to delays in the results and thus the

starting time of consults. This again leads to patients arriving late at their following appointment at for example the daycare center. The daycare center is under high pressure to anticipate to the large fluctuations in patient flows just as the care administration and the pharmacy.

The following paragraph will discuss the level of actual use.

3.4 Actual use

This paragraph will discuss the level of actual use. At the end of this paragraph the following set of sub questions will be answered:

- What prevented consultation rooms from being used efficiently while observing the consultation rounds?
- What is the actual use of capacity for the lung oncology and how can it be compared to the scheduled use?
- What is the actual use of the hematology and how can it be compared to the scheduled use?

The previous sections have shown how the use of the consultation rooms is planned and scheduled. However, for the planning to work, the reality has to be like this planning. To get an indication on whether this is the case, measurements were taken during some consultation rounds (blocks of 3,5 hours wherein consults take place). In week 21 (25th of May 2010 until the 28th of May 2010), the actual use of the consultation rooms was researched. The three specialties were not evenly measured since some specialists did not want to participate in the research. The lung oncology department however did participate. During their consultation rounds specialists marked all of their activities with a digital pen on a measuring form as shown in appendix F. This gave more insight in the specialist's activities during a consultation round and showed the duration of each activity. The measurements were taken to be able to indicate factors influencing the consultation rounds of specialists. Of course a general idea existed on what activities affected the progress of consultation rounds; however measurements were needed to prove these presumptions. The measuring forms were created together with the help of managers and specialists to make sure the most important activities were measured. The specialists kept their measuring form and digital pen with them during the whole consultation round and marked every new activity they started. The pen then digitally measured time. The results provided more insight in the time a specialist was actually with a patient and the time he was doing other activities. The hematologists were not willing to measure themselves and therefore, during five of their consultation rounds, their activities were measured for them according to the measuring form in appendix G. The insight this provided was not as extensive as the other measurements. However, the time a specialist was present in a consultation room was still measured as well as whether he was with a patient or not. Again, the results provided more insight in the time a specialist was seeing a patient and the time he was doing other activities.

The medical oncology was not measured at all since they did not want to participate in the research. The structure of paragraph 3.4 is shown in figure 21. This paragraph consists of three sections. Section 3.4.1 describes some observations during the consultation rounds. Section 3.4.2 discusses the results of the measurements during the consultation rounds of the lung oncology. Finally, section 3.4.3 discusses the results of the measurements during the consultation rounds of the hematology.

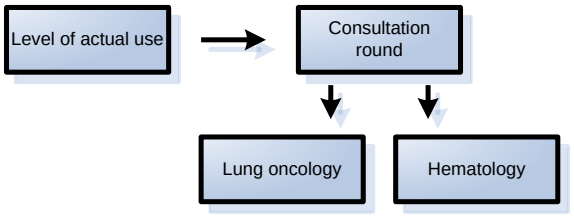


Figure 21 structure of analysis, level of actual use

3.4.1 Consultation rounds

This section will address the following sub question: *What prevented consultation rooms from being used efficiently while observing the consultation rounds?*

When observing the course of the consultation rounds, remarkable situations came forward. Even though these observations were made during a random sample of consultation rounds, they still bring forward interesting facts. In some cases situations that were described earlier actually occurred. In other cases, new facts came forward which is good to be aware of even though they could not be extensively researched.

Several times specialists complained about computers starting up slowly and the software application X-care which was not working. This all lead to consultation rounds starting late. Once the specialist was ready to see a patient, the results from the blood laboratory were frequently not available. Therefore, the specialist could not start the consultation round since blood results need to be available for nearly every patient. One striking point concerning the blood laboratory is the fact that they always start with a delay. This is caused by the outpatient clinic opening at 8am. Patients report at the administration desk before they get sent to the blood laboratory to get their blood tested. Tests takes 30 minutes in most cases. However, since patients do not arrive at the blood laboratory until 8.05 am or even 8.10 am, they are already late. This delay is even larger for the lung oncology. Most of the patients visiting a lung oncologist need extensive blood results which take 60 minutes to produce. This is not the case for new patients and 2nd opinion patients and they should therefore be planned at the start of the consultation round. However, this is not always done. This leads to major delays when blood results do not arrive until 9.00 am for patients planned at 8.30 am.

Around noon, when the first consultation round should be finished and the patients for the second consultation round arrived to get their blood tested, it was very crowded at the administration desk. The majority of the administrators went to have lunch at that time. Most often one of them stayed behind to serve the patients. However, since it was crowded from patients leaving the first consultation round needing a new appointment, and new patients arriving who needed to report themselves before they could go to the blood laboratory, waiting lines started to form. One person was switching between two desks and at the same time specialists arrived asking in what room they could have their consultation round. Therefore, between noon and 12.30 pm it was somewhat chaotic when the new consultation round started. Discussions arose over what room was available, what specialist was running late, and where new specialists could start their consultation rounds. There did not seem to be a clear overview of all rooms and specialists did not stick to their assigned rooms stated in the master plan. Eventually, situations occurred where a specialist wanted to start the consultation round but no room was available. Everything was there; the specialist, the patient, the blood results, but no available room. The fact that all this was observed does not mean it is like this every day. However, when discussing these observations with specialists and the administration, they confirmed this to occur regularly and to affect the efficient actual use of the consultation rooms.

