CHALMERS
UNIVERSITY OF TECHNOLOGY

Managing waiting lists at an outpatient clinic by improving the production planning process

Master's thesis in Quality and Operations Management and Supply Chain Management

SIMON ERIKSSON

LINDA TEDENBRANT

Department of Technology Management and Economics
Division of Logistics and Transportation
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2015
Report number, E2015:082

REPORT NO. E2015:082

Managing waiting lists at an outpatient clinic by improving the production planning process

SIMON ERIKSSON

LINDA TEDENBRANT

Department of Technology Management and Economics
Division of Logistics and Transportation
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2015

Managing waiting lists at an outpatient clinic by improving the production planning process

SIMON ERIKSSON
LINDA TEDENBRANT

Technical report no E2015:082
Department of Technology Management and Economics
Division of Logistics and Transportation
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone + 46 (0)31-772 1000

Printed by Chalmers Reproservice
Göteborg, Sweden 2015

Abstract

Waiting lists at hospitals are becoming an increased problem in Swedish healthcare. The requirements of efficiency at healthcare clinics increase further with political pressure of providing appointments within 90 days to all patients who seek specialized care. The gynecological outpatient clinic at Skaraborg's hospital in Skövde is one of the Swedish clinics experiencing difficulties regarding the waiting list situation. It has been shown that an improved production planning and control (PPC) process can ease the waiting list situations in terms of increasing the controllability. The gynecological outpatient clinic at Skaraborg's hospital in Skövde has therefore requested some improvement suggestions regarding the PPC process as means to control the waiting list situation in order to enable the clinic to sustain waiting lists within target levels. The purpose of this study is to provide such improvement suggestions.

The study was conducted through gathering of data about the current PPC process at the gynecological outpatient clinic, by studying a different PPC process at another outpatient clinic at Skaraborg's hospital, and by literature studies. The current PPC process was mapped and an analysis of the current situation was conducted. The analysis revealed six main problem areas in the current PPC process. The first three problem areas found were related to poor ability to adapt lower level planning with upper level planning, to lacking of a short term planning method and to planning based on the available staff rather than the requested staff. The other three problem areas were found within supporting functions of the PPC process. One was related to poor forecasting ability, one to poor considerations of care requests when planning and one to poor waiting list prediction ability. The problem areas then acted as a basis to generate improvement suggestions.

An improved PPC process was suggested in which capacity planning was suggested to be based on capacity requirements, created by patient demand. Improved forecasting in combination with better information quality of care requests was also recommended. These changes would allow the clinic to foresee the capacity requirements and the development of the waiting list and thus provide the clinic with ability to react in time and, by doing so, control the waiting list levels. The improvement suggestions were critically evaluated and further studies were suggested to support the potential implementation of the improvement suggestions.

Keywords: *PPC in healthcare, production planning, waiting lists, waiting list control*

Acknowledgements

This thesis has been carried out during the spring 2015 by two students from Chalmers University of Technology, one from the Master's program of Quality and Operations Management and one from the Master's program Supply Chain Management. The thesis has been conducted in collaboration with the gynecological outpatient clinic at Skaraborg's hospital in Skövde.

Our sincerest appreciation goes to Mats Johansson who has not only supported the study as supervisor, but also as the person who made this thesis possible by bringing the authors and Skaraborg's hospital together. We would like to express great gratitude to the gynecological outpatient clinic at Skaraborg's hospital in Skövde, thank you for having us. A special thank you to Iris Wikström and Pernilla Käll who have contributed greatly to the study with their experiences, knowledge and devotion.

We hope that this thesis will support the gynecological outpatient clinic in Skövde to in the long run gain sustainable waiting list control by improving the production planning and control process.

Simon Eriksson and Linda Tedenbrant

Gothenburg June 3, 2015

Contents

1 Introduction

Sweden's healthcare system performs very well according to several performance indicators, such as life expectancy and cancer survival rates (OECD, 2013). However, when compared to other European countries, waiting times for treatment in Sweden are highly problematic (Health Consumer Powerhouse, 2015). During the last decades the problems with long waiting times for patients, resulting in long waiting lists for hospitals, have increased (Hanning and Spångberg, 2000).

1.1 Background

Waiting lists occur when healthcare demand exceeds supply (Kosnik, 2006). In healthcare, demand is represented by patient requests for care and supply is commonly seen as the capacity or the resources available. To match demand and supply in a healthcare setting is considered a complex task since healthcare professionals have evolved in silos with focus on individual needs and expertise without realizing the importance of the overall system (Kosnik, 2006). It has been proven that correct matching of supply of caregivers to patient demand affect patient safety, patients' perceived care quality and also the satisfaction of care providers (Litvak et al., 2005). Incorrect matching on the other hand can cause long patient waiting times, creating several different societal problems; lower quality of life from a health perspective (Derrett et al., 1999), absenteeism from work cause costs for society (Hoel and Sæther, 2003), dissatisfaction from both healthcare practitioners because of high work load and from patients who feel neglected (Risberg, 2014; Aujalay, 2012).

Problems with long waiting lists and waiting times are discussed in Swedish media and politicians are pressured by the Swedish citizens to solve these problems (Hesselius, 2014). Reforms have been constructed as means to address these problems to try to control the availability. The care guarantee is the greatest example of this and it was introduced as a statute in 2010, regulating the maximum waiting time to 90 days for all patients in Sweden with a referral to a specialist (SFS 2014:349).

The idea of a maximum waiting-time guarantee came from the UK and was introduced in Sweden in 1992 (Hanning, 1996). In 2010 the care guarantee became statute and included four types of waiting time regulations that all counties should follow (SFS 2014:349): 1) Availability guarantee – The same day as a person seeks care at a primary care clinic the person should be able to contact this primary care clinic, either by phone or by a visit. 2) Visit guarantee primary care – A person who sought care at a primary care clinic should see a doctor within seven days if the contact at the care clinic determines the person to be in need of medical care. 3) Visit guarantee special care – The patient have the right to see a specialist within 90 days from a physician's referral or, if no referral is necessary, has him- or herself contacted the special care clinic. 4) Treatment guarantee – The patient is entitled to treatment within 90 days from the decision from the physician that treatment should be conducted. Furthermore, it also includes a paragraph that forces all hospitals and care providers to report the current waiting times into a national system (SFS 2014:349).

Since 2010 the healthcare policies to decrease waiting times have increased further with the queue billion (translated from Swedish *kömiljarden*) and a new patient law. The queue billion was introduced in 2008 (Lövtrup, 2008). All care units that were able to follow the rules of the care guarantee were given a share of a billion SEK that the government had put away into the queue billion as a means to shorten the waiting times (Hansson, 2014). The incentive of the queue billion was thus money to put in the organization but instead of giving the poorest performing hospitals the most money the queue billion instead privileged the best performing hospitals (Lövtrup, 2008). Other criticism aimed at the care guarantee and the queue billion is the fact that it only includes first time visits (Hansson, 2014).

The patient law was updated in January 2015 including possibilities for patients to choose public healthcare providers and open special care providers all over Sweden (Sveriges Kommuner och Landsting, 2014). Freedom of choice regarding care provider can help to even out the waiting lists at hospitals, thus reducing the variations in waiting times for patients and providing care on a more equal basis (Dawson et al., 2004)

In the Swedish healthcare system, the provision of health care is the responsibility of 21 county councils or regional councils. Region Västra Götaland runs four hospital groups, one of which is Skaraborg's hospital. Skaraborg's hospital, in turn, consists of four hospitals located in Skövde, Lidköping, Falköping and Mariestad. Skaraborg's hospital provides all forms of specialized care, employs about 4 200 people and had 378 000 out-patient and 37 070 in-patient episodes in 2014 (Västra Götalandsregionen, 2015b). Skaraborg's hospital is one Swedish hospital where problems with long waiting lists are a reality. At the gynecological outpatient clinic several projects have been conducted to reduce the waiting lists. Even though the projects somewhat ended up in positive results the problems reoccur and the solutions have thus not proven sustainable.

1.2 Problem description

The gynecology outpatient clinic at Skaraborg's hospital is struggling with long waiting lists. Several attempts have been made to shorten the waiting time for patients to get an appointment at the department. Even though the attempts have been considered successful, they have been conducted as punctual efforts and have so far not proven to be able to sustain short waiting times. Once the punctual efforts stop, the waiting lists increase. Problems with matching patient demand with available supply, in terms of capacity, are mentioned as an underlying cause. The gynecological outpatient clinic is interested in improvement suggestions based on changes in the production planning and control (PPC) processes to reduce their waiting list problem.

1.3 Purpose

The purpose of this master's thesis is to provide improvement suggestions concerning the production planning process at the gynecological outpatient clinic at Skaraborg's hospital in order to enable the clinic to sustain waiting lists within target levels.

The current production planning process at the gynecological outpatient clinic will be assessed in order to find possible problem areas. The areas will then be further subjects to improvement suggestions regarding the production planning process. The improvement suggestions should improve the ability to sustain waiting lists within target levels. The waiting lists' target levels will be determined by the production goals and the ability to react to increased or decreased inflow of patients to the waiting lists.

1.4 Research questions

It has been found that waiting lists can be reduced by improved production planning (Smeds, 2011). However, to improve a production planning and control (PPC) process there needs to exist some improvement potential. As a first step to understand if the current PPC process at the outpatient clinic has any improvement potential, the first research question will regard examining the current PPC process at the outpatient clinic.

- *What is the current PPC process at the outpatient clinic?*

The PPC process at the outpatient clinic will be mapped to clearly illustrate different activities being carried out at different stages in the process. Once the current PPC process is mapped, the next step is to find out in what ways the current PPC process contributes to causing the waiting list problems experienced by the outpatient clinic. The second research question is thus:

- *How does the current PPC process contribute to the waiting list problems?*

In order to understand what improved production planning means it seems reasonable to firstly explore how PPC processes are usually carried out and what makes the processes successful. The purpose of the thesis is to provide improvement suggestions for the PPC process. After finding the contribution of the current PPC process to the waiting list problems, the next step is to investigate how the current PPC process can be improved. The third and final research question is thus:

- *How can the current PPC process be improved?*

Since the purpose of the study is to find out how the waiting lists can be managed by an improved PPC process, the relation between a PPC process and waiting list problems needs to be learned.

1.5 Scope and delimitations

This study has been conducted in cooperation with the gynecological outpatient clinic at Skaraborg's hospital. The purpose is explicitly to find improvement suggestions suitable for this specific gynecological outpatient clinic. The approach to find the improvement suggestions was conducted by studying literature about PPC processes in manufacturing and in healthcare, gaining information about another PPC process used at a dermatological outpatient clinic and finding problem areas in the current PPC process used at the gynecological outpatient clinic.

The information about the PPC process at the dermatological outpatient clinic was given through an interview with the unit manager of the dermatological outpatient clinic at Skaraborg's hospital in Skövde. The main reason for conducting the interview was the possibility to gain knowledge about what PPC processes at other outpatient clinics can look like. The PPC process at the dermatological clinic was considered highly successful by several of the managers at the hospital and was therefore considered suitable also from an improvement aspect. The information about the PPC process at the dermatological outpatient clinic also contributed to finding improvement suggestions for the gynecological outpatient clinic because of its relevance in terms of being applied at Skaraborg's hospital.

The gynecological outpatient clinic is one of several clinics operated by the women's health unit. Therefore, some control of the PPC process steps affecting the gynecological outpatient clinic are regarded at higher hierarchal levels, which the outpatient clinic cannot change. The PPC process steps regarded for improvement subjects are thus only the ones actually conducted at the gynecological outpatient clinic itself.

The study is only conducted to supply improvement suggestions related to the PPC process steps conducted at the gynecological outpatient clinic. Therefore, the implementation of the improvement suggestions is only discussed in terms of what resources would be necessary and what the improvement suggestions could result in if implemented. How the implementation of the improvement suggestions generated could be conducted is recommended to be investigated separately since implementation constitutes a large challenge itself, as is always the case with change.

1.6 Outline of the report

The report is structured using 7 main chapters. The first chapter is an introduction to why the subject of controlling waiting lists is desired. It includes background information about the subject and a problem description and aim for the study conducted. The second chapter describes the theory studied for the thesis and presents information about PPC processes with specific focus on the capacity planning perspective. The theory is summarized in a theoretical framework that will be used as basis for the investigation of the improvement suggestions related to PPC. The third chapter is the method in which further information about how the study has been conducted, and what research questions that have been used, are presented.

The fourth chapter is a presentation of the current situation at the gynecological outpatient clinic in terms of PPC process and waiting lists. The fifth chapter provides an analysis of the current situation. Some potential problem areas are localized and investigated. The sixth chapter then provides a resulting PPC process improvement suggestion based on the analysis of the current situation. The improvement suggestion has several dimensions and some supporting activities are presented and recommended. The seventh chapter is a discussion of the improvement suggestion found including a

recommendation for future actions for the gynecological outpatient clinic to change the current PPC process. The report then ends with a conclusions chapter.

2 Theoretical framework

This chapter describes the theory studied which led to the creation of the theoretical framework upon which this study is based. Section 2.1 describes the field of production planning and control in its general principles. Section 2.2 describes a PPC framework adapted to healthcare settings, which was chosen as the core of the theoretical framework. Section 2.3 describes a number of techniques and methods for matching supply and demand. Section 2.4 describes barriers that exist when applying PPC in healthcare, as healthcare has certain special characteristics. The resulting theoretical framework is presented in section 2.5.

2.1 Production planning and control (PPC)

Production planning and control (PPC) originates from the production industry where planning has been used as means to reach production goals for decades (Jonsson and Mattsson, 2009). The subject includes one part concerning the materials management and a second part referred to as production management.

In this section, the principles for PPC will be described, in order to form a general understanding of how PPC is conducted. Different models will then be presented, including one model common in manufacturing, the MRP II model, and a model adapted for use in healthcare settings.

A General Model for Production Planning and Control

To control operations in a manufacturing company includes management of many different activities. Decisions regarding these activities need to be coordinated in order to achieve efficiency and competitiveness. To facilitate decision coordination, activities are commonly divided into three hierarchical levels of control: *strategic*, *tactical* and *operative* (Jonsson and Mattsson, 2009).

Strategic control aims at ensuring that the company is in its business environment by taking decisions related to long term goals of production and overall allocation of resources, thus making a company frame. What type of customers to target, in what market area to be active in and how much to sell over the next one to five years are common tasks handled at the strategic control level. Once a company frame has been developed decisions can take place at the tactical control level.

Tactical control decisions include sales and operation plans, capacity planning, selecting planning system and method, all according to the company frame that was established at the strategic control level. The decisions are taken within a time frame of about six months to a year and are commonly reassessed monthly.

The third and lowest level of control regards decisions on operations in terms of ongoing activities and daily procedures. It is at the operative control level that the strategy developed at the strategic and tactical control levels is put into practice. To fulfill the company strategy decisions at the operative control level regards customer delivery dates, planning of manufacturing orders, short-term capacity planning, assigning priority in production, and controlling stock levels. The operational control is

carried out in shorter time spans related to the production pace and available material and capacity. The time spans are related to the time it takes to make decisions of the different kinds. A strategic decision could take a long time to assess and decide upon, whilst an operational decision is of easier nature in terms of difficulty in assessment and therefor also takes less time to decide.

To succeed with a planning structure with different levels, it is crucial that the decisions on lower levels are made with regards to the decisions taken at higher levels. It is also important that general decisions can be transferred from one level to another, meaning that decisions must be taken to ensure that what have been decided on at higher levels will be executed at lower levels. If decisions cannot be transferred, or if decisions are taken without consideration to decisions made at previous levels, the planning will be meaningless because of inapplicable planning methods or overwriting decisions at lower control levels affecting the overall planning goals. To avoid inapplicable planning methods, Jonsson and Mattsson (2009) suggest four questions that should be asked at all of the control levels:

1) What is the demand, and for when?
2) How much can be delivered?
3) How much has to be produced or purchased, and for when?
4) What is the required capacity to fulfill this demand?

The questions relate to the future manufacturing in terms of both materials planning and capacity planning. Materials planning represents planning concerning all products necessary to produce, how much and when to have them finished. Capacity planning regards how much capacity that is required to be able to produce according to the demand. Planning according to both materials and capacity perspective is relevant at all planning levels. At all companies there is always need to consider how much that can be produced given the available material and the available capacity. Thus there exists a need to balance demand and supply, where demand states what needs to be delivered and supply in terms of materials and capacity states what the possibility is to deliver. Planning is therefore suggested to be conducted not only using different control levels but also using separate materials and capacity perspectives. The MRP II model as described by Jonsson and Mattsson (2009) is a common model for production planning and control (PPC) in the manufacturing industry. It is usually modeled as in Figure 1 for illustrative reasons.

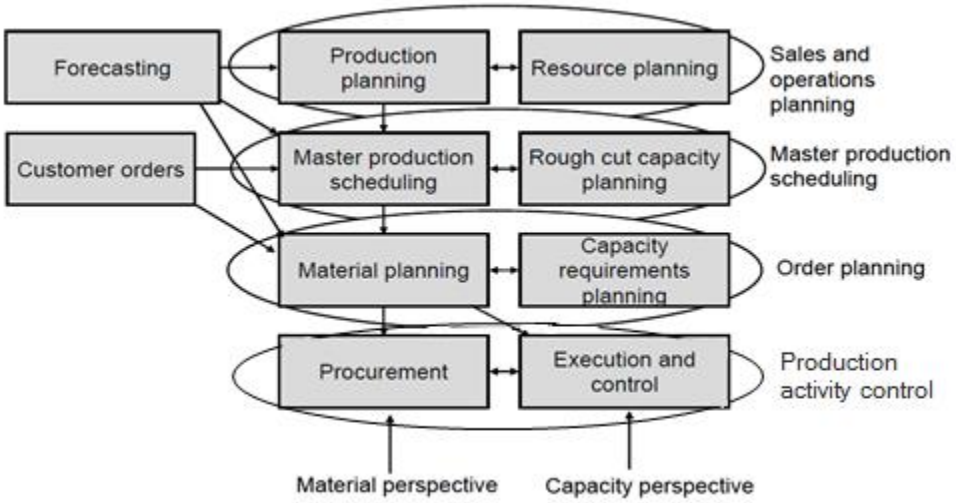


Figure 1: The MRP II model (Jonsson and Mattsson, 2009)

The MRP II model is divided into different control levels, which are represented horizontally in Figure 1, and materials and capacity perspective which is illustrated vertically in Figure 1. In the MRP II model there are four control levels instead of the three previously mentioned. The fourth level is below the operative level and is called execution. As stated by the name the execution level describes the planning of how execution should be conducted. The execution level is called production activity control and is the lowest decision making level and regards decisions on the shortest time horizon.

In addition to the planning levels and the different perspectives the model also includes the topics *forecasting* and *customer orders*. Forecasting is used as means to predict the demand in this model and can be used at different control levels. The customer order perspective regards orders that have been obtained from customers and is commonly used in combination with forecasting to predict the demand. The forecasting component feeds information into the *production planning, master production scheduling* and *material planning* levels. Forecasting allows these plans to be adapted to expected demand patterns, which allows more accurate matching of supply and demand. Forecasting is used as input to the upper control levels, but is increasingly replaced with actual customer orders as the planning horizon decreases and more information becomes available.

2.2 PPC in Healthcare

Even though the MRP II model has been developed for planning and control in manufacturing industries it has also be found useful as a basis for planning also in a healthcare setting (Plantin and Johansson, 2012). However, several conceptual frameworks for production planning and control in healthcare exist, of which three were found by Nguyen et al. (2014) to be predominant in the literature: Hans et al. (2011), Vissers et al. (2001), and Roth and van Dierdonck (1995). All three frameworks are in essence hierarchical with strategic, tactical and operational levels, with the more detailed planning levels restricted by the decisions in the more strategic ones. The MRP-

inspired framework of (Roth and van Dierdonck, 1995) is an attempt to use diagnostic-related groups (DRGs) to form bills of resources, to use as the basis of resource planning. Vissers et al. (2001) considers production planning and control in one hospital department and treats the hospital as consisting of loosely connected business units, in a form of *virtual organization*. The more comprehensive model of Hans et al., 2011 seeks to include four managerial areas: medical, resource, materials and financial planning, while also distinguishing between *online* and *offline* planning, where the former refers to decisions made in reaction to events not accounted for in the *offline*, in-advance, planning.

In this thesis, a framework for production planning and control was chosen in order to structure the study and guide the gathering of data and analysis, through the identification of mismatches between reality and the framework. The framework from Vissers et al., (2001) was considered suitable for this study, as it concerns production planning in one department unit, with capacity constraints caused by bottleneck resources. The framework of Roth and van Dierdonck (1995) was not found to be adaptable to a situation where access to resources is constrained by other units. The framework of Hans et al., (2011) was found to be excessively extensive.

It should be said that as with any model, no PPC framework is flawless, since they are always simplifications of reality. Nguyen et al. (2014) evaluate the match between PPC frameworks and the planning environment in hospitals. Their findings include that many fail to take into account: the variation in patient condition both at admission and during treatment, prioritizations or triage due to condition, variation in the characteristics of resources such as varying experience of staff, and the complexity of healthcare organizations.

The PPC framework of Vissers et al. (2001) is based on the design requirements found by de Vries et al. (1999), which aim to deal with three issues: *coordination of supply and demand, goods flow control and production unit control,* and *aggregate and detailed control.* De Vries et al. (1999) observe that a hospital can be seen as a *virtual organization,* which is experienced by patients as one organization, but actually consists of autonomous organizations. A characteristic of such an organization is the split between *strategic* and *operational* level. De Vries et al. (1999) find that this fact leads to a number of organizational dilemmas regarding conflicts of interest, access to information (aggregate vs. patient-level information) and sharing of control, which must be considered in a PPC framework for healthcare. Important concepts outlined in de Vries et al. (1999) are the distinction between *structural* and *operational coordination* of supply and demand, production units delimited by *decoupling points*, and the distinction between *aggregate* and *detailed* control.

The framework of Vissers et al. (2001), then, consists of five planning levels: *strategic planning,* where decisions are taken on the long-term goals and definition of patient groups, *patient volumes planning and control,* which regards the number of patients in the patient groups to be treated, corresponding to “master production scheduling” in the

MRP II-framework, *resources planning and control*, where the requirement of each resource type is determined based on the demand planned for in the previous level, *patient group planning and control*, where resources and patient flows are planned in more detail, e.g. in production periods, and *patient planning and control*, which is the day-to-day operational control of planning activities at the healthcare unit, such as scheduling of individual patients. The five planning levels are pictured in Figure 2.

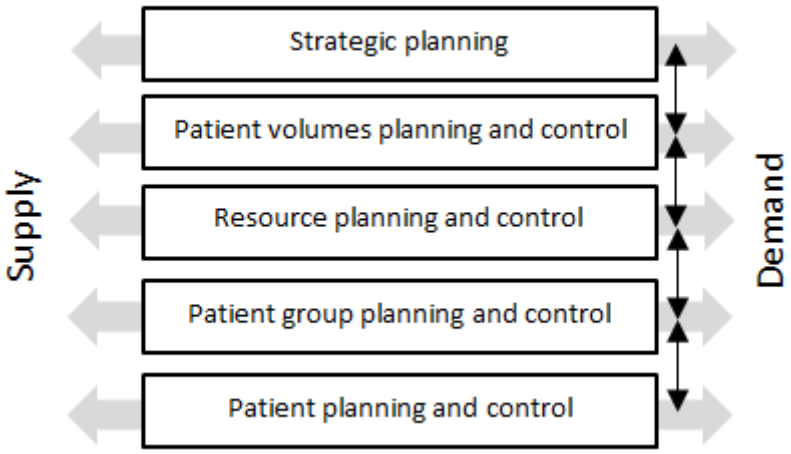


Figure 2: The PPC framework of Vissers et al. (2001)

To ensure the fulfillment of the decisions taken in higher control levels by the lower control levels, each level requires horizontal and vertical *control functions*. The horizontal control function is meant to ensure the matching of supply and demand at each planning level, while the vertical control function should both "feedback" the fulfillment of targets to the next upper level and "feed forward" targets for the lower level, which is based on *performance indicators* for each planning level.

2.3 Capacity planning

Jonsson and Mattsson (2009) argue that there exist basically two different approaches for optimizing planning in terms of matching capacity demand and capacity supply. The first approach is to consider the capacity demand as a first step and then adjust the capacity supply to match the capacity demand. The second approach is vice versa, the supply is considered first and production is planned to utilize the capacity to largest possible extents at all times. The first alternative is the most common approach used, it considers material flows and is product and market oriented rather than a production focused. The second approach is commonly applied in manufacturing industries where the production is capital intense, as in the processing industry, or when set-up times are long and pricy and it is more profitable to work in a process oriented way than to consider the true customer demand.

The first approach, prioritizing of materials, is the more commonly used approach of the two described and Jonsson and Mattsson (2009) mention four main reasons for this. The first reason is the ability to focus on the customer and the market in order to stay competitive compared to competitors. The second reason is that capacity is not always

fixed but can be adjusted to some extent and therefore allow for improved match between demand and supply if capacity is adjusted to match demand. The third reason is that available capacity is not always known in beforehand and with only an approximate idea of the available capacity the matching between demand and supply cannot be conducted properly. The fourth and last main reason as to why the approach with material prioritization is more commonly used is that it is easier to rearrange capacity than to rearrange production.

In this specific case where an outpatient clinic is regarded, the capacity demand could for example be a patient's demand for a specific specialist and the capacity supply would in that case be the availability of scheduling that type of specialist. A patient-centered healthcare system certainly demands a possibility to adjust capacity to actual demand. For these reasons, a planning approach based on prioritization of materials or in this case, prioritization of patients, seems the more reasonable approach.

Theory of constraints

The theory of constraints is an approach to optimize the capacity when applying the prioritization of materials approach. The theory of constraints is characterized by the finding of production flow constraints, known as bottlenecks, and to arrange the capacity scheduling to utilize these fully to reach on optimal production plan with regards to matching of production demand and capacity availability. Jonsson and Mattsson (2009) present the theory of constraint as a five step process to accomplish matching and to continuously improve the production flow.

1) Identify constraint
2) Bring maximum efficiency from the constraint
3) Subordinate everything else
4) Elevate the constraint if necessary
5) Go back to step 1

In the same sense as when introducing the materials prioritization approach, a specialist can represent capacity supply and thus also a bottleneck if this specialist is considered a capacity constraint. As Vissers et al. (2001) write, specialists often become bottleneck resources, which creates a need for high resource utilization. A theory of constraints approach can thus be useful for optimizing capacity use at the department.

Capacity planning using overall factors

Another method, described by Jonsson and Mattsson (2009), to plan the capacity is capacity planning using overall factors. It is considered one of the easiest planning methods there are. The capacity plan is conducted using the same units as the production volumes are expressed in and different plans are made for all types of end products. However, all end products must be regarded as similar for the overall factor method to work. This is because all calculated capacity requirement is aggregated and then compared to the demand.

If for example patient group A is given capacity of two physicians per day every week and patient group B is given capacity of one physician every day per week this capacity plan can be compared to the required capacity from a materials planning perspective. If the required capacity for this week is three physicians per day all week the difference in capacity requirement and availability is zero, which is wanted. Then for the next week there might be a capacity requirement for four physicians per day that week. However, the available capacity is still two physicians for patient group A and one physician for patient group B, which results in a capacity shortage of one physician per day that week. This can be conducted for the entire planning period and the capacity shortage, or over capacity, can be calculated for the same. If there is a clear imbalance, the planning should be revised to fit with actual need. The overall factors method is commonly used at high control levels with longer time horizons where the capacity plan can be used to view periodic goals. The method is easy to understand and can easily be revised. It is most suitable in environments where the production is uniform and for high control levels such as sales and operations planning and master production scheduling in the MRP II model.

When planning capacity, it is also important to monitor the outcome of the plans, with regards to both periodic and accumulative correspondence.

Periodic and accumulated correspondence of capacity

Jonsson and Mattsson (2009) argue that there are two different planning situations where capacity correspondence should be considered. The first planning situation is the periodic one which represents a short time perspective, usually a week or a month. The second planning situation when correspondence should be regarded is in a longer time perspective, commonly a year. If there is no correspondence of either periodic or accumulated kind then measures should be taken since this implies a mismatch between what needs to be produced and the available capacity. The correspondence has been presented by Jonsson and Mattsson (2009) as a figure for easier understanding of how to act when there is no correspondence in either or both periodic and accumulated perspectives (see Figure 3).

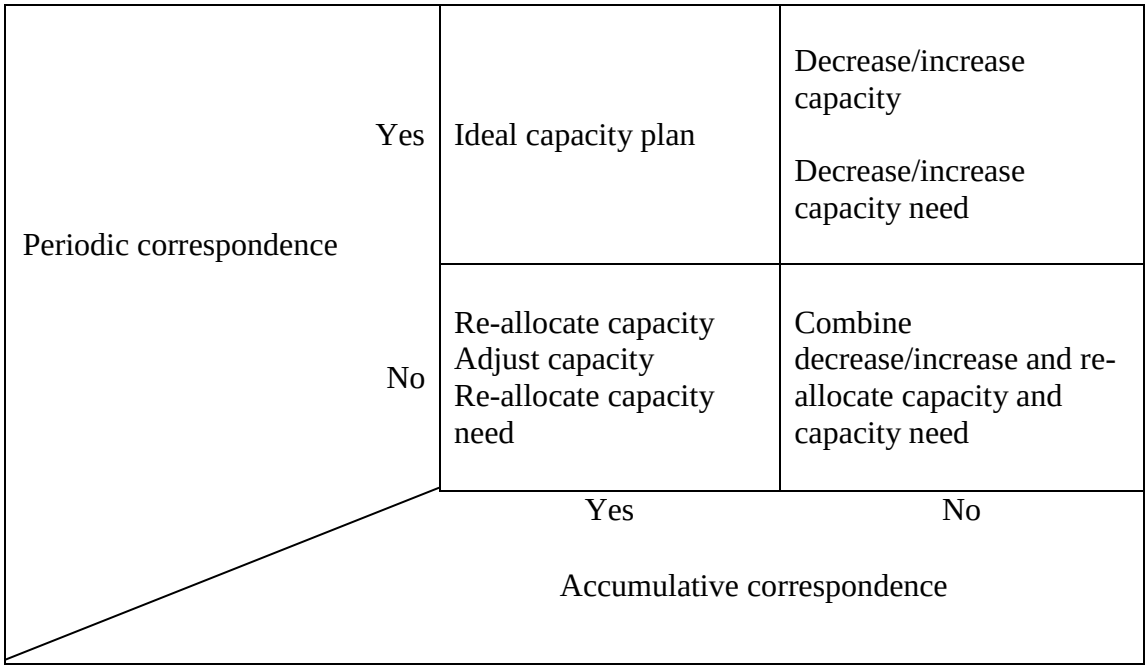


Figure 3: Planning situations with respect to correspondence between demand for capacity and supply of capacity (Jonsson and Mattsson, 2009)

The ideal situation occurs, as mentioned, when there is a simultaneous accumulative and periodic correspondence, as can be seen in the figure. Another example of how to act is if there is no periodic correspondence but accumulative correspondence. Then the capacity should be re-allocated, the capacity should be adjusted or the capacity need should be re-allocated.

Re-allocation of capacity means shifting of capacity from one workplace to another (Jonsson and Mattsson, 2009). At the outpatient clinic it could imply having physicians come work at the outpatient clinic instead at the inpatient clinic. Re-allocation of capacity should only be conducted between work centers where there is lack of capacity in one and overflow in another. If there was lack of capacity already in both work centers then re-allocation of capacity would only make the situation worse by decreasing capacity when there is already lack of it. At the outpatient clinic re-allocation of capacity is frequently used, but not to increase the capacity but to fill the capacity need at another part of the women's health department.

Re-allocation of capacity requirements is another means to cope with imbalanced capacity demand and supply (Jonsson and Mattsson, 2009). Instead of re-allocating staff this would imply to re-allocate patient visits. If many patients have contacted the outpatient clinic in one and the same week to receive an appointment it would cause most patients to originally be planned for the same week. By using re-allocation of capacity requirement the number of patients who cannot be given an appointment in that specific week because of lack of capacity are re-allocated to the week before and the week after, thus balancing the patient requirement for capacity.

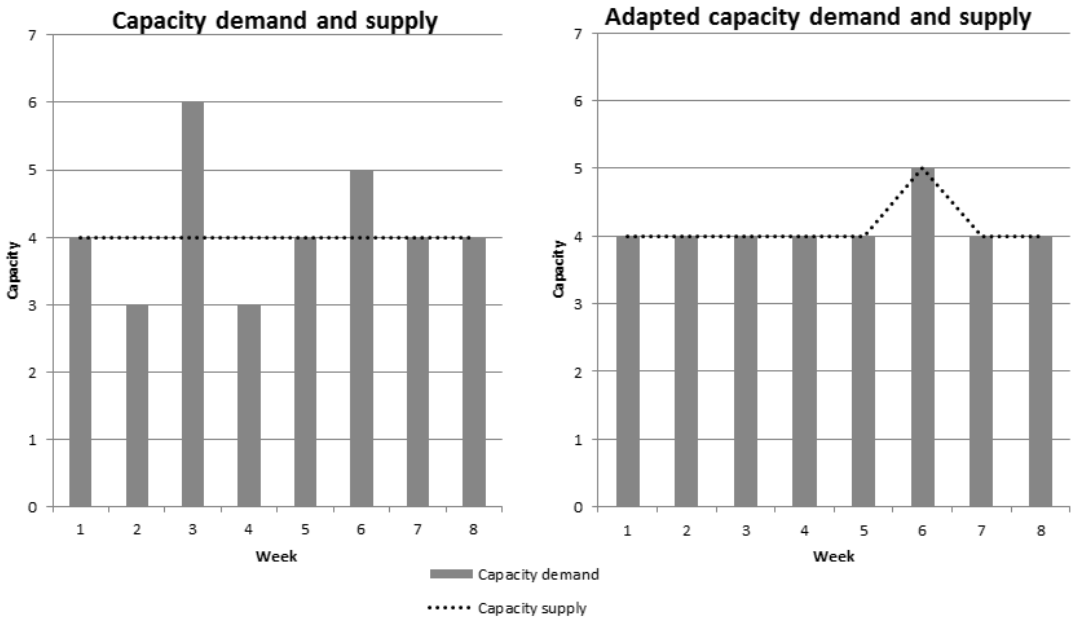


Figure 4: Re-allocation of capacity and capacity requirements

Figure 4 shows an example of how re-allocation of capacity can be done. The capacity demanded in week 3 is too high compared to supply. Through use of re-allocation of capacity requirements, capacity demand is shifted to weeks 2 and 4, levelling demand for these weeks. The high capacity demand in week 6 cannot be shifted in the same manner, and instead capacity supply is increased, through re-allocation of capacity.