To conclude, slow computers, delayed blood results and a chaotic situation between two consultation rounds, prevent the consultation rooms from being used efficiently. As stated at the beginning of this section, these are all observations and not results of measurements. However, they do provide insight in the situation and confirm situations to occur that were described in earlier sections.

3.4.2 Lung oncology

This section will address the following sub question: *What is the actual use of capacity for the lung oncology and how can it be compared to the scheduled use?*

In this section the results of the measurements during the consultation rounds of the lung oncologists will be discussed. The lung oncologists measured during their consultation rounds whether they were present in their consultation room and what they were doing. During one week, all consultation rounds of the lung oncologists were measured. This came to a total of only seven measured consultation rounds due to absence of specialists and a

national holiday. Some consultation rounds were planned to start late. In those cases, the planned starting time will be taken as the starting point of the measurements.
In two cases the consultation round started early or on time. On average the consultation round started 7,5 minutes late (st. dev.=11). However, in all cases the specialist was present at the outpatient clinic on time. Therefore, when a consult starts late, it does not necessarily mean that the rooms is empty during the first minutes of the consultation round. It means the specialist is busy doing things other than seeing patients or he/she is waiting for something. It is remarkable that none of the consultation rounds ended on time. Fluctuations in ending times have a great impact on the planning of the rooms. When specialists finish early, the room is reserved until the end of the consultation round and therefore, no other specialist is scheduled to exploit the room even though it is available. When a specialist finishes late it can have major effects as well. The afternoon consults cannot start until the morning consults are finished. When specialists are running late it also has an effect on the administration. When normally morning patients already left the outpatient clinic, they now need to be helped together with the afternoon patients. It is also unfavorable since patients have to wait longer when specialists are running late and patients may arrive late at their next appointment at for example the daycare center. However, one modification should be made here. When specialists know their room is not occupied during the next consultation round, they sometimes deliberately consult their last patient longer than planned for. The reason for this is that they want to take the time for a patient to offer a good service and they know that their delay will not have a negative effect on the next consultation round or another department.
As can be seen in table 3, specialists spend a lot of time on different activities. The fact that only 51% of the time a patient was consulted does not mean that the other activities do not belong in a consultation round. It is just good to be aware of the time different activities take. This enables one to indicate time consuming activities which can then tried to be reduced.

An example is preparation: some specialists prepare all their consults the day before while others do not. In some cases this is caused by the fact that the results needed for preparation are not available yet. In those cases, preparation needs to be done right before the consult in the consultation room. This lowers the efficient actual use of that room. When results would be available the day before the consult, specialists would need less time for preparation during their consultation rounds.

Activity	% of total time
Busy with a patient in the room	51
Preparation in the room	14
Picking up/bringing away patients not in the room	10
Remaining activities not in the room	6
Telephone in the room	5
Administration in the room	4
Remaining activities in the room	2
Waiting for a patient not in the room	1
Waiting for a patient in the room	1
Away from outpatient clinic	1
Request consultation in room	1
Giving advice/education in room	1
Waiting/calling for results of research in room	1
Giving advice not in room	1
Waiting/calling for results of research not in room	0
Receiving advice not in room	0

Table 3 results actual use lung oncology

When talking to specialists, they complained about blood results which are often not available on time. However, only

1% (st. dev.=1) of the total time of their consultation round specialists were waiting or calling for blood results. Therefore, when discussing the measurements, this does not seem the biggest issue. However, often while specialists are waiting for results they start doing other things like administration or seeing another patient. Therefore, the time they literally wait for the results seems short, but this is only because they start doing other things (which they normally might not have done) to stay busy. This makes it hard to conclude, based on these measurements, whether waiting for blood results delays the consultation round and the following patient processes. However, this can be concluded after our observations and talking to the specialists.
On average only 76% (st. dev.=30) of the total effective capacity (i.e. the maximum output that can be expected under normal conditions) was scheduled to be spent on consultation. Therefore, theoretically there would be enough room to see more patients. Since specialists are still often running late, it seems that the consult durations and the time spent on other activities are planned inaccurately. From the measurements it is often not clear how much time a specialist spent with a patient. This makes it impossible to draw a conclusion on the time that should be planned per type of consult.
To conclude, at the lung oncology on average consults started late and none of the consultation rounds ended on time. Time spend on time consuming activities, other than seeing patients, should tried to be reduced.
Now the results of the lung oncology are discussed, it is interesting to address the results of the hematology.

3.4.3 Hematology

This section will address the following sub question: *What is the actual use of the hematology and how can it be compared to the scheduled use?*
During the consultation rounds of the hematologists it was measured when they were present in their consultation room and when they were, whether they were with a patient or not. During one week, consultation rounds of the hematologists were measured. Only five consultation rounds were measured which had several causes. There was a national holiday, only one observer was available who could observe one consultation round at a time, and during some consultation periods none of the hematologists would have a consultation round planned.
In two out of five cases the consultation round started early or on time. This means that in the other cases it was starting late. On average the consultation round started 8 minutes late (st. dev.=6). However, in all cases the specialist was present at the outpatient clinic on time. One out of five consults ended on time. On average the consults ended 17 minutes late (st. dev.=12).