Utilization rates

When making production plans regarding capacity it is important to understand that the time set up for patient receptions will often not be utilized to full extent. There will be some time spent on other things than treating patients, for example getting advice from a colleague about a patient distress, having a short meeting with the manager or cleaning the room after a patient visit to prepare for next patient. These types of interruptions cause capacity reductions. The most common way to consider these capacity reductions in planning is to use utilization rates. Instead of stating what the lost time is the utilization rates measure the proportion of the planned time that is spent on treating patients. The relation between the actual capacity for treating patients (Net capacity), the utilization rate and the planned capacity (Nominal capacity) looks like this (Equation 1):

*Net capacity = Utilization rate * Nominal capacity* Equation 1

The utilization rate is commonly around 85 percent in the manufacturing industry. A utilization rate of 100 percent would indicate that there were no capacity losses, and thus no interruptions. The goal is often to be as efficient as possible, trying to reach the

highest utilization rate possible, or doing the most with the time given as the utilization rate is perceived at the outpatient clinic.

2.4 PPC integration barriers

Even if frameworks for production planning and control exist for the healthcare sector they still lag behind (Hans et al., 2012). Since healthcare is different from production industry there have been some compatibility issues when applying existing production planning and control methods in the healthcare sector (Plantin and Johansson, 2012). There are differences in terms of patients and products which creates a need for differentiation between frameworks for the different sectors. However, these are not the only differences. Plantin and Johannson (2012) emphasize the differences in planning tradition. In industry, planning has been highlighted for decades whilst in healthcare the planning concept is relatively new.

The planning levels are still few in healthcare and at many places planning is conducted on one or two levels only. This unfamiliarity to planning makes it harder to control the production outcome for longer time spans. Hans et al (2011) point out some additional barriers when it comes to PPC in the healthcare system (Hans et al., 2012):

- Healthcare organizations consist of different professions with sometimes conflicting goals, thus making cooperation about common tasks somewhat difficult.
- The development of information systems to share planning information between staff, care units and hospitals has been slow.
- Poor cooperation between care units and hospitals, most care unit managers are busy with their own unit and do not communicate over the unit boarders.
- Healthcare managers are untrained in the concept of resource utilization and many prioritize patient service in the short term and leave administrational tasks overlooked.

In addition to requiring special consideration regarding the technical aspects of production planning and control, healthcare has some unique characteristics regarding its organization that complicate management of it. Glouberman and Mintzberg (2001) perceive healthcare as consisting of four different worlds: *care, cure, control* and *community,* which are disconnected from each other due to differing interests, values and structures. They state that although healthcare requires some division of labor, the disconnections between these worlds are destructive for healthcare as a whole. Thus, the *cure* world, consisting of physicians, who have a high degree of autonomy in their work, intervene intermittently to cure a disease or fix a broken limb, while the *care* world, consisting of nurses, are continuously responsible for the caring of the ill. The *community* has different expectations on the performance of the healthcare system, and the *control* world is tasked with the mission to manage the *care* and *cure* worlds. Glouberman and Mintzberg (2001) find that only through integration of these four worlds can healthcare systems solve their problems.

As PPC in healthcare largely concerns the scheduling of different staff groups, it has high impact on work conditions, and it can thus be expected that changes in PPC will be affected by the barriers described above. The four worlds framework is thus considered useful for understanding these barriers and adapting the solution to the department's conditions. In this study, the four worlds framework was used to contribute to the understanding of the causes to some of the problems found. It was also used to guide the formulation of improvement suggestions, as these could also be expected to have impact on the relation between the four worlds.

2.5 Resulting framework

Figure 5 below is a graphical representation of the theoretical framework which this study is based on. The theoretical framework is a synthesis of the findings of the theory reviewed in the above sub-sections, and is an attempt to combine ideas and hypotheses from the different relevant fields.

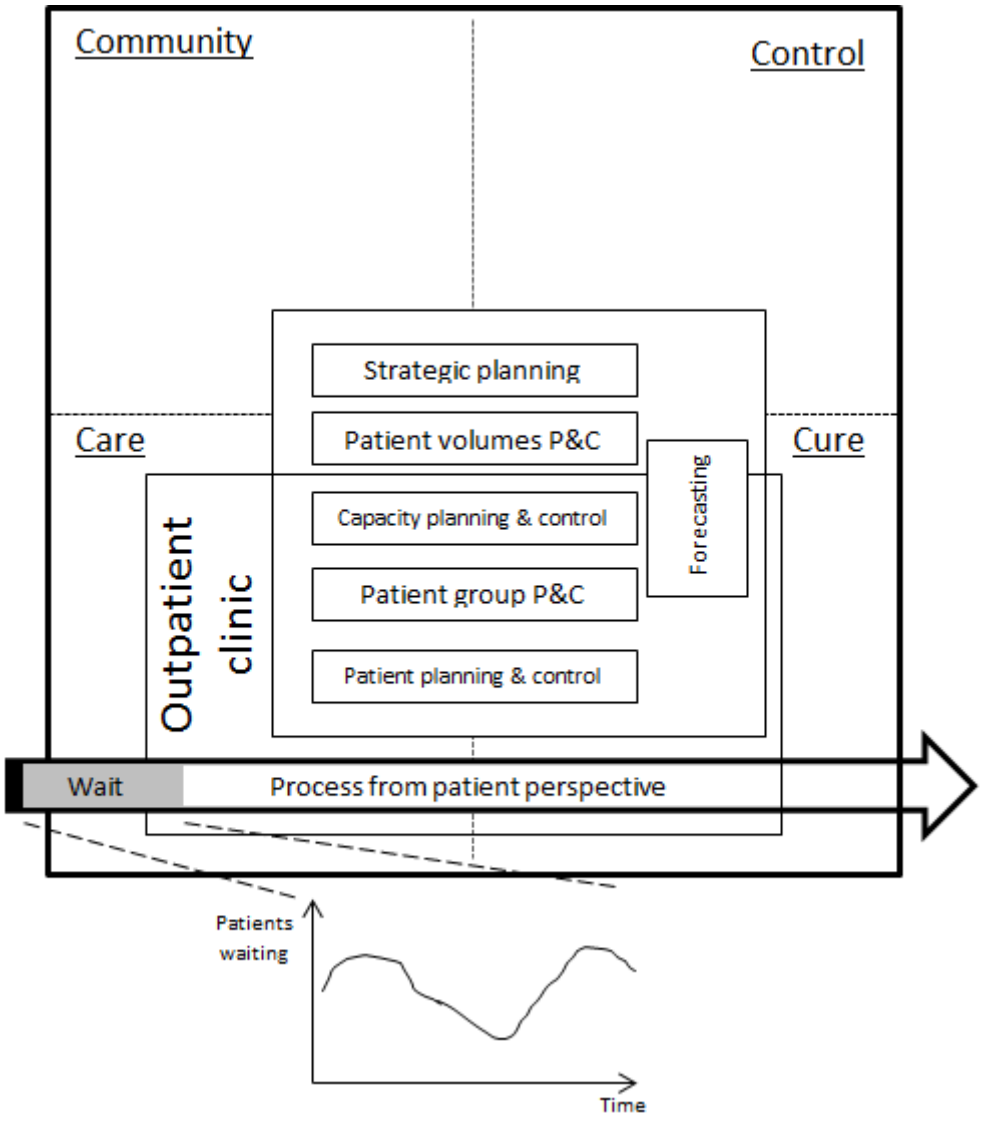


Figure 5: Theoretical framework

The framework is based on the idea that the main goal of the gynecology outpatient clinic, as with the healthcare system in general, is to create value for the patient by provision of specialized health care services. As shown by Conway and Willcocks (1997), healthcare quality is influenced by perceived outcomes as well as expectations, in which the patient's waiting time plays a large part. Waiting time can be influenced in several ways. For example, queue theory suggests that the shortening of treatment times will allow more patients to be seen per time unit, thus shortening the waiting time. For the purpose of this study however, the focus is on production planning and control.

In non-urgent, ambulatory care such as the case with the gynecology outpatient clinic, where patients are treated in booked appointments, as opposed to immediately at the first contact (as in emergency care), the production planning and control process strongly affects the waiting time by determining the matching between production needs and capacity requirements. A waiting list is formed when capacity is less than demanded production. The waiting list is thus bounded by the PPC process in two ways. First, by the maximum capacity that can be generated. Second, as Vissers et al. (2001) find, by the fact that a waiting list is needed as a buffer in order to ensure high resource utilization, which is crucial in healthcare as demand is always higher than supply, and there are bottleneck resources in the form of specialists.

The PPC process can be conceptualized through the framework of Vissers et al. (2001), where it is conducted in five hierarchically ordered levels, from strategic planning to individual patient planning and control. Control functions are required at each level in order to ensure matching between demand and supply, and the fulfillment of requirements set at higher levels. The planning at each level is conducted by different hospital departments – in particular, the three lower levels, from capacity planning and control to patient planning and control, are conducted at the outpatient clinic level, as shown in the figure.

The framework of Vissers et al. (2001) lacks the forecasting function that is present in the MRP II framework, although the framework does prescribe consideration to expected future demand in the upper planning levels. Forecasting can certainly be useful in a healthcare setting. Just like in manufacturing, it can be used to calculate the expected required capacity for the predicted demand. Some types of healthcare demand can be expected to follow seasonal patterns, or be dependent on other demand. The theoretical framework is therefore augmented with a forecasting function as input to the PPC process.

In addition to the logistical question of how to plan and control production, there are also organizational aspects that contribute to or obstruct optimal management of production planning, which were discussed in the section on the four worlds of healthcare from Glouberman and Mintzberg (2001). Indeed, the production and control function does not exist in a vacuum, but is restricted by the same structures, values and norms as all organizations are. In the theoretical framework, this is shown by the PPC framework and the outpatient clinic being bounded by the four worlds of Glouberman

and Mintzberg (2001). Gaps between the four worlds will impede good planning and control, and as Glouberman and Mintzberg (2001) conclude, proper functioning of the highly differentiated healthcare system will require increased integration between the four worlds. Thus, the four worlds are included in the theoretical framework as a way to understand how the gaps contribute to the planning problems, how they obstruct the improvement of planning and how to form improvement suggestions that contribute to integrating the worlds.

3 Method

This chapter describes how the thesis was conducted to reach the goal of finding improvement suggestions for the PPC process at the gynecological outpatient clinic, to enable the clinic to sustain the waiting list levels. The first section in this chapter, 3.1, includes an introduction to all of the chapters in this report and conveys how the study was carried out. In section 3.2, additional information will be given on the collected data, findings and usage of it. The third and last subsection in this chapter, 3.3, includes further information about the research questions and their contribution to the structure of both the study and the report.

3.1 Structure and content

As a starting point, some theory was studied about production planning and control processes in healthcare including procedures and preconditions. The theory found most useful to understand feasible production planning procedures and preconditions related to healthcare was presented in chapter 2, *Theoretical framework.*

With the *theoretical framework* as a foundation, interviews were held and internal data was collected to provide information about the current situation regarding the PPC process and waiting lists at the gynecological outpatient clinic. All information regarding the current PPC process and the waiting list situation is presented in the fourth chapter in this report, named *Current situation.* The current situation ends with a mapping of the current PPC process.

The information provided in the *current situation* chapter was then used in combination with the presented theory as a basis to map the current PPC process and find problem areas with considered improvement potential from a PPC perspective. The problem areas and their relation to the PPC process steps are presented in the fifth chapter, *Analysis of current situation.* The chapter was divided up into three categories: Capacity planning, Production planning and Outcomes. The problem areas were related to mismatching of demand and supply and were thus considered potential causes to increased waiting lists or decreased possibilities to control the waiting list levels. The chapter includes a figure of the PPC process where the problem areas are illustrated.

Following the *Analysis of the current situation* is chapter 6, *Generation and evaluation of improvement suggestions.* The chapter includes improvement suggestions regarding the main problem areas found. The chapter includes a new PPC process suggestion, improvement suggestions regarding supporting functions forecasting, care requests and waiting list prediction. It also includes a critical evaluation of the improvement suggestions and a summary of the improvement suggestions.

Once the improvement suggestions have been provided the following chapter, chapter 7, is a discussion regarding the new PPC process and the improvement suggestions overall. How well this new PPC process corresponds to what the gynecological outpatient clinic needs and if it could work at other outpatient clinics are some of the topics discussed. The last chapter is a conclusion, including the contributions of this

study to the purpose to provide improvement suggestions concerning the production planning process at the gynecological outpatient clinic at Skaraborg's hospital in order to enable the clinic to sustain waiting lists within target levels. Figure 6 summarizes the method used in this study.

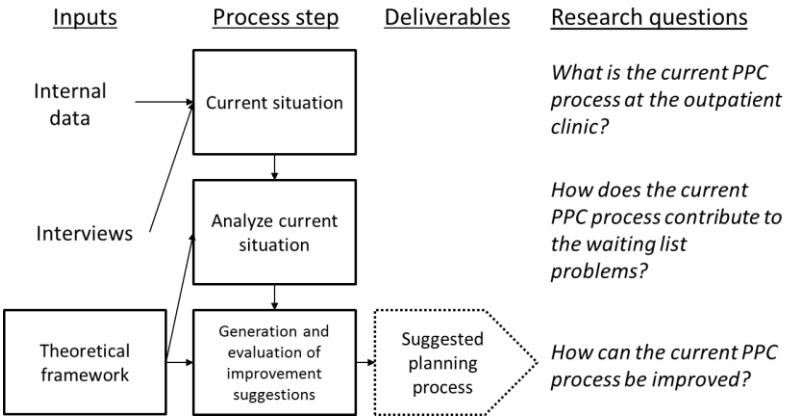


Figure 6: What means that were used to fulfill the purpose of this thesis

3.2 Data Collection

Information was gathered through literature search regarding production planning and control theory and processes in healthcare and in manufacturing. The MRP II model, as described by Jonsson and Mattsson (2009), and a PPC framework adapted to healthcare settings by Vissers et al. (2001) constituted main focus areas. Some methods of capacity planning and integration barriers to consider when conducting production planning in healthcare were also studied. The theory found most useful to understand feasible production planning procedures and preconditions related to healthcare was used throughout the study and summarized in Figure 5, at the end of chapter 2 *theoretical framework.* The information found in the *theoretical framework* (chapter 2) was used as input to chapter 5 (*analysis of the current situation)* to enable appropriate analysis of the current situation.

To gain information about the current PPC process and the current waiting list situation at the gynecological outpatient clinic, interviews were held and internal data was collected. All interviews conducted were semi- or unstructured to facilitate interviewee's answers to be thorough by allowing for follow-up questions and increase the chance of dedication to the project (Bryman and Bell, 2011). The interviews were held to gain information about what the PPC process looks like in the current state in terms of activities conducted at different stages of the process and whom it involves at the different steps. Interviews were held with different people at the gynecological outpatient clinic, a business developer, the manager of the gynecology unit, a secretary responsible for handling data and updating the production plan, the process manager, responsible people for scheduling of staff and several interviews with the assistant nurse responsible for scheduling and booking of appointments at the gynecological outpatient clinic. More information about the interviews is presented in Appendix A.

In addition to interviewing staff at the gynecological outpatient clinic an interview was also conducted with the unit manager of the dermatological outpatient clinic. The dermatological outpatient clinic is one where the PPC process is considered successful and therefore an interview was held with the unit manager to learn more about why it was considered successful and examine the possibility to learn from the dermatological unit to improve the PPC process at the gynecological outpatient clinic. Further information about this interview is included in Appendix A.

In addition to data provided through interviews some quantitative data was also collected. Quantitative data was provided by the gynecological outpatient clinic about the current PPC process, including current production goals, production plans, outcome from the planned production, previous staff schedules and current waiting list situation. Most data was provided through excel-sheets. The current production plan including production goals and outcome was administrated as an excel-sheet and information from year 2014 and 2015 constitute the basis for all main quantitative findings regarding the production planning and capacity utilization information presented in this report. Data regarding the number of patients in the different waiting lists were also kept in excel-sheets and has also been used in this study.

3.3 Analysis of research questions

The three research questions stated will be answered one by one starting with research question 1 (What is the current PPC process at the outpatient clinic?) in chapter 4, subsection 4.5 *Current PPC process.* The second research question (How does the current PPC process contribute to the waiting list problems?) will be answered in chapter 5, *Analysis of the current situation.* The third and last research question (How can the current PPC process be improved?) will be answered in chapter 6, *Generation and evaluation of improvement suggestions.*

The three research questions thus relate to the method as presented in Figure 6, where the current situation will first be presented based on internal data and interviews provided by the gynecological outpatient clinic and to some extent also the dermatological outpatient clinic. The *current situation* will then be analyzed with regard to the information found in the *theoretical framework*. The analysis will then constitute the basis for finding improvement suggestions based on the problem areas found in the *analysis of the current situation*. The improvement suggestions will be generated and evaluated in chapter 6. Once the improvement suggestions are generated the outcome should be a suggestion for an improved PPC process.

The method chosen was considered favorable because of the ability to identify improvement suggestions from department staff by using interviews and making them highlight difficulties of the PPC process as it is perceived by the personnel working with it every day. By interviewing involved staff at the gynecological outpatient clinic itself, and in addition also the dermatology department's unit manager, the improvement suggestions were considered to function in the healthcare environment and give

perspectives on what is possible to achieve yet still be very well adapted to the gynecological outpatient clinic specifically.

To use identified problem areas as basis for finding improvement suggestions seemed a fair method since it both highlights current potential problem areas and made improvement suggestions more tangible in terms of what problems that need to be resolved. A critical evaluation of the generated improvement suggestions was one way to convey what the different improvement suggestions would require to actually create PPC process improvement.

4 Current situation

This chapter is intended to describe the current situation at the gynecology outpatient clinic regarding its general characteristics, the production planning process and the waiting list situation. It also describes the PPC process of another outpatient clinic at Skaraborg's hospital. The current situation is meant to form the foundation of the analysis.

Section 4.1 is a general description of the hospital, the women's health department and the gynecology outpatient clinic. Section 4.2 describes the demand and supply relation at the outpatient clinic. Section 4.3 includes further information about the demand in terms of incoming care requests. Section 4.4 includes information about the resources used at the outpatient clinic to provide supply in terms of appointments. Section 4.5 describes the current PPC process, both how the upper planning levels relate to the clinic, and how the lower levels are conducted at the clinic. The answer to the first research question will be given here. Section 4.6 describes the current waiting list situation. Lastly, section 4.7 describes the PPC process used at another outpatient clinic, and is included for benchmarking purposes.

4.1 Description of the hospital

Skaraborg's hospital applies a management model they call "Offensive operations development", which aims to illuminate patient flows and processes as well as institute continuous improvements. There have been several initiatives at Skaraborg's hospital in recent years, often in cooperation with academia, to improve the delivery of healthcare, both in terms of quality and availability. Examples include hospital-wide Six Sigma training of medical staff (Lifvergren et al., 2009), experience-based co-design (Gustavsson, 2013) and attempts at using production planning and control (PPC) methods (Plantin and Johansson, 2012). Skaraborg's hospital considers production planning in order to achieve a balance between planned and emergency flows as one of the great challenges in the coming years (Västra Götalandsregionen, 2015a).

Gynecology is the field of medicine which deals with the health of the female reproductive organs and mammary, and obstetrics is the discipline which deals with childbirth. At Skaraborg's Hospital, the practice of gynecology and obstetrics is handled by the *women's health department*, which in turn is divided into several units. *Outpatient gynecology units* are located in all four locales, and provide treatment and assistance with varying issues such as childlessness, incontinence, STDs, and abortions. More advanced care, such as surgery, gynecological cancer treatment, and palliative care, is located in Skövde. The women's health department at Skaraborg's hospital consists of a gynecological outpatient clinic, a gynecological inpatient clinic, a gynecological oncology clinic and a maternity ward. The gynecological outpatient clinic functions in Skövde, Lidköping and Mariestad but most of the activities are located in Skövde.

This thesis was conducted at the gynecological outpatient clinic in Skövde, which is part of the gynecology branch of the women's health department (see Figure 7).

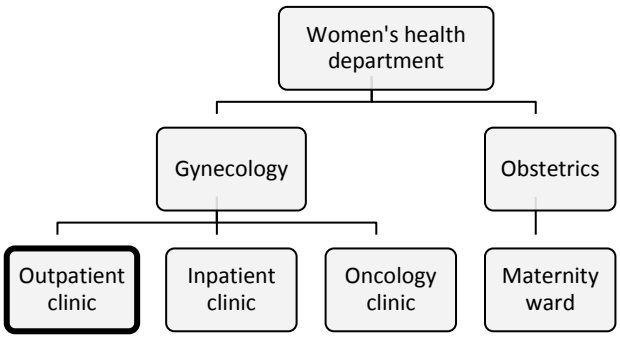


Figure 7: Organizational structure at the women's health department at Skaraborg's hospital

4.2 Demand and supply at the outpatient clinic

This section outlines what demand and supply is and means at the gynecological outpatient clinic. Demand is interpreted as the patient requests for care at the gynecological outpatient clinic of Skaraborg's hospital. The supply is interpreted as the ability and resources to fulfill the requested demand at the clinic. The patient requests for care cause a demand for appointments at the outpatient clinic. The requests can be divided into six different groups causing the total demand, as seen in Figure 8. The supply is generated by the number of physicians and midwifes scheduled for work at the outpatient clinic but with a restriction of maximum capacity in terms of examination rooms. The following sections will discuss all of the mentioned topics to have effect on the demand and supply as shown in Figure 8.

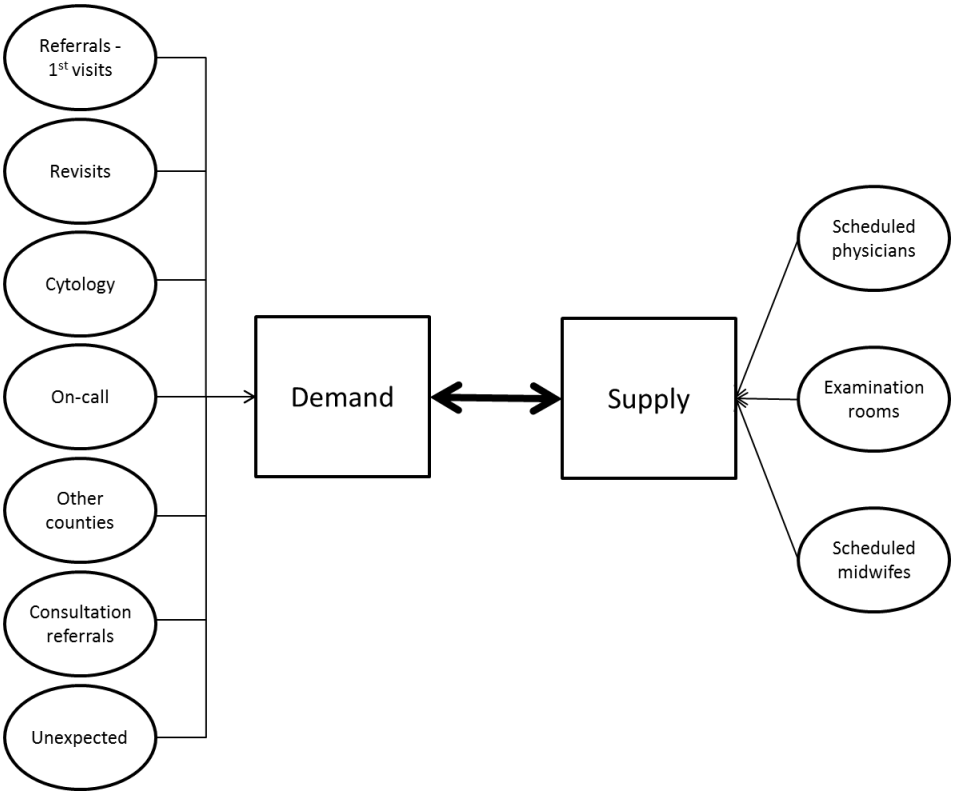


Figure 8: Demand and supply at the gynecological outpatient clinic

4.3 Demand

Demand for care at the outpatient clinic is the inflow of care requests, which is generated from different sources. All different inflows are further described in this section.

Referrals – 1st visits

The largest group of patients who visit the outpatient clinic is the first visitors with referrals from primary care clinics. In average 135 referrals were registered each week at the outpatient clinic in 2014. However, there was some variation in the number of incoming referrals from week to week. The weekly inflow of referrals for first time visiting patients in 2014 is shown in Figure 9. Data after week 44 was not available, due to a change in data registration procedure.

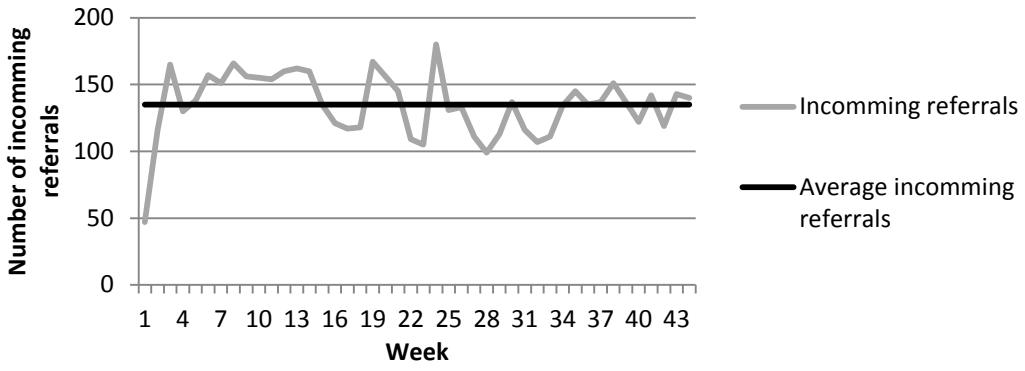


Figure 9: Incoming first visit referrals per week in 2014

Out of the incoming referrals a few are considered inaccurately forwarded and these patients should have been treated at the primary care clinic itself. However, instead of sending these referrals back to the primary care clinic they are usually accepted and treated at the gynecological outpatient clinic, thus increasing demand for appointments at the clinic even further.

Revisits

For some first visiting patients there will be one or several revisits. The revisit date is known as the medical target date and is determined by the physician or midwife who ordered the revisit. The medical target date is used to determine when the patient should at the latest make their revisit at the outpatient clinic. If a patient has not been provided a revisit appointment before the medical target date the patient is put in a revisits waiting list.

Cytology

In Sweden, all women get an opportunity to take a cytology test of the cervix every third year in the ages of 23-49 and every fifth year for women between 50-60 years. The tests enable early detection of cell changes (cytology) that could evolve into cancer. All women who test positive for cell changes are scheduled for further examination at

gynecology specialists, as the gynecological outpatient clinic in Skövde. In 2014 there were 590 patients who sought care at the outpatient clinic for cytology causes.

On-call

The outpatient clinic offers scheduled appointments but also an on-call service. The on-call service is supposed to handle patients who have become ill unexpectedly and who need acute care. It also functions as a way for those who have not sought help at primary care clinics to see a specialist straight away. This is seen as quite a flexible system since no appointments should have been booked in advance at the on call schedule. However, in rare cases some patients are scheduled to the on call physicians when all appointments are booked at the outpatient clinics general schedule, thus lessening the flexibility of the on call service.

Other counties

The outpatient clinic has the possibility to purchase healthcare services from other counties. In 2014, to cope with the waiting list situation, 200 patients were offered care in other counties, around half of which accepted. Referrals forwarded to other counties do not appear in the records of the gynecological outpatient clinic, but still represents patients who sought care at Skaraborg's hospital. Therefore it is important to also consider the number of referrals forwarded to other counties to estimate the true demand.

Consultation referrals

To rule out some possible causes to illness related to the area of the body, but not in the specialized are of a specific unit, consultations can be used. Consultation referrals are common within hospitals. If a female patient suffers from abdominal pain she might be referred to the gynecological outpatient clinic by a physician at another unit at the hospital, e.g. the emergency department, to rule out any gynecological causes to the pain. The gynecological outpatient clinic handles approximately two consultation referrals five days a week.

Unexpected

Apart from all previously mentioned patients who seek care at the outpatient clinic there is also a small addition in the demand caused by unexpected patients. The category of unexpected patients consists of patients who show up at the outpatient clinic's reception without a booked appointment or any previous notice of their need for care the given day. This demand is estimated to two patients a week.

4.4 Supply

This section intends to explain why scheduled physicians, midwifes and available examination rooms are considered supply at the outpatient clinic, as illustrated in Figure 8. Firstly, an explanation to how available resources affect the supply is given and then further below the implications of the availability with regards to scheduling is described.

Available resources

Patients who seek care at the gynecological outpatient clinic expect to meet with a specialist within the area of their distress. This specialist is commonly a physician. In some cases the expertise requested at the gynecological unit is compatible with the skill of a midwife. To fulfill demand, there thus needs to be a supply of specialists, represented by physicians and midwifes at the gynecological unit to provide appointments for all incoming care requests. The number of possible appointments is limited by the number of available physicians and midwifes or by the number of examination rooms.

There are 6 examination rooms at the gynecological outpatient clinic in Skövde and it is therefore not suitable to schedule more than 6 physicians and midwifes at the same time. Furthermore, the on-call service is carried out in the same facilities as the outpatient clinic in Skövde and therefore shares the examination rooms. Out of the 6 available rooms in the facility 5 are used for booked appointments and 1 is used by the daily on-call service. During one weekday physicians and midwifes can be scheduled at the outpatient clinic for patients appointments in the morning or in the afternoon. At every scheduled morning or afternoon period 5 patient appointments can be booked for every working physician or midwife. The daily on-call service has one physician on duty every weekday and the number of patients that can be seen during one day at on-call is 10.

In 2014 the utilization of examination rooms was as illustrated in Figure10. The examination rooms seem to not be limiting the capacity to large extent. The increase of maximum capacity utilization (visualized as the dashed line in Figure 10) in week 44-49 is caused by the evening receptions held at the outpatient clinic last year.

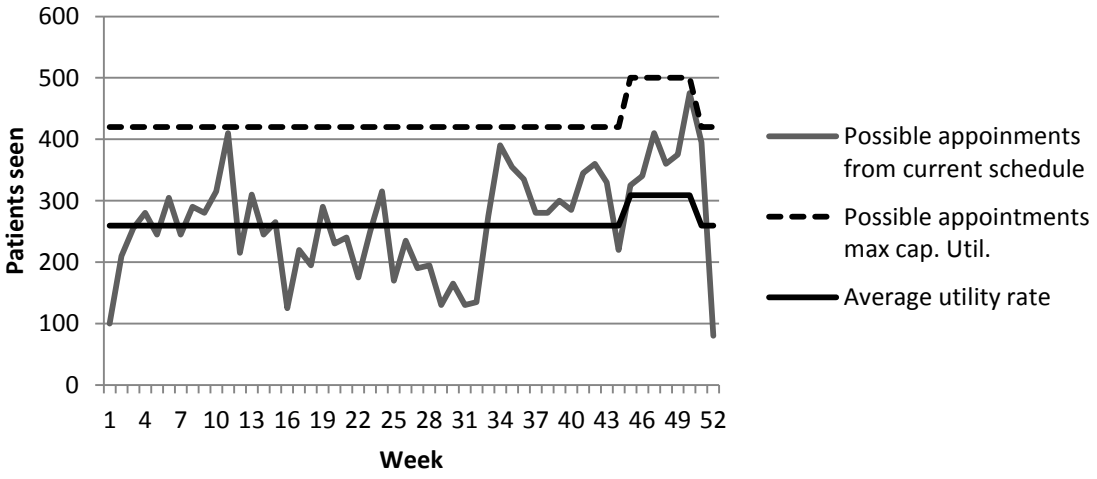


Figure 10: Utilization of examination rooms in 2014

To conclude, the supply of care is determined by the number of physicians and midwifes scheduled at the outpatient clinic with a maximum limit set by the number of existing examination rooms.

Scheduled physicians and midwifes

All physicians who work at the gynecological outpatient clinic are part of a team of physicians working at the women's health department at Skaraborg's hospital. The outpatient clinic is the least prioritized workplace at the women's health department from a scheduling perspective. One physician is always scheduled for the daily on-call service. The scheduling is rather uneven, meaning that some days no physicians are scheduled for morning or afternoon periods at the outpatient clinic, other days there are five physicians working both morning and afternoon being limited by the number of examination rooms. A suspicion about a correlation between the number of scheduled physicians at the outpatient clinic and Swedish holidays was raised from one of the interviews. This suspicion will be subject for further discussion in the analysis of the current situation chapter.