Activity	% of total time
In room with patient	68
In room without patient	22
Not in room	9

Table 4 results actual use hematology

As can be seen in table 4, hematologists spend quite some time without patients during their consultation rounds. However, it is not known what the hematologists were doing when they were not with a patient. Therefore, one cannot indicate time consuming activities which could be reduced. Neither is it possible to conclude from the measurements whether the scheduled time and the actual time per patient coincide.
On average only 90% (st. dev.=16) of the total effective capacity was scheduled to be used during the measured consultation rounds. Therefore, just as with the lung oncology, theoretically there would often be room to see more patients. However, since there is no waiting list at the outpatient clinic it is not possible to fill all consultation rounds.
To conclude, on average consults started late. One out of five consults ended on time and nothing can be said about real consultation times or time consuming activities which should try to be reduced.

3.4.4 Conclusion

In paragraph 3.4 the third set of sub questions as defined in section 1.2.3 has been answered:

- What prevented consultation rooms from being used efficiently while observing the consultation rounds?
- What is the actual use of capacity for the lung oncology and how can it be compared to the scheduled use?
- What is the actual use of the hematology and how can it be compared to the scheduled use?

The main conclusions coming forward from the analysis are:

Consultation rounds

- Consultation rounds started late because computers started up slowly or blood results were not available
- The blood laboratory always starts with a delay
- Extensive blood tests for the lung oncology take longer
- Between noon and 12.30 pm it is chaotic at the outpatient clinic
- Specialists do not stick to their assigned rooms

Lung oncology

- On average consultation rounds started late
- None of the consultation rounds ended on time
- Time consuming activities other than seeing patients should tried to be reduced
- Nothing can be said about real consultation times compared to scheduled consultation times.

Hematology

- On average consultation rounds started late
- One out of five consultation rounds ended on time.
- Nothing can be said about real consultation times or time consuming activities which should tried to be reduced.

These are conclusions drawn from the measurements of actual use. The outcomes are an indication, therefore more measurements are needed to be able to draw statistically justified conclusions.

4 Conclusion

This chapter will provide an answer to the main research question. This research question was stated as follows: *"How is the room capacity planned at the outpatient clinic for oncology focusing on the amount, the spread and the real use, what are the consequences of this planning on the utilization and availability of capacity and what recommendations can be provided to improve this utilization and availability of capacity?"*

In order to provide insight in the planning of capacity, three levels were distinguished starting with the master level, followed by the operational level and the level of actual use. The analysis was structured according to figure 4 on page 17. In this chapter, the main findings on the planning of capacity will first be discussed. Subsequently some recommendations for improvements will be provided.

Planning of capacity
As stated in the main question, this research is divided in three parts. First the amount of capacity will be discussed, followed by the spread in the use and lastly the real use. Subsequently, the consequences of the planning are formulated.

Amount
On the master level 20% of the designed capacity is still available. The complaint of having too little capacity is thus not grounded and stems from the fact that specialists request extra rooms at peak moments. According to the planned use, in a leveled situation only 7 rooms are needed to accommodate the three specialties. In the future situation, 38% of the designed capacity is still available on the master level.
Currently on the operational level only 56% (st. dev.=12, min=26, max=104) of the effective capacity is scheduled to be used which is remarkably low. The utilization is only 37% (st. dev.=11, min=13, max=74).

Spread
In the current and future situation all three specialties have an unleveled planned use based on the master plan and they all influence the total unleveled situation. The scheduled use on the operational level fluctuates as well. The fluctuations in requested appointments compare to the fluctuations in scheduled appointments. Therefore, it can be concluded that the outpatient clinic does not lower the variability when scheduling appointments even though they have possibilities to do so. One option is to lower the variability in the master plan which will lower the variability in the patient flow. Other possibilities are to lower the double bookings and to take demand into consideration when cancelling consultation rounds.

Activities in reality used for
On average all consultation rounds started later than planned. Causes were among other things computers starting up slowly and blood results which were not available. This is not strange since the blood laboratory always starts with a delay and the extensive tests for the lung oncology take longer than average. Consultation rounds starting late lead to specialists using the room for other activities while waiting. Time consuming activities other than seeing patients should tried to be reduced. Nothing can be said about real consultation times compared to scheduled consultation times.

Consequences
A fluctuating planned use at the master level leads to a fluctuating scheduled use at the operational level and thus to a fluctuating patient flow. This again leads to problems at different steps in the patient flow. The blood laboratory can often not process the sudden increase in tests which leads to delays in the results and thus the starting time of consults. This again leads to patients arriving late at their following appointment at for example the daycare center.

The daycare center is under high pressure to anticipate to the large fluctuations in patient flows just as the care administration and the pharmacy. Other effects are unused effective capacity and inflexible designed capacity. Peaks in the patient flow lead to chaotic situations between noon and 12.30 pm at the outpatient clinic as well.

Recommendations

Now the planning is described, recommendations will be brought forward to improve the planning and lower the effects of fluctuations. The recommendations will be presented using several subheadings.