4.5 The current PPC process

This section will provide information about the PPC process used at the gynecological outpatient clinic as it is currently conducted. It is intended to answer the first research question: *What is the current PPC process at the outpatient clinic?*

The parts of the PPC process conducted at the outpatient clinic are the three lower control levels of the framework by Vissers et al. (2001). Some general assumptions have been made regarding the decisions taken at the two higher planning levels, based on the framework of Vissers et al. (2001) and current healthcare policy. The upper control levels are determined by the hospital management or by government regulation, decisions that frames planning at the department. The steps considered in this study are thus those under the influence of the gynecological outpatient clinic itself, which belong to the three lower levels.

In Figure 11, steps involving the outpatient clinic, but not directly under their control, have dotted borders. Steps under the outpatient clinic's control have solid borders. Detailed descriptions of the latter will be given further below, after a loose description of the strategic and patient volumes planning and control steps.

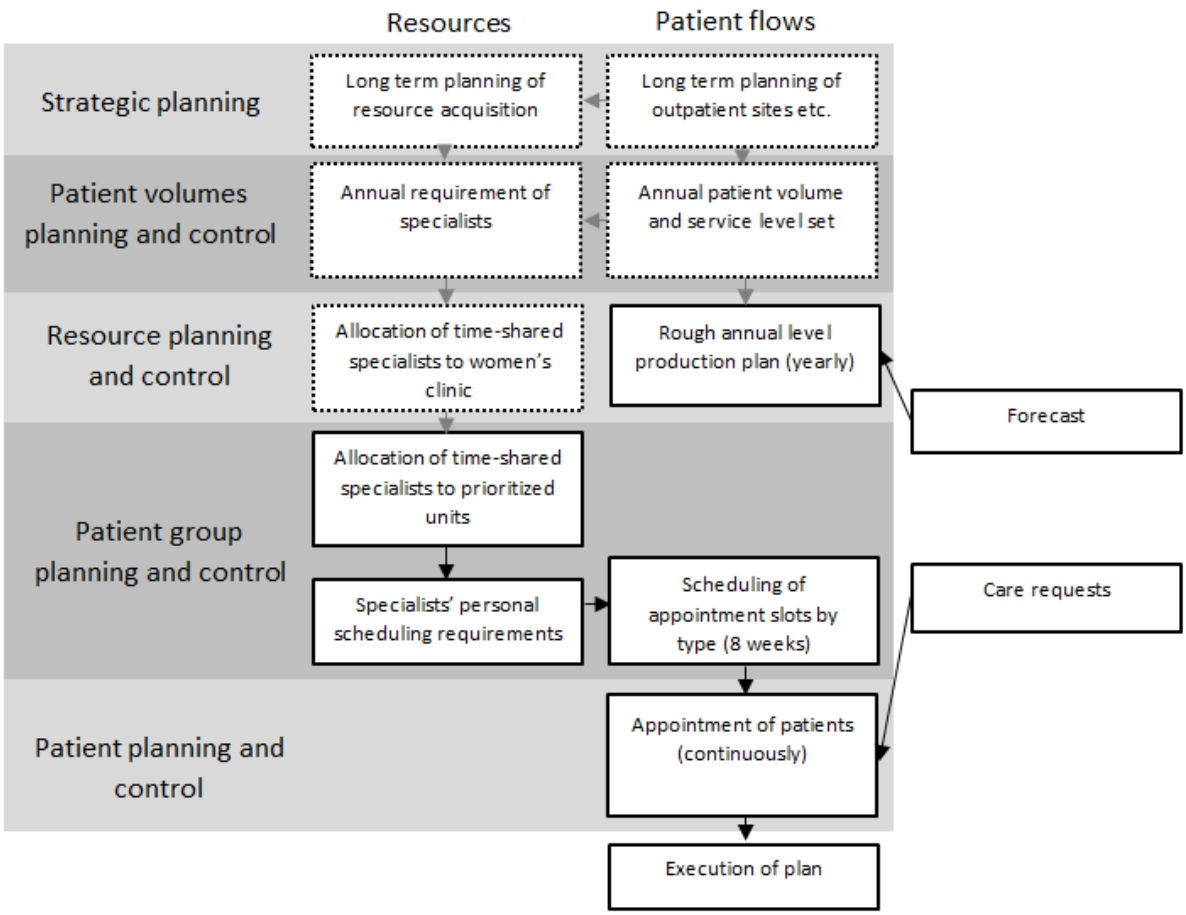


Figure 11: PPC process for the gynecological outpatient clinic

Strategic planning and Patient volumes planning and control

Strategic planning conducted at a national and regional level involves setting national goals for healthcare availability, such as the care guarantee, acceptable distance to hospitals, what healthcare to provide and the healthcare budget, which sets the ceiling for spending and thus determines hiring of staff. Strategic planning is also conducted by hospital management, and involves decisions intended to fulfill the political strategic goals. At the *patient volumes* level, hospital management then takes decisions on allocation of resources and production volume targets for different patient groups.

Resource planning and control

At the *resource planning and control* level the specialists working at the women's health unit are distributed among the different clinics, including the outpatient clinic. The distribution of specialist is not conducted at the gynecological outpatient clinic and that is why this planning step is illustrated with dotted boarders in figure 11. However, some things should still be mentioned about the distribution of specialists. Many physicians are scheduled for work at different geographical locations and in both in- and outpatient clinics. This makes the planning somewhat complex and to cope with the situation a prioritization rule has been developed. For medical reasons, the outpatient clinic has the lowest prioritization. Moreover, the prioritization rule also implies that short term physician vacancies are resolved by rescheduling physicians from the

gynecological outpatient clinic to wherever the vacancy appeared, causing physician shortage at the outpatient clinic if there is a physician missing at an inpatient clinic.

The patient flow perspective of the resource planning and control level is however regarded at the gynecological outpatient clinic, constituted by a rough annual level production plan. The planning regarded in this step includes a yearly production plan of the number of first visiting patients to appoint per week, the number of revisiting patients to appoint per week and the number of physicians and midwifes that should be scheduled per week. The planning is conducted using the numbers from the previous year as a forecast. The average number of cure requests from previous year is used, creating a *uniform* plan, meaning that all weeks are planned to have the same capacity demand. The current production goal for first visiting patients per week is 135 and for revisiting patients the number is 200.

Patient group planning and control

In addition to having a yearly production plan at the gynecological outpatient clinic there is a shorter production plan, regarding the upcoming 8 weeks. The planning can be described as *scheduling of appointment slots by type*, since the planning is conducted by first regarding what specialists are available for the gynecological outpatient clinic. From the different skills the available specialists hold, different types of activity slots are generated. As an example there are some physicians who are specialists within the field of incontinence and patients who seek care for an incontinence disease or disorder will thus need an appointment at such a specialist. Other patients seek care for what is considered more general diseases which all physicians can supply care for, independent of specialization. As a result, some diagnosis groups are more sensitive to physicians' absence when in need of specialized care.

Before scheduling all the specialists distributed to the outpatient clinic there are applications for time-off and other known out-of-office hours e.g. educations, parental leave, meetings etc. that has to be regarded. These applications are taken into great consideration and are rarely questioned and the physicians thus have high freedom when it comes to influencing the own work schedule. The applications for time-off influence the number of available appointment slots for patients.

Once the schedule for all available physicians is set, staffing is planned for all midwifes and nurses with regards to fit with the schedule provided for the physicians. The number of nurses and midwifes to schedule is based on the number of scheduled physicians, how many rooms they acquire and what kind of patients they will supply care for. The physicians work schedules are constructed by a chief physician, whilst midwifes' and nurses' schedules are constructed by a secretary and both schedules are constructed using different IT support systems.

Patient planning and control

Once the appointment slots are created and assigned intended type of patient to appoint based on required expertise the schedule is further divided into slots based on rules of

prioritization. The patients are prioritized appointments based on an assessment by a physician. The prioritization of first visiting patients is conducted using three categories: double prioritization *FF*, single prioritization *F* and non-prioritized patients *O*, where FF is the highest priority and O the lowest. FF patients are given an appointment within 10 days, F patients within 30 days and O patients within 90 days. By having some slots reserved for FF and F patients these can be scheduled with shorter notice than the O prioritized patients. The only patients who are put up on the waiting list for a first visit appointment are the ones with priority O. Some first visiting patients will need a revisit appointment in the 8 week period for which the current schedule is due and therefore a few appointment slots are reserved for upcoming revisits.

Once the schedule is up and running patients can be assigned to appointments. Prioritized patients (FF and F) are scheduled as such referrals arrive. Non-prioritized patients (O) are scheduled using first in – first out principle, meaning that the patient who has been waiting the longest is offered the first available time.

Patients are informed about when to visit once they have been scheduled for an appointment. The information is sent to patients by mail. No response is requested and the patient is expected to visit the outpatient clinic at the appointment given. It is the patient's responsibility to inform the outpatient clinic if the given appointment is badly suiting and request another appointment. The patient has the right to make a request for a new appointment twice without losing their right to visit the outpatient clinic. However, since it takes some time to find new appointments slots a patient with prioritization O who requests a new appointment will likely be one who will have to wait more than 90 days to see a physician at the outpatient clinic.

Even though some patients request new appointments the cancelled appointments are usually filled by offering the appointment slot to the next patient in line or to any other patient who seek care at the outpatient clinic. By looking at data from 2014 regarding the available capacity in terms of appointments scheduled and the number of patients seen, the utilization of the available appointment slots is high, see Figure 12.

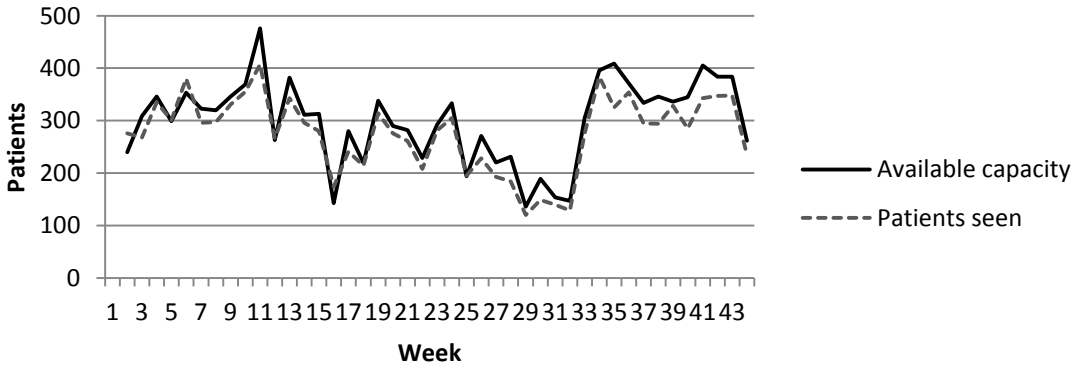


Figure 12: Available capacity vs. patients seen

In some cases, as in week 2, 6, 12 and 16, the number of patients seen is greater than the available capacity. In this case it implies that more patients were given an appointment

than was considered available from a scheduling perspective. The possible number of appointment slots is based on the number of physicians and midwifes working. One working physician or midwife generates 5 appointment slots for every 3 hours. It is thus possible to see more patients if the scheduled appointments take less time than 36 minutes (3 hours to see 5 patients) including work breaks. This way of using possible appointment slots to estimate capacity causes the capacity utility rate to be more than 1 in some cases, which can be seen in Figure 12 where the capacity utilization per week is displayed. Using the capacity utilization during all weeks in 2014 and the data provided in Figure 13, the average fill rate was calculated to 92 percent and the mean value of possible appointments, both new visits and revisiting patients, were 299 per week.

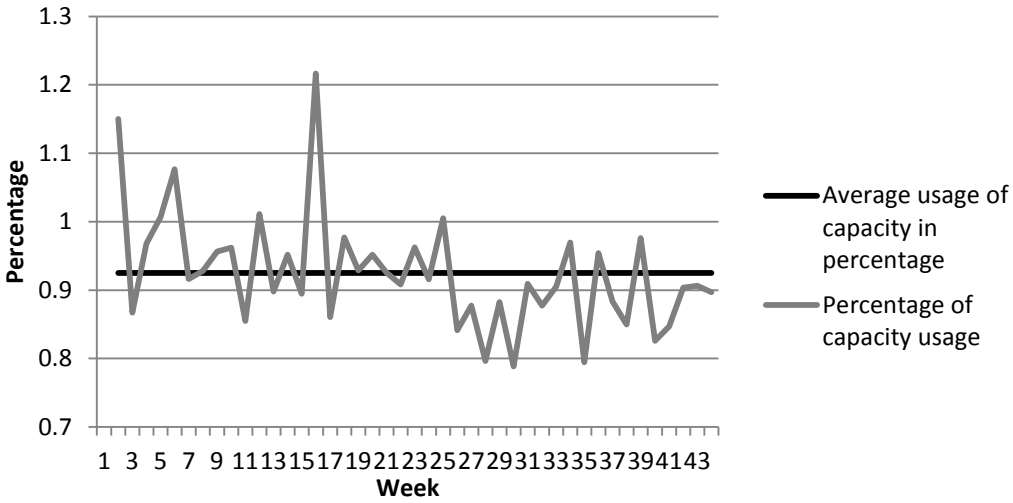


Figure 13: Capacity utilization per week in 2014

Given this data about the current capacity utilization it is clear that the appointments scheduled are currently being utilized to a very large extent. The steps of the PPC process have been explained and the first research question has been answered. In the following section, data will be presented concerning the current waiting list situation.

4.6 Waiting list situation

The current waiting list situation at the gynecological outpatient clinic will now be described. There are currently two types of waiting lists at the gynecological outpatient clinic, one is for patients waiting for a first appointment (first visitors) and the second waiting list is for patients who are expecting a revisit appointment (re-visitors). The two waiting lists will be presented in different sections to facilitate the reading.

First visitors' waiting list

The outpatient clinic maintains data on the number of patients waiting for their first visit. A patient is put on the waiting list based on the date of the incoming of the patient's referral from a primary care clinic to the outpatient clinic. First visitors' waiting list data is grouped according to how long the patients have been waiting. All patients in this waiting list are patients who have been prioritized as O patients, as

previously explained. Figure 14 shows how the waiting list for first visitors has developed since the beginning of 2013.

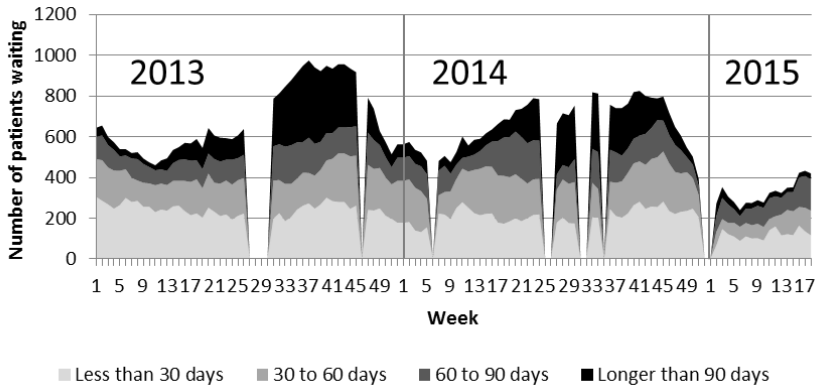


Figure 14: Patients in waiting list each week since 2013

In summary, the number of patients waiting for their first visit week 1 in 2014 was 563, and in week 52 there were 393 patients waiting. The top value of patients waiting in 2014 was 825 and was measured in week 41. From week 45 and six weeks after, the clinic arranged evening receptions to decrease the waiting list. After the evening arrangement the number of patients waiting for a first visit was approximately 310.

As patients wait, they will eventually move from one category to the next. Each patient in the black category has previously been in the darker gray category, and lighter gray category before that. Data for some weeks are missing because of responsible data gathering staff was off duty. The waiting list peaks at almost 1 000 patients waiting in the summer of 2013. In 2014, the waiting list also peaks during the summer weeks. The same pattern seems to repeat itself both years, i.e. the number of patients is relatively stable or decreasing for the first few weeks of the year but then begins to increase with a peak in the summer. As the waiting list continues to increase after the summer and throughout the first half of autumn the situation becomes unbearable and the clinic requests extra resources to cope. The extra resources (money) were granted in both 2013 and 2014 and were spent on evening receptions for 6 weeks. Once the evening receptions were introduced in week 44 the waiting list decreased greatly.

As for the number of patients who have been waiting for more than 90 days, this group reaches about a third of the total number of waiting patients in the middle of the year. The clinic then works down this part of the queue at the end of the year. It can be observed that as 2015 starts, the waiting list is shorter than it has been in the two previous years, and while this looks like a promising start, it does not guarantee that this level will be kept, as is obvious from previous years.

The outpatient clinic has a goal of appointing all first visiting patients within 60 days. Even if the waiting list is now shorter than it was in 2013 there are still many patients who have to wait longer than 60 days for an appointment. The categories of patients

waiting more than 60 days are historically building up during the summers and are treated first in November.

The patients waiting for a first visit at the outpatient clinic are served according to a first in - first out principle, meaning that the patient who has been waiting the longest is given an appointment. The first in – first out principle is however sometimes disregarded when rebooking of given patient appointments are requested. There is a national directive giving patients the right to rebook their appointments twice without losing their place in the waiting list. This directive causes some increased difficulty for the outpatient clinic since most patients are booked when they reach the 90 day limit and rebooking often causes extended waiting list time.

To further understand the current situation at the outpatient clinic some demand and supply data was provided by the women's health department at Skaraborg's hospital. The demand concerning the first visitors is caused by patient referrals. The supply is regarded as the available capacity in terms of number of first visitors seen. The capacity demand and supply relation is interesting in both short and long term since the fit can vary in the two perspectives as stated by Jonsson and Mattsson (2009). Therefore the current situation regarding demand and supply fit is investigated both in terms of accumulated fit over the year and weekly fit. Figure15 illustrates the accumulated number of incoming referrals and first visit patients seen.

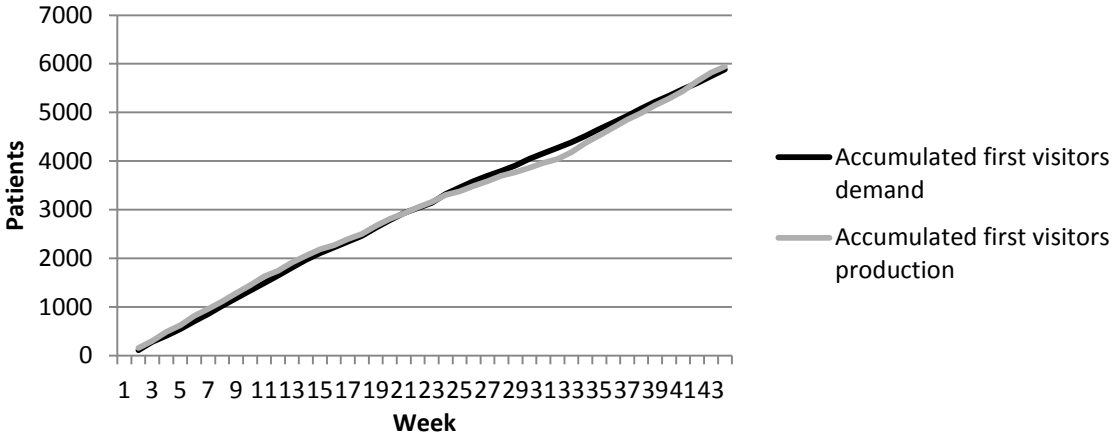


Figure 15: Accumulated first visitors' demand vs. first visitors' production

From Figure 15 it can be seen that the accumulated first visitors' demand and the accumulated number of first visitors seen follow the same pattern and seem to fit to large extent. Since there is a fit, the long term demand and supply fit does not seem to be a large issue in the first visitors' category.

Next to understand is then what the current fit between demand and supply in the short term looks like. Data for demand and supply per week in 2014 is presented in Figure 15.

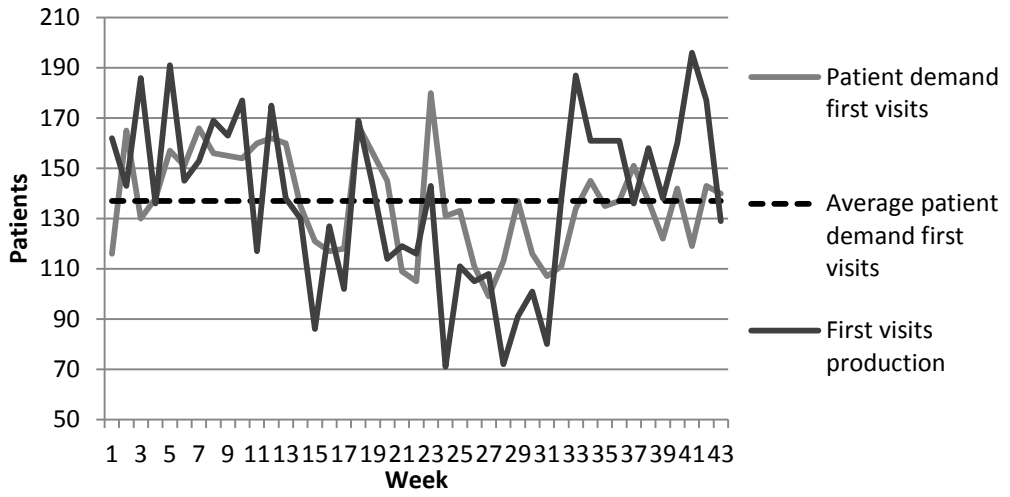


Figure 16: Production vs. Demand in 2014

The lighter gray line in Figure 16 represents the number of incoming referrals for week 1 to week 44. The average patient demand during this time was 135 incoming referrals and is visualized as the dashed line in Figure 16. The dark line represents the number of patients that were treated each week at the outpatient clinic. Since incoming referrals in general not are given appointments in the same week as they arrive the fit between the lighter gray line and the dark line in Figure 16 is not particularly important when considering demand and supply one week at a time. The variation is rather what can be considered interesting in Figure 16 since it illustrates how the average can be misleading when anticipating referrals and planning capacity. As can be seen, there are extensive variations in demand defined as incoming referrals. The production, as number of patients seen, also varies a lot during the year with high peaks during the spring and autumn, and with lower general capacity during the summer.

The comparison between demand and supply in the same week shows the variations in both demand and supply. However, it is not correct to assume that the incoming demand in one week should be given the same amount of capacity in that same week. The incoming demand for one week does not necessarily have to be met in that same week since there are different prioritizations to the different incoming demand. Some patients are prioritized FF and they should be scheduled within 10 days but other demand is based on referrals that should be handled within 60 days to reach the queue billion goal. Therefore the demand needs to be divided into the future and then compared to the capacity planned for that week to give a proper comparison of how large the difference in demand and supply is per week.

Information about the waiting list for first visitors at the outpatient clinic has now been discussed. In the next section data about the re-visitors' waiting list is presented.

Re-visitors' waiting list

The re-visitors' waiting list is different from the firs visitor's. The re-visitors are kept in different lists belonging to specific physicians to whom the patients paid their first visit

and who ordered the revisit. Physicians who order revisits state that patients should make the revisit before a specific time period for example in two weeks, in four months, in two years or in any time frame between. Based on this time period for revisit a so called goal date is set in the system as a way to control what date the patient should be scheduled for their revisit. Re-visitors are put in a specific waiting list first when their time for a revisit has been exceeded. Similarly to the first visitors' waiting list waiting patients are divided into groups but here with regards to the lateness of the appointment given in exceeded days. The current waiting list in terms of lateness for re-visitors is presented in Figure 17.

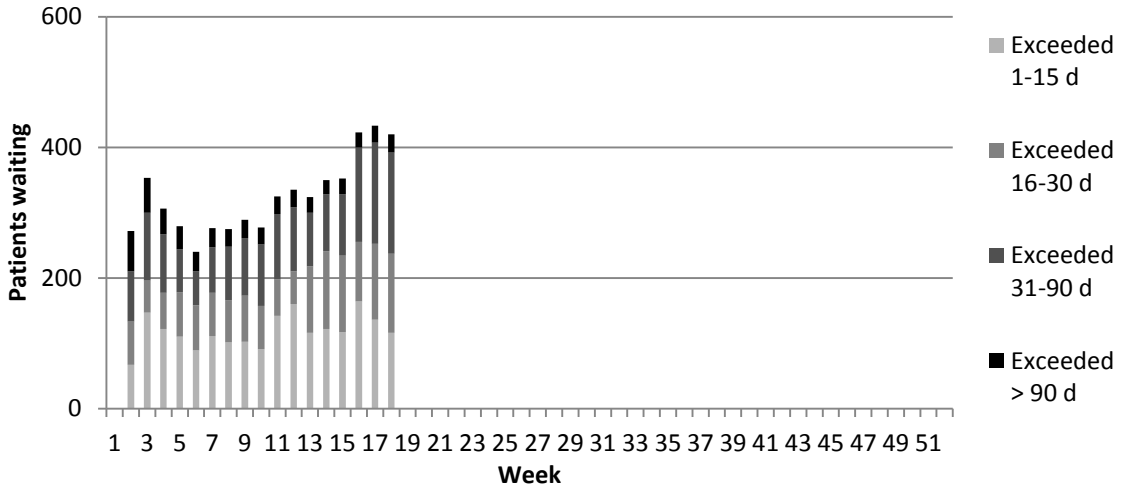


Figure 17: Patients waiting for revisits where the goal date has been exceeded (2015)

To measure and save data about the number of patients waiting for a revisit where the goal date has been exceeded was first introduced in the last weeks of 2014. Therefore the available data about the revisitors' waiting list is from the current year, 2015. Figure 17 illustrates how many patients with exceeded goal dates that are waiting for a revisit appointment at the outpatient clinic per week. The different grays show the extent of exceeded time for the patients in the revisits' list. The lightest gray indicates exceeded 1-15 days of goal date, second lightest gray16-30 days, darkest gray 31-90 days and black more than 90 days. Similarly to the first visitors' waiting list this revisits' list has also increased during the spring.

The number of patients who demand revisits on a yearly, monthly or weekly basis is perceived as harder to estimate than the number of first visitors. This is because revisiting patients are referred to specific physicians, and each physician thus has an individual waiting list. Apart from being harder to predict the revisits are also a bit trickier to schedule because the goal dates for revisits are regarded as somewhat flexible. Instead of considering the goal dates as absolute, the goal dates are considered guidelines as of when to schedule the revisit, especially in cases where the revisit goal date is far into the future.

During 2014 the production goal of revisiting patients, meaning the number of revisiting patients predicted to appoint, was 200 patients per week. This goal was based on the production plan of 2013. In 2014 however, this goal was never reached. The data about the number of conducted revisits compared to the goal of 200 patients per week is visualized in Figure 18.

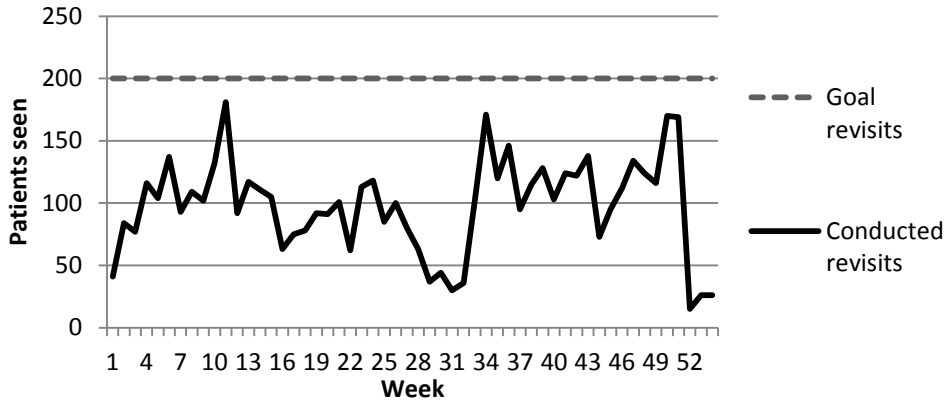


Figure 18: Conducted revisits compared to the production goal 2014

The production goal of seeing 200 revisiting patients per week was not reached in any week in 2014. The average number of revisiting patients seen per week was in fact 100 in 2014. The waiting list situation at the gynecological outpatient clinic at Skaraborg's hospital Skövde has now been presented.

4.7 Production planning process at the dermatology unit

To further understand the current situation at the gynecological outpatient clinic in terms of preconditions related to the specific site and industry on what the PPC needs to be based upon and to further develop perspectives of how PPC can be conducted, an interview was held with the unit manager at the dermatology unit at Skaraborg's hospital Skövde. The dermatology unit was selected suitable as interview object because of its reputation of having one of the most successful PPC processes at the hospital. It was studied in order to have a benchmark for what a good PPC process is. It also provided insight to how such a process can be achieved. It will be related to in chapter 7, *Discussion,* when discussing the challenges of implementing the improvement suggestions.

The dermatology outpatient clinic at Skövde is different from the gynecological. For starters the dermatological clinic does not have a dermatology inpatient clinic. All patients who need to undergo surgery related to dermatological causes are treated at another department and are sent home only hours after their surgery. This implies that most staff only works at one location, the outpatient clinic. Most patients who visit the dermatology outpatient clinic have been referred to Skövde from a primary care clinic and medical conditions treated are all types of skin conditions, as melanomas, and also STD's. The dermatology outpatient clinic treats fewer medical conditions and has fewer demand categories than the gynecological outpatient clinic. These are the main

differences between the two outpatient clinics regarding the patients they treat and under what conditions they can be run.

Similar to the gynecological outpatient clinic the dermatology unit also has the hospital board and government goals and targets to fulfill. Therefore, the main differences between the PPC processes are based on the different activities conducted at the different units at the lower PPC control levels.

The production planning process at the dermatological outpatient clinic includes three main steps. First a preliminary demand based schedule is produced. The schedule includes the forecasted demand for different types of appointment slots. The demand varies a bit depending on the season, in the summer the demand for further investigation of skin dots increase, but the demand is perceived as quite stable. Once the demand based schedule is produced the second step concerns scheduling of physicians and nurses to match the demand in terms of number of receptions and the specialization need. The third step is to book patients. Patients are booked as referrals arrive. Once a referral is received the patient is immediately booked to the closest available appointment slot. Revisiting patients receives a card with a number and a date to call the dermatological outpatient clinic to book a revisiting appointment. Once the call is received the revisiting patient will be given the closest available appointment, in the same way as new visiting patients would.

Schedules cover six weeks and are produced when two weeks of the present schedule remain. The schedules are produced by a few people at the clinic who work together to handle the “scheduling puzzle”, as it is perceived to be with all education days, conferences, parental leave, holidays and other know staff absences. Instead of splitting the planning chores however, as is the case at the women’s health department, the chores are shared in terms of having a few people do the same thing and discussing different solutions to reach a favorable schedule.

The fourth and last step is an evaluation step where the waiting times for different types of appointment slots are evaluated, including both the current and future situation. The evaluation step is conducted daily. Morning meetings are held with all staff who is working at the dermatology outpatient clinic every day. Nurses, physicians, secretaries and unit manager participate in the morning meeting every day where different topics are discussed, where the production plan is one of the topics. The production plan is displayed using an excel document where the key performance indicators are displayed in terms of current waiting time for an appointment for the different medical conditions. If the waiting time is acceptable the figure is displayed in green. If the waiting time is considered too high the figure is displayed in yellow. If the waiting time is considered unacceptable the figure is displayed in red. By displaying the production plan in this way every day, staff is given an opportunity to prepare for a more intense work situation if the figures are yellow or red. Also, it encourages fast reaction and coping of the situation when waiting times change from green to yellow.

When there is a change from green to yellow in the waiting times for one or several types of appointment slot the staff works together to lower the waiting times back down to green. The most common way to lower it back down is to increase capacity in terms of seeing more patients, by decreasing the time for each patient, or by over time. If all physicians take one extra patient each per hour many more patients can be seen without having one single physician work an entire evening. The sharing of the responsibility to cope is based on the mutual trust and believe in the staff as a group to work together to solve problems. The feeling of belonging to a team is something that the unit manager has been working to accomplish for several years.

One of the steps to accomplish this production planning process was for all staff to realize that it is not reasonable to demand days of during both Christmas and Easter or for all physicians having summer vacations the same weeks. In the long term an even staff scheduling is perceived to decrease the production variation and also decrease the number of peaks where patients waiting times are yellow or red. If the waiting times can be held even the work pressure will also be more stable. To have an even amount of workload for every day at work is a dream for many in the health care industry, including the staff at the dermatology outpatient clinic. The even work load in combination with being able to provide patients with high quality care without long waiting times is perceives as the success of the current PPC process at the dermatology outpatient clinic according to the unit manager.

The current waiting list situation and PPC process at the gynecological outpatient clinic has now been described. It has been found that two different waiting lists exists; new visits and revisits. The PPC process at another clinic at Skaraborg's hospital has also been presented to stipulate an example of what a successful PPC process within the healthcare industry is considered to include.

5 Analysis of current situation

In this chapter the current situation is analyzed through the theoretical framework in order to find areas of improvement in the current production planning process. Furthermore, research question two will be answered: *How does the current PPC process contribute to the waiting list problems?* The analysis is divided into capacity-side issues, section 5.1, and production-side issues, section 5.2. Following the capacity-side and production-side issues are also some outcomes of the issues regarding the results on the waiting list situation, section 5.3. The analysis is concluded with a summarizing figure where all issues found are grouped into main problem areas in section 5.4.