Planning

- First, the dilemma of leveling. Since the situation is not leveled at the master level, the effects continue at the operational level and the level of actual use. Therefore, the master plan should be spread more evenly over the week to prevent peaks. When the consultation rounds are spread more evenly over the week for all specialties, it reduces the variability in the patient flow, lowers the number of rooms needed and makes capacity more flexible. One problem with leveling is the fact that more consultation rounds should be planned in the afternoons in the current situation as well as in the new situation. Treatment patients mostly need to be seen in the mornings and therefore other patients should be planned in the afternoons as much as possible to prevent double bookings in the mornings.
- When consultation rooms are reserved for a whole consultation round in the master plan and only a few short appointments are scheduled in the operational schedule, it leads to unused capacity which is unfavorable. Therefore, the master plan and the operational schedule should be linked. This makes the master plan less static and enables the operational schedule to schedule not only the appointments but the rooms as well. This way rooms can be assigned to specialists for a short time period instead of for a whole consultation round. It then gives the opportunity to another specialist to make use of the left over capacity. It will provide a clearer overview of the absence of specialists and it will enable the administration to reassign their rooms to others.
- A consultation room should never be reserved for specialists running late. The administration should rather make sure the planning is accurate which makes this unnecessary. When it is hard to make an accurate planning, for example when the consult duration of a specialist highly fluctuates, another option would be, when the master plan and the operational schedule are linked, to reserve a room for only part of a consultation round.
- One should prevent double bookings not only for the lung oncology but also for the other two specialties since it increases the patient flow at peak moments and thus the chance of a specialist running late.
- If there is some flexibility in planning an appointment, for example yearly check-ups, try to plan them during quiet consultation periods such as the afternoons.
- There exists a great difference between the scheduled consults at the operational level and the actual use. This leads to inefficient use of the rooms and specialists running late. Therefore, more insight should be created in the duration of different types of consults as well as the duration of other activities. The goal is then to make the planning more accurate and to optimize the efficiency of the rooms. As long as the planning is accurate, the outpatient clinic can use fewer rooms which have a higher efficiency. Insight in duration of consults and other activities to be able to make a more accurate planning should be created through more extensive measurements. This was not feasible in the current research since specialties were not willing to cooperate and it was only possible to measure one week. However, one should take into consideration the fact that on the one hand efficiency should be maximized as underutilized consultation rooms represent unnecessary costs. On the other hand, a consultation rooms that is fully planned without any time buffers is very unstable. The slightest change may cause high costs like patient deferrals and staff overtime (Cardoen et al., 2009). Therefore, it might be necessary to build in time buffers.

– When consultation rounds get cancelled or rescheduled, take into account the patient flow as much as possible. Thus, cancel consultation hours when the patient flow is small to prevent a low efficiency rate. Reschedule consultation hours when the patient flow is large and the current capacity is not sufficient. However, reschedule it to a quiet consultation period in the afternoons to spread the pressure on the outpatient clinic.

Blood tests

– Every day the blood laboratory starts with a delay when patients need to report themselves at the outpatient clinic at 8.00 am and do not arrive at the blood laboratory until 8.05 am. There are a few possibilities to solve this problem: the outpatient clinic has to open earlier to make sure the blood laboratory can start at 8.00 am, patients report themselves at the blood laboratory at 8.00 am without visiting the outpatient clinic, or patients should get their blood tested earlier. For example at their family doctor a day before visiting the specialist.
– Lung oncologists often need more extensive blood results than other specialties. These results take 60 minutes to prepare and can thus never be ready before 9.00 am. Therefore, patients for the lung oncology should not be planned until 9.00 am except for new patients and second opinions for which these extensive results are not needed.

Manager

– To make sure specialists do not run late and stick to their assigned rooms, one person should be in charge of the rooms at the new AOC. This person could also try to reduce the variability in the master plan for the problem is not that no capacity is available, the problem is that none of the specialists wants to/can change his planning to level the use. When the master plan is leveled, it will have effects on the operational level and the level of actual use as well. This leveling is harder than expected since it will affect other departments of the organization as well. After all, the consultation round might be rescheduled to a time when normally the specialist would be in a weekly sector meeting for example. This meeting then needs to be rescheduled as well. However, according to De Vries and Beijers (1999) it is important for hospitals not to focus on fragmentation but to work towards an optimal synchronization of activities and responsibilities between care professionals to optimize the logistic process. Hospitals then change from a function-focused entity to a more process-focused one. Since at this point nobody at the outpatient clinic is really in charge of the rooms, nobody can demand the specialists to switch their consultation hours and thus no changes are made.

Computers

– Finally, a recommendation which can prevent a consultation round from starting with a delay. Since specialists complained about computers starting up slowly and X-care which was not working, it is important to make sure X-care always works, to get computers which start up faster, or to let somebody from the administration start them up at 8 am to make sure they are ready to be used when the specialists arrive.