5.1 Capacity planning issues

As shown in chapter 4, *current situation*, the scheduling of specialists is the main determinant of how many appointments that can be produced in a day, meaning that specialists are a bottleneck resource for the clinic. The specialists can be classified as time-shared resources in the terminology of Vissers et al. (2001) as they are shared between several units at the women's health department, and are allocated to the units in time slots. The allocation of specialists is complicated because of the interdependencies between resources. The scheduling of specialists creates demand for other resources and specialists can thus be considered a "leading" resource. The specialists at the women's health department are required for a number of different activities, which creates a need for some allocation mechanism.

At the women's health department, a prioritization rule is used when allocating time-shared specialists. For medical reasons, the outpatient clinic has the lowest priority. This means that when resources are lacking at the women's health department, the required resources will always primarily be pulled from the outpatient clinic. In a situation where there is a perpetual lack of resources, this will lead to an inability for the clinic to fill the schedule with specialists.

Three main mechanisms cause lack of resources at the outpatient clinic. First, the production plan cannot be fulfilled if there are too few specialist-hours to allocate already when the department schedules are being made. Second, unplanned absences of staff at the department will lead resources to be pulled from the outpatient clinic, leading to sudden changes in the scheduling and possible rescheduling of patient appointments. Third, the fact that individual scheduling requests, such as paid leaves to attend courses, and requests for vacation, are considered before the scheduling of the outpatient clinic, also contribute to lack of specialists at the point of scheduling for the outpatient clinic. Thus the first and third mechanisms cause shortage at the moment of scheduling, while the second causes sudden pulling of resources.

Thus these three mechanisms lead to different patterns of resource shortage. The first causes a general lack of specialists, roughly evenly spread out over the year, which is known at the time of planning. The second leads to sporadic absences that cause cancellations of appointments, and is difficult to plan for. The third causes "lumpy"

shortages, as requests for vacation tend to be clustered around popular holidays and summer. They are also known at the time of planning, and tend to occur at predictable dates. These patterns are illustrated in Figure 19.

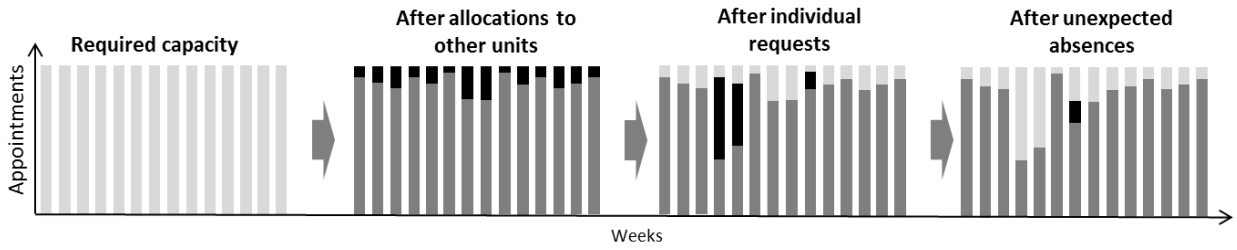


Figure 19: Patterns in available capacity

It is difficult to argue with the fact that the outpatient clinic does not treat the most medically urgent cases, and thus changing the prioritization within the medical divisions would be a prime example of sub optimization. However, the logic of fulfilling individual scheduling requests before filling the outpatient clinic scheduling needs can be questioned. It could be argued whether this practice is consistent with the goal of providing patient-centered care. On the one hand, the medical profession requires continuous education, and attendance at courses is required for their professional development. On the other hand, this privilege is not available for other staff groups, such as nurses. In any case, the policy restricts scheduling at the outpatient clinic.

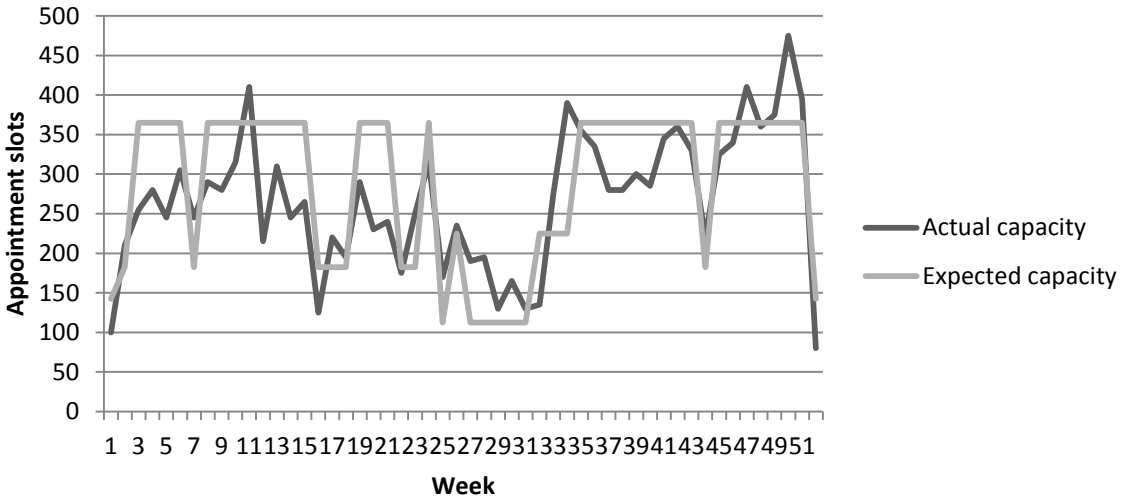


Figure 20: Actual capacity compared to expected capacity in 2014 with regard to Swedish holidays

Figure 20 shows the correspondence of actual capacity in terms of available appointment slots with expected capacity dips due to Swedish holidays and school breaks. The dips in expected capacity are for illustrative purposes set to half the targeted capacity these weeks. The targeted capacity is the weekly production goal set in the production plan. Compared to the actual capacity that was used per week in 2014 there are clear correspondences. This proves the hypothesis stated by the staff at the

outpatient clinic, that physicians were given less appointment slots at the outpatient clinic in weeks with Swedish holidays and school breaks.

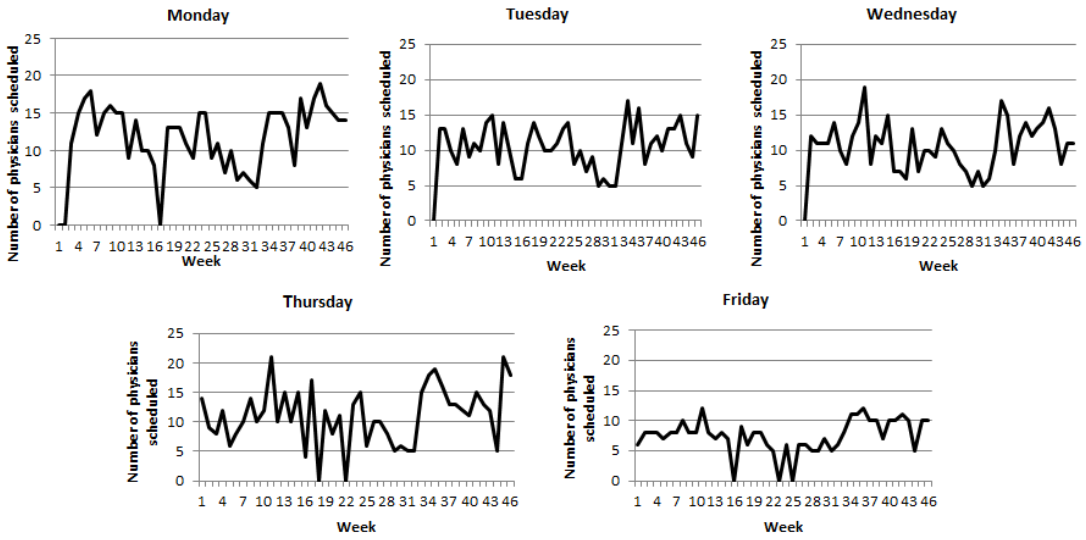


Figure 21: Number of physicians scheduled per week based on week day

Figure 21 shows the symptomatic variation in physicians scheduled on each day of the week in 2014. Thursdays are in general the days when the most receptions are planned. Fridays are the days when the lowest number of receptions is planned. It should be mentioned that the number of receptions is lower on Fridays because of weekly physician meetings being held then.

The fact that scheduling of specialists and nursing staff is conducted separately by separate schedulers is problematic for two reasons. It reinforces the divide between the specialists and the nursing staff, which is undesirable for two reasons. First, it diminishes the horizontal control function that should ensure matching of supply and demand. This is because it requires an additional communication effort, compared to if it was done by one scheduler, or by several schedulers together. The specialist scheduler has knowledge about individual specialists and when they are available, while the nursing staff scheduler has knowledge about when appointment slots need to be filled and when rooms are available. Second, it reinforces the care-cure divide as described by Gloubermann and Mintzberg (2001).

All of the above contributes to creating a capacity planning process where no consideration is taken to demand required, as capacity supplied to the outpatient unit is completely determined by external factors. As discussed in the theory chapter, a prioritization of materials-approach, where capacity planning is based on the capacity required for planned production, is desirable. But the situation today corresponds to a prioritization of capacity-approach, where capacity is treated as given. This means that the outpatient clinic is hit by large supply variations, leading to un-even, insufficient scheduling of time-shared specialists.

5.2 Production planning issues

The outpatient clinic currently creates a yearly production plan for first visits and revisits, based on demand the previous year. The production plan uses leveled weekly production targets of 135 first visits and 200 revisits per week. The leveled target in itself is not unreasonable on this planning level. However, the fact that scheduling of specialists is based solely on left-over capacity means that the outpatient clinic lacks the means to adapt production to the production plan. There is also no adaptation of the production plan to the actual capacity situation. As there is no adaptation of capacity to planned production, and no adaptation of the plan to capacity, the plan does not have any meaning except as a statement of what the clinic would wish to achieve, and the difference between required and actual capacity.

The current production plan corresponds roughly to the Master Production Schedule in the MRP II-framework and the *resources planning and control* level in Vissers et al. (2001). Both frameworks prescribe a planning level between these and the lowest planning level. However this is not existent at the clinic. In fact, as described in the above paragraph, the production plan is not at all adapted or considered at the lower planning levels, as production is dictated by capacity. The method currently used resembles the overall factors method, which is considered most appropriate when planning on a rough level, when demand is leveled and products are homogenous. Thus there is a lack of a short-term planning method.

Vissers et al. (2001) prescribe that planning on the patient group level should include decisions based on project number of patients and the available specialist capacity. Further, the vertical control function should ensure "readjustment of service level standards". This means that even if production goals cannot be achieved, adjustment of the plan to real conditions could contribute to more successful planning by allowing more accurate information to travel up the planning hierarchy. This would make the fact clearer that current production goals are not realistic and thus not appropriate.

Another component largely lacking in the current planning process is forecasting. Forecasting is done to the extent that the production goal is based on total demand the previous year. This leaves the clinic with little predictive ability about demand the coming periods. A short-term planning method, combined with accurate forecasts on specialist needs, would allow better knowledge of the number of specialists of each type required in the coming period.

An important aspect of PPC is to consider the demand since it often stipulates the basis for planning for both production and capacity. Therefore, from a planning perspective, the better the knowledge of the true demand the more accurately production and capacity can be planned for, and in extension, executed on. By true demand, the demand caused by patient requests is referred to. There is currently poor knowledge of the true demand caused by the demand category of revisiting patients. Furthermore, the current planning process does not consider the different medical conditions and associated type of appointment slot efficiently and therefore the specialist need of patients in the current

waiting lists is uncertain. If the true demand would to be determined, then planning could be conducted to fit more efficient production plans.

It was shown in chapter 4 that the capacity utilization of the allocated capacity is very high, 92 percent. This in combination with the situation described above leads to the important conclusion that there is little to be improved in the actual appointment of patients. The area of improvement is on the upper planning levels. Vissers et al. (2001) make the distinction between operational and structural matching. It can be concluded that the issue is not with operational matching but on a structural level.

When available staff is limited, the resources are naturally set to handle the most acute cases. During the summers the staffing is at its lowest, this implies that hardly any non-prioritized first visiting patients or revisiting patients are appointed at the outpatient clinic during the summers. The queues thus build up during the summer since the capacity demand is continuously larger than the capacity supply. As a result of the growing waiting lists, extra resources in terms of evening receptions have been an only option to cope with the situation and decrease the waiting lists. The evening receptions are however conducted late in the autumn, making patients how seek care at early autumn also wait a very long time. If resources had been spent earlier during the year to decrease waiting lists, particularly before the summer, the queues would not have increased with as many patients waiting more than 90 days as it did in the autumn of 2014. This conclusion is based on a calculation using the capacity and demand given in 2014 where the extra capacity used in the autumn was instead planned in the late spring, and the effect is illustrated in Figure 22.

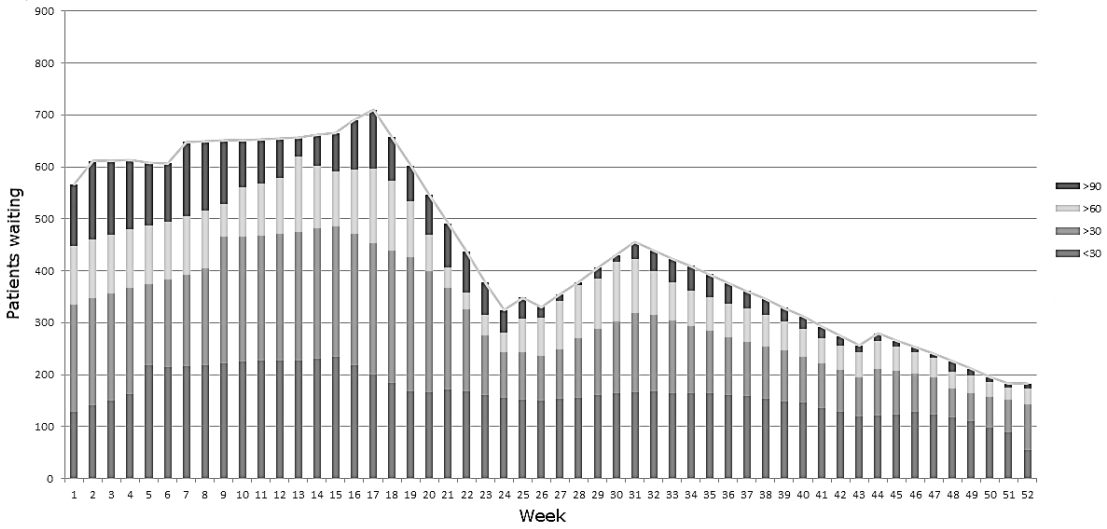


Figure 22: Projected waiting list development after rearrangement of extra receptions

By waiting for an emergency situation to appear before daring to use extra resources represents a too late reaction.

It seems that there has been lack of realization about the need to prepare before times of low capacity in the past. This is probably related to the queue levels appearing stable

before the summer and “firefighting” in the end of the year makes the waiting list level at the end of the year appear low. To reach a sustainable solution however, that keeps waiting lists under control throughout the year, the waiting lists need to be decreased before times of low available capacity in order to keep the waiting list from increasing rapidly. To reach a sustainable solution that will last from year to year is the goal, but the budget controls the mindset to large extent and draws the focus upon the yearly basis. The lack of a long term perspective largely contributes to the late reactions that in turn lead to the lack of periodic fit and firefighting.

5.3 Outcomes

The hospital is responsible for the fulfillment of strategic goals for service delivery performance set by political decisions, such as the care guarantee and the queue billion. The healthcare budget determines the availability of resources at the hospitals. This means that policymakers are ultimately responsible for ensuring that healthcare providers have the resources necessary to achieve the goals. But increasing healthcare costs combined with higher expectations from patients create a necessity for increased efficiency. When ambition levels are increased for performance targets without allocation of extra funding, this creates pressures for new ways of working. Improved production planning and control could be one method.

The clinic is currently not able to meet the performance targets for first visits and revisits. The current planning situation analyzed above does not give the clinic much possibility for improving the situation. Instead they have to resort to “firefighting”. A result of this is that supply and demand match when accumulated over the year, but there is a lack of periodic correspondence. Periodic correspondence is especially important in healthcare, as delaying of production means that a patient needs to wait longer for their care, possibly with decreased quality of life, and possibly causing worsening health conditions.

As has been shown, the problem is largely connected to structural matching, i.e. the inadequate allocation of resources to the clinic. A high utilization rate will not be enough to balance supply and demand. The contribution of an improved PPC process regarding this issue, would be to allow information to travel up the planning hierarchy, forcing better decision-making at top levels.

5.4 Problem areas

The analysis has highlighted many issues related to the current production planning process. Many of the issues found are related to one another and some even cause new issues as outcomes, as has been explained. To improve the current PPC process the relation between the different issues needs to be taken into consideration. Thus, by reviewing the entire current PPC process map (as previously shown in Figure 11) with regard to the issues found some main problem areas in the PPC process can be discovered.