5 Discussion

This thesis contributed to the field of healthcare logistics by providing additional empiric knowledge on the subject of capacity utilization. The case discussed, gave a detailed insight in the decisions underlying the planning of capacity. However, this research has some limitations from which ideas for future research can be subtracted. First of all, the measurements of the actual use are limited. Only a few consultation rounds were measured at the lung oncology and the hematology. The medical oncology was not measured at all. This made it hard to draw statistically justified conclusions. Also, this research did not provide insight in the real consultation times compared to the scheduled times. Therefore, nothing can be concluded on whether the planning coincides with the real situation and how the planning should be adjusted to match the real use. Since the extensive measurements were only taken at the lung oncology, only little information is available on time consuming activities other than seeing patients. When more extensive information would be available, one could provide recommendations on what activities should be avoided or done by other people than the specialists. Therefore, more extensive measurements should be taken to create a better insight in the difference between the operational level and the level of actual use. Also, more insight should be created in urgent patients and the lead times of the blood laboratory to enable one to plan more accurately.

When one wishes more precise insight in the effects of the current fluctuations, the impact on the daycare center and the radiotherapy department should be researched more extensively. However, this was not the focus of this report. Finally, most insight is created in the current situation due to the fact that the head-neck oncology and the clinical genetic, which will be established at the new AOC, were not researched. When one prefers better predictions on the future use of capacity at the operational level and the level of actual use, these two specialties still need to be researched.

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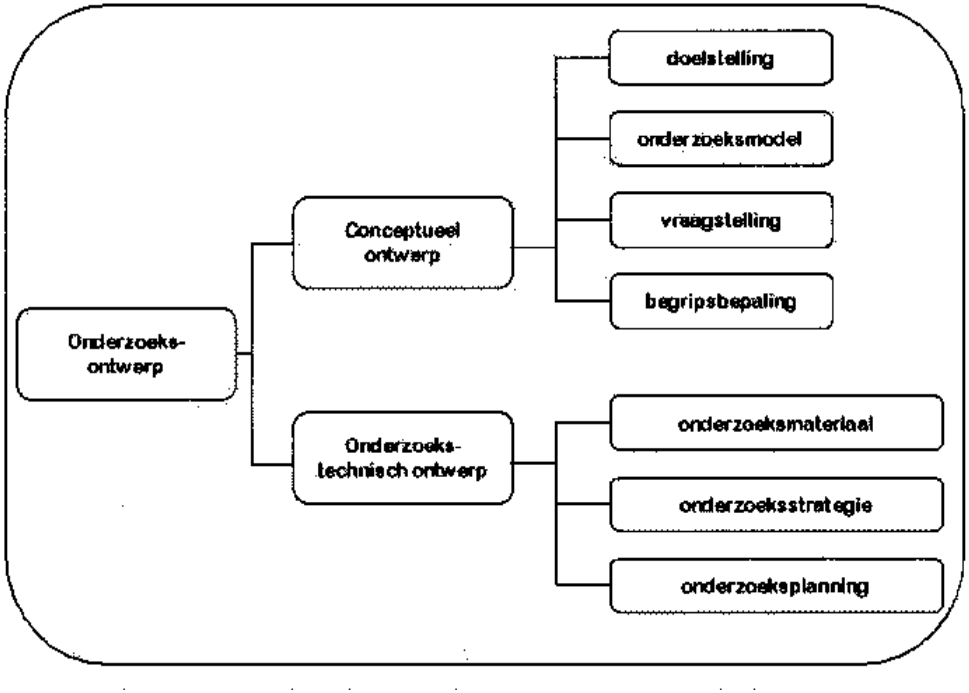
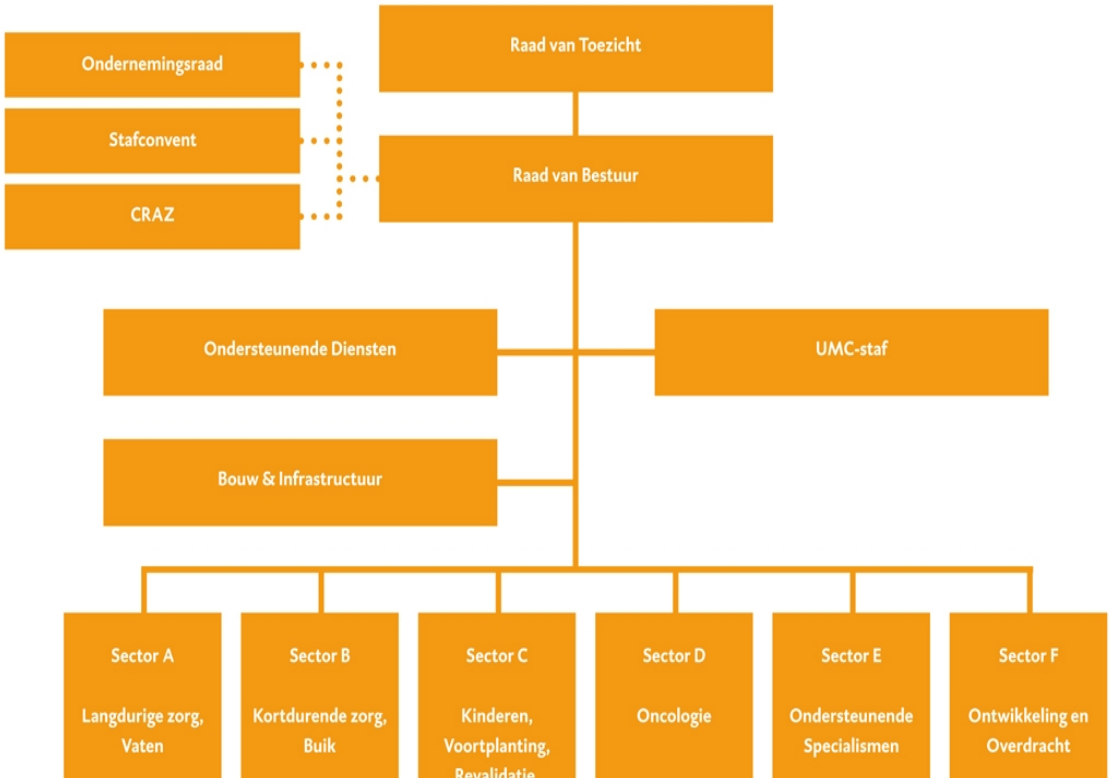
Appendix A Research design



Source: Verschuren & Doorewaard (2003)

Appendix B Organizational chart UMCG



Appedix C Artist impression of the new Ambulant Oncology Center

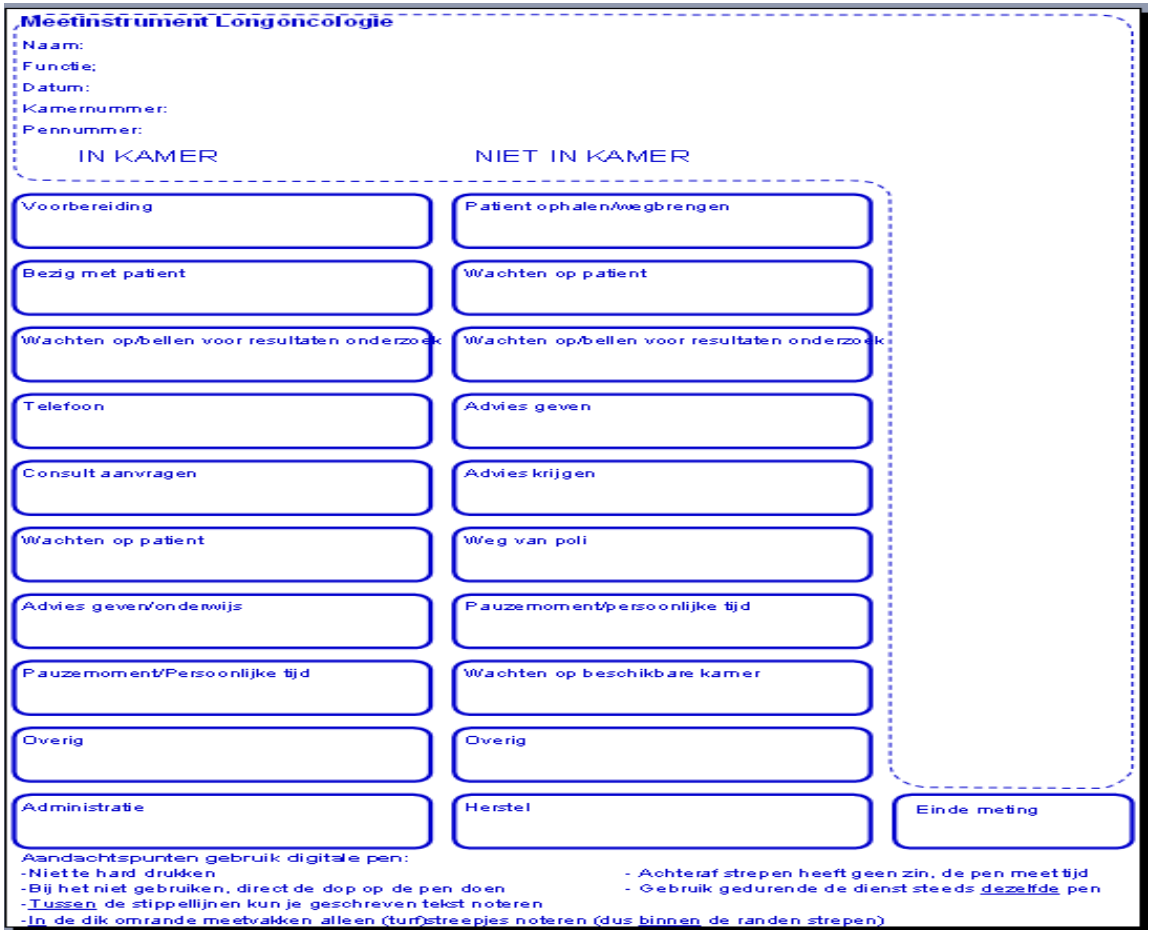
Appendix D The master plan

	maandag		dinsdag		woensdag		donderdag		vrijdag	
KMR	ochtend	middag	ochtend	middag	ochtend	middag	ochtend	middag	ochtend	middag
1			Oosting IAO		?? IHM i.o.	Schroder IAO	Roerig IHM	Siemerink IAO	IHMV	IAO/IHM/ILO
2	Hospers IAO	Span IHM	Walenkamp IAO	Huls IHM	Daenen IHM	Siemerink IAO	Kluin IHM	Mulder IAO	Huls IHM	Reker IHM
3	Reijners IAO	Daenen IHM	Gietema IAO	Vellenga IHM	IHMV	de Groot IAO	de Wolf IHM		Vellenga IHM	Hospers IAO
4	Vplo IAO	IHMV	Vplo IAO/IAO3	IHMV	de Waal IHM	Vplo IAO	IHMV/Tite Reker	Vplo IAO	Vplo IAO	
5	IAO3	ILO	de Groot IAO	van Imhoff IHM	Hiltermann ILO	Nuver IAO	van Imhoff IHM	IAO3	Bunskoek IAO	
6	Hiltermann ILO		Hypertensie	Bijl IKI	Groen ILO	Groen ILO	Ziengs ILO	Interne ALG.	de Vries IAO	
7	Kraan ILO		dinamap (da)	Kallenberg IKI	Ziengs ILO	IAO3	Corporaal IGH .	Reumatologie	Oosting IAO	
8	vd Berg OLT	Harkema IGH	IBD/OLT vpk		Lacor ILO		Harms IGH	Interne ALG.	Wachters ILO	Allergologie
9	Haagsma OLT	Koornstra IGH	Haagsma/V.d.Berg	Raki IKI	Stokroos ILO		Kleibeuker IGH	Laverman/Ozylmaz	Groen ILO	Allergologie
10	Ziengs ILO	staf MDL	vdr Wouden (a) IGH			Boonstra (st) INE	Stagist IGH	Jong/Niamut INE	Lacor	Allergologie
11	OLT verpl		Weersma IGH	lutgers IEN	Kerstens IEN		v.d. Horst IEN	Gansevoort/Mui	Boonstra INE	Allergologie
12	Meijer/Roelofs	Verburg IEN	Homan vd H. INT	Stagist IEN			GHDH IEN	v.d. Berg IEN	Westerh./Nap INE	v.d. Berg IEN
13	Arts IHT	Kerstens IEN	van Son INT	Wolffenbuttel IEN	Cepacia		Links IEN	v. Beek IEN	Van Son INT	Kerstens IEN
14	Arts IHT	Dullaart IEN	de Maar INT	keuring voor nbc	R. Georg Inf		Stek IAI/INF	v.d. Klauw IEN	Homan vd H. INT	v.d. Klauw IEN
15	Sprenger (IAIP)		Seelen INT	keuring voor nbc	P.v.d. Meulen NP		v. Assen (IAI)	Interne ALG.	de Maar INT	Hoving NEA
16	R. Georg NP INF		Dijkstra/vd Heide IG	keuring voor nbc	v. Assen INF		P.v.d.Meulen NP		Seelen INT	
17	v. Leeuwen INF		Esther Meyer cysteni	keuring voor nbc (v)	1x p/mnd HIVfam		Sprenger INF		Diëtiste pré-dial.	
18	Reker (v) IHM		Bunskoek IAO				Kraan ILO		**W. van El**	
19	Tuinier IAO	juco	Bakker INT O *	juco	juco		juco	juco	**INTP juco**	juco
20	Netters IAO	juco	Juco Lipi 1	juco	Juco Lipi 1		Juco Lipi 1	juco	INTPjuco	juco

Appendix E Vocabulary

Vocabulary	
Actual use	How a consultation room is used in reality.
Bottleneck	Bottlenecks limit the capacity of the overall process (Waters, 2002).
Capacity	The maximum output that can be achieved in a given time (Waters, 2002).
Consult	A specialist meeting with a patient.
Consultation period	A weekly time period in which consultation rounds take place. For example, Monday morning.
Consultation round	A block of 3,5 hours wherein consults take place.
Designed capacity	The maximum output that can be achieved in ideal circumstances (Waters, 2002).
Directed informal talks	Informal talks the researcher has with informants. The researcher directs these talks to ensure the right question is answered (Verschuren & Doorewaard, 2003).
Effective capacity	The maximum output that can be expected under normal conditions (Waters, 2002).
Efficiency	The ratio of actual output to effective capacity (Waters, 2002).
Future master plan	Master planning for the new AOC showing a general planning per specialty but not defined per specialist.
Level of actual use	The third level of analysis in this research using observations and measurements from the measuring week.
Master level	The first level of analysis in this research using the master plan.
Master plan	Planning that shows when specialists have a room reserved for their consultation hour (see appendix D).
Operational level	The second level of analysis in this research using the operational schedule.
Operational schedule	A detailed schedule with patient appointments. The consultation round of each doctor is subdivided in different time slots for appointments.
Planned consult time	Time that is scheduled for a consult in the operational schedule.
Planned use	The number of reserved rooms at the master level.
Reserved	Rooms which are reserved in the master schedule, the reserved consult time is the total time these rooms are reserved.
Scheduled use	The scheduled consult time at the operational level.
Utilization	The ratio of actual output to designed capacity (Waters, 2002).
σ	Standarddeviation.

Appendix F Measuring form lung oncology



Meetinstrument Longoncologie

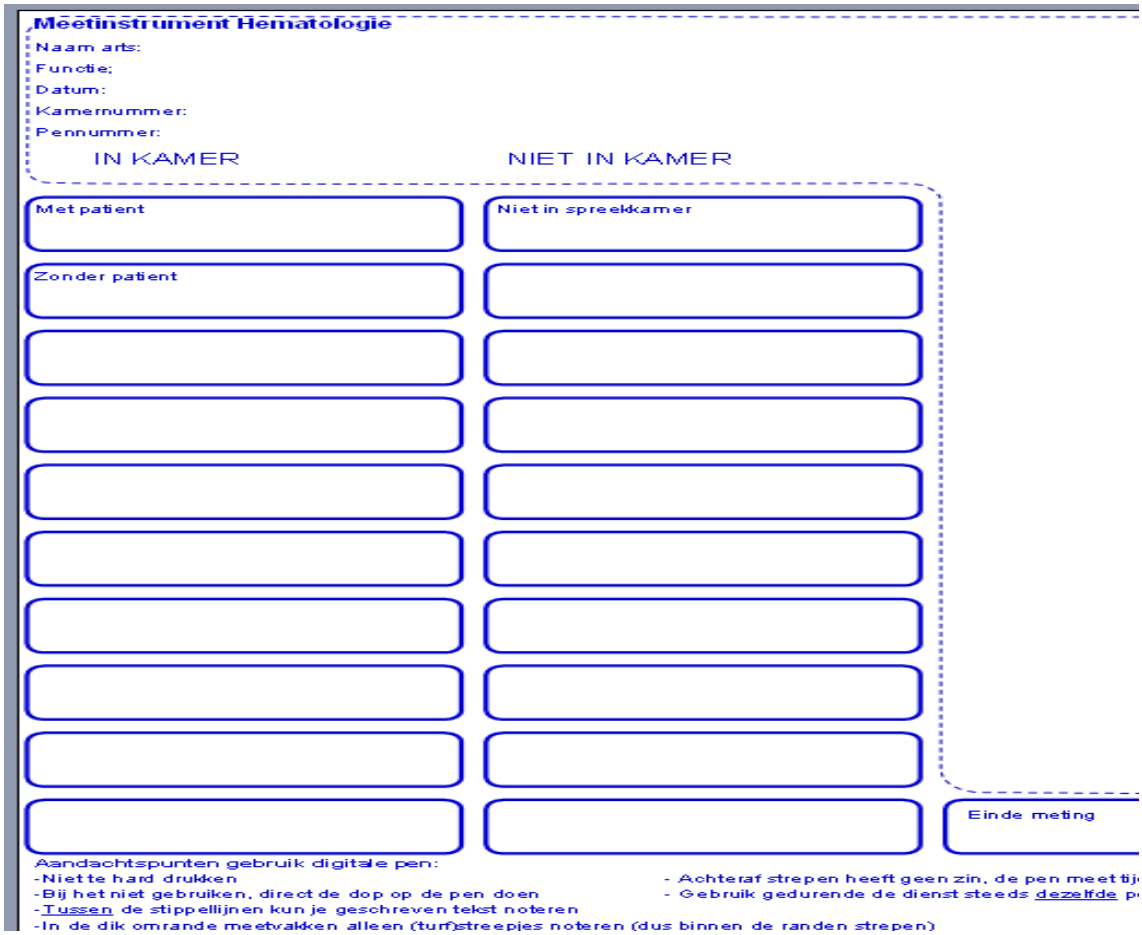
Naam:
Functie:
Datum:
Kamernummer:
Pennummer:

IN KAMER	NIET IN KAMER
Voorbereiding	Patient ophalen/wegbrengen
Bezig met patient	Wachten op patient
Wachten op/bellen voor resultaten onderzoek	Wachten op/bellen voor resultaten onderzoek
Telefoon	Advies geven
Consult aanvragen	Advies krijgen
Wachten op patient	Weg van poli
Advies geven/onderwijs	Pauzemoment/persoonlijke tijd
Pauzemoment/Persoonlijke tijd	Wachten op beschikbare kamer
Overig	Overig
Administratie	Herstel

Einde meting

Aandachtspunten gebruik digitale pen:
-Niet te hard drukken
-Bij het niet gebruiken, direct de dop op de pen doen
-Tussen de stippellijnen kun je geschreven tekst noteren
-In de dik omrande meetvakken alleen (turf)streepjes noteren (dus binnen de randen strepen)
- Achteraf strepen heeft geen zin, de pen meet tijd
- Gebruik gedurende de dienst steeds dezelfde pen

Appendix G Measuring form hematology



Meetinstrument Hematologie

Naam arts:
Functie:
Datum:
Kamernummer:
Pennummer:

IN KAMER	NIET IN KAMER
Met patient	Niet in spreekkamer
Zonder patient	
	Einde meting

Aandachtspunten gebruik digitale pen:
-Niet te hard drukken
-Bij het niet gebruiken, direct de dop op de pen doen
-Tussen de stippellijnen kun je geschreven tekst noteren
-In de dik omrande meetvakken alleen (turf)streepjes noteren (dus binnen de randen strepen)
- Achteraf strepen heeft geen zin, de pen meet tij
- Gebruik gedurende de dienst steeds dezelfde p