The first problem area is the linkage between the patient flows-side of the planning process and the resources-side. The current way of planning causes *no adaption of specialist allocation to production plan* and thus contributes to the difficulties of reaching the goals set up in the rough annual level production plan.

The second problem area is constituted by the *lack of a method for short term-planning*. There is currently no connection between the yearly plan and the plan of 8 weeks, thus making it very difficult to adapt the short term-plan to reach the production goals set up in the rough annual level production plan.

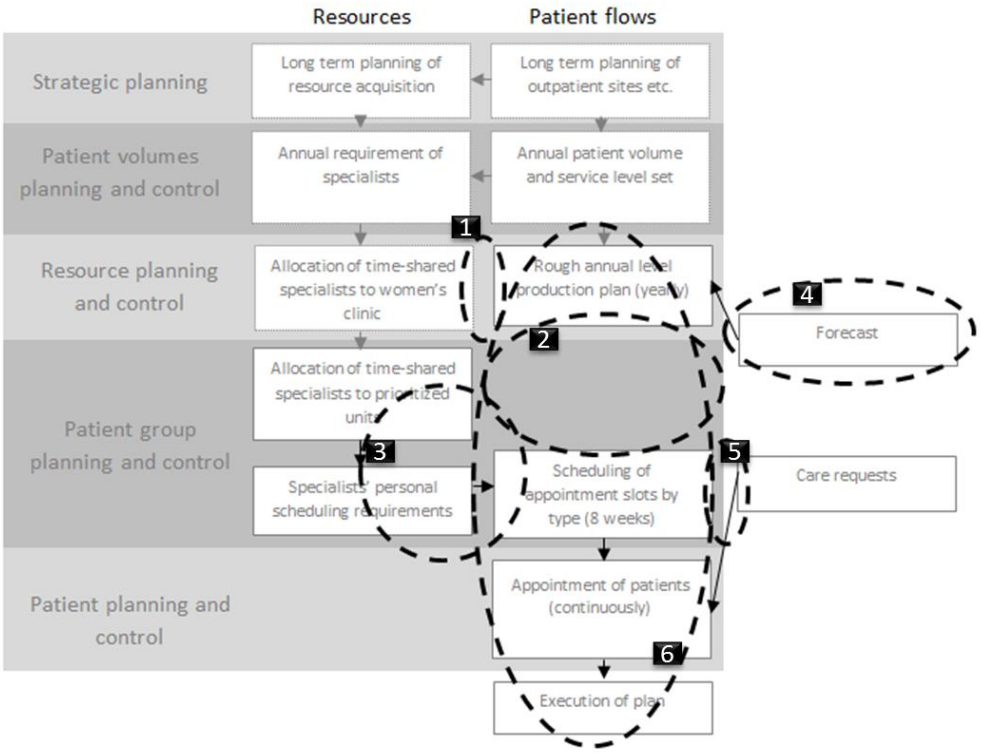
The third problem area realized is the *lack of adapting capacity requirements regarding the schedules*. The current staff scheduling procedure contributes to the prioritization of capacity rather than capacity requirements.

The fourth problem area is the *little forecasting conducted and little use of it in planning*. Since forecasting is not conducted, it is difficult to predict the capacity requirements in beforehand. If the capacity requirements cannot be predicted, the production planning will hardly include any trustable numbers of capacity requirements and the trustworthiness of such a production plan will be low. Thus, the focus on planning from a capacity perspective will be further strengthened, since the capacity requirements are not trustworthy.

The fifth problem area is *lack of consideration to true demand when scheduling appointment slots*. The true demand is currently not being considered when the schedules for appointment slots for the upcoming 8 weeks are planned. This also causes lack of consideration to capacity requirements and furthermore possibly contributes to some medical conditions to have to wait longer waiting times for care than others. If the true demand is not considered it will be difficult to ever reach matching of demand and supply.

The sixth and last main problem area found is related to the *poor realization of when to act*. The inability to realize when to make a new production plan to recover from faulty scheduling in the past or when to use extra resources to keep the waiting lists from increasing has proven to cause firefighting behavior. The lack of prediction ability of the future waiting list scenario causes inability to foresee the waiting list levels and thus also the need to revise the current production plan.

The six main problem areas have now been described. The problem areas are illustrated and summarized in Figure 23.



	Problem areas
1	No adaptation of specialist allocation to production plan
2	Lack of a method for short term-planning
3	Lack of adapting capacity requirements regarding the schedules
4	Little forecasting conducted and little use of it in planning
5	Lack of consideration to true demand when scheduling appointment slots
6	Poor realization of when to act

Figure 23: Problem areas found linked to the current PPC process steps

6 Improvement suggestions

In this chapter one main improvement suggestion will be presented in terms of a new PPC process. To support the new PPC process some additional improvement suggestions regarding three support functions were found: forecasting, care requests and a waiting list prediction. These functions and their impact on the new PPC process will be further presented in this chapter. The results found in this chapter will act as basis to answer the third research question: *How can the current PPC process be improved?* The chapter ends with a critical evaluation of the improvement suggestions and a summarizing part where the problem areas found in the analysis of the current situation (chapter 5) are related to the improvement suggestions presented.

6.1 New PPC process suggestion

A new suggestion for the PPC process at the gynecological outpatient clinic is hereby presented (Figure 24).

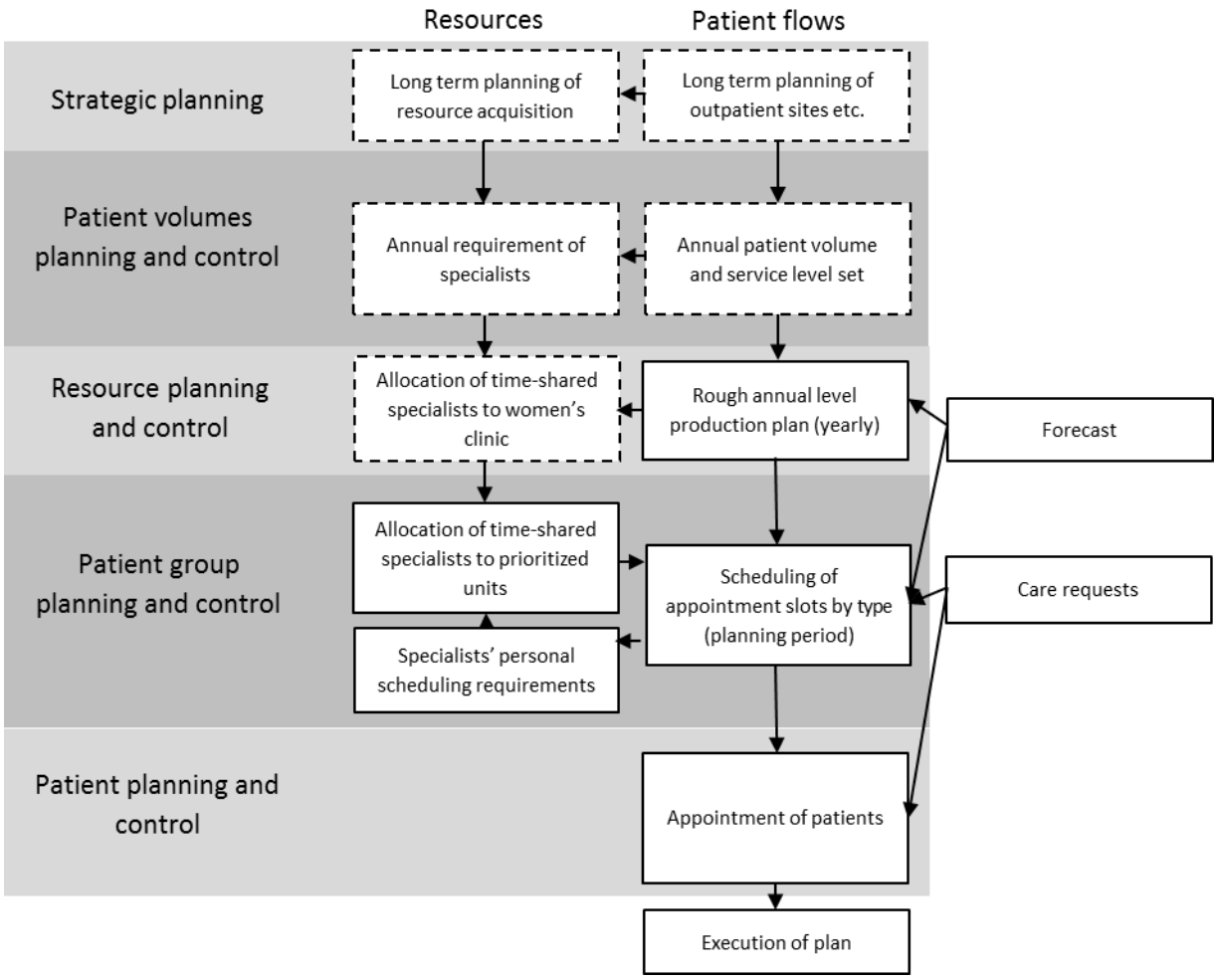


Figure 24: Suggested new PPC process

The planning steps on the highest control levels are not for the gynecological outpatient clinic to decide upon, and are thus not subjects for any changes. Those planning steps are represented by dashed outlining boarders. The planning steps which constitute basis

for possible improvements are instead the ones with solid outlining boarders. Improvement suggestions have therefore been regarded for all the solid outlined boarders and are presented below. The section is divided up in subsections by control level in the same way as the planning steps were presented in section 4.5, *The current PPC process.*

Resource planning and control

From the resources perspective at the control level resource planning and control the specialists working at the women's health unit are distributed among the different clinics, including the outpatient clinic. The distribution of specialist is not conducted at the gynecological outpatient clinic and that is why this planning step is illustrated with dashed boarders in figure 23.

From the patient flow perspective the planning is currently conducted using the numbers from the previous year as a forecast. The average number of cure requests from previous year is used, creating a uniform plan, meaning that all weeks are planned to have the same capacity demand. To plan for the patient flows at this level, the method capacity planning using overall factors could be adopted. According to Jonsson and Mattsson (2009) the method is suitable on a higher planning level and the method would have great resemble with the plan currently being used. Since the accumulated correspondence currently is high the method is subjected as suitable at this control level. However, instead of using forecasts based on last year's numbers, there are other forecasting methods that could be used to improve the rough annual level production plan.

Patient group planning and control

The gynecological outpatient clinic is currently using a capacity prioritization approach for planning the production. However, as found in the analysis of the current situation (chapter 5) it seems more reasonable for the outpatient clinic to carry out a materials prioritization based approach. In order to successfully carry out such an approach, proper forecasting and considerations to care requests need to be taken into consideration. Since the demand would constitute the basis for the planning, faulty demand would cause improper planning.

Once all of the demand is registered the production planning for the upcoming planning period can begin. It is then a matter of matching the demand in terms of the different categories and (sub-) specialization required and type of reception. As suggested by Jonsson and Mattsson (2009) a theory of constraints approach could be used to reach a proper schedule. The theory of constrains approach seems appropriate because of the scarce resources in terms of specialists that act as bottlenecks when creating a production plan for the gynecological outpatient clinic in Skövde. Since the specialists are found to be bottlenecks the utilization should be as high as possible to require an efficient and effective production plan. The planning method is suitable at somewhat lower planning levels and is considered quite easy to change if necessary. By using this

planning method it will become clear when there is a mismatch in the available capacity supply already in the making of the next work schedule.

To reach a PPC process where schedules are produced using the demand as basis for the capacity need, it is important to consider all staff simultaneously. If for instance all physicians are scheduled before everyone else, it is not certain that the demand can be properly supplied if there is a lack of knowledge about the entire staffing availability. All appointment slots needs to be filled for the planning to work, and all employees want the best individual work schedules they can get. To schedule physicians in a first step might thus not only cause lack of supply but also create unexpressed conflicts since physicians in general could seem to be getting better work schedules than midwifes or nurses at the outpatient clinic. A method where the focus is on the scarce resources, instead of acquiring the physicians alone as a first step, is therefore suggested.

The planning method theory of constraints is furthermore regarded suitable because of the simplification implied from a scheduling perspective. If there are not enough physicians available for scheduling at the outpatient clinic for some period of time it will be clear early on and potentially encourage schedulers to have a discussion about the reasoning in having patients wait because of lack of capacity caused by holidays or low prioritization of the outpatient clinic.

At the outpatient clinic, the theory of constraints would thus facilitate the fitting of appointment slots. Once the appointment slot have been determined the physicians and midwifes should be scheduled on fitting slots so that the most difficult appointment slots to fill are filled first (for example based on specialization) and the more general appointment slots are filled last. The schedule for the outpatient clinic should be conducted simultaneously with the other schedules produced at the women's health unit to make sure that no work regulations are conflicted and to provide an immediate overview of the schedule.

The currently applied requests for off-days are recommended to be treated in close consideration with the staff scheduling. Thus, instead of considering the off-day requests as something the schedulers have to obey, the off-day requests are suggested to be considered in combination with the scheduling situation. It does not seem reasonable to have all specialists within the same area on vacation simultaneously, as an example. The suggestion is to consider requests with respect to the planning situation and both the type and urgency of the off-day requests. The specialists' personal scheduling requirements should be considered as an input to the allocation of time shared specialists to prioritized units but it should also be possible for the schedulers at the scheduling of appointment slots by type process step to evaluate the off-day request and return the request to the physician in question and discuss if the request can be changed, thus altering the allocation of time shared specialists to prioritized units and the scheduling of appointment slots by type.

Another possible scarce resource mentioned was the examination rooms at the outpatient clinic. However, as discussed in the analysis of the current situation (chapter 5), the examination rooms are almost never a scarce resource. It is the occasional Thursday that the examination rooms could be considered a scarce resource. Therefore this also needs to be taken into consideration when conducting the production plan for the execution level. To reach a high level of utilization in the examination rooms the planning is required to be more even, using many rooms for both morning and afternoon receptions all weekdays.

Patient planning and control

Given the data about the current capacity utilization it was found in the analysis of the current situation (chapter 5) that the appointments scheduled are currently being utilized to a very large extent. Therefore the appointment of patient step in the PPC process will not be a subject for improvement suggestions to reach the purpose of this paper.

6.2 Supporting functions

Three supporting functions are presented in this subsection: forecasting care requests and waiting list prediction. Forecasting and care requests are currently regarded in the current PPC process. However, some improvement suggestions are recommended to support the new PPC process as presented in section 6.1. The waiting list prediction it the only support function that has been developed in addition to the existing ones and constitute a new suggestion for how to predict the future waiting lists levels.

Forecasting

As the analysis showed, there is a lack of proactivity in the production planning of the outpatient clinic, and the long waiting lists are handled through firefighting when the problem becomes unmanageable. The outcome of this is high accumulated correspondence but low periodical correspondence. To improve the periodical correspondence proper forecasting could be one solution to apply. Forecasting is commonly conducted on the highest control levels in PPC and is increasingly replaced with actual customer orders as the planning horizon decreases and more information becomes available. However, if information becomes available just before the very last minute, forecasting should also be conducted on lower planning levels. If the lower planning levels are not planned for, the matching of capacity demand and supply will hardly be successful. Forecasting is therefore suggested to be carried out not only at the resource planning and control level but also at the patient group planning and control level.

At the outpatient clinic there have been clear trends visible from the analysis of the current situation (chapter 5) in terms of seasonal variations in capacity supply. By using this information, that physicians request off-days in larger extent when there is a Swedish holiday or school break, re-allocation of capacity and capacity requirements could be used to larger extent to cope with the drop in capacity supply.

To forecast based on the type of appointment and the availability of specialist is another important step towards greater control of the waiting lists situations. The demand must be known in order to be met. The current way of using the waiting list diagram (Figure 14) to foresee the future waiting list situation is not enough from a matching of capacity demand and supply perspective. There might be many available specialists within certain specialties and non in others. To enable control of the waiting lists to such extent that the number of patients waiting more than 90 days should be forever zero, thus requires knowledge of what type of specialist is required. To reach a sustainable solution where no patients will have to wait more than maximum 90 days for care at the outpatient clinic the demand needs to be properly measured and forecasted.

Care requests

The first step towards measuring and forecasting demand is to find out what the demand is. From the current situation (chapter 4) it was derived that there were many different categories of patients that form the demand (Figure 8).

As mentioned, some patients are more sensitive to physicians' absence when in need of specialized care because different medical conditions require different specialists. Therefore there exists a need to map and register the incoming demand in terms not only based on incoming demand category but also on medical condition. One improvement suggestion is thus to find out the true demand by mapping all incoming patients into demand category and medical condition. Once the demand is mapped it could be used for further analysis of patterns or seasonal variations. It could also be used as a basis for future planning, for example in terms of extra receptions for some exposed medical conditions with long waiting lists. Once the true demand is analyzed it could also contribute by improving the forecasting.

The better knowledge of the input data in terms of demand for given categories the better the forecasting can be. Without correct input data proper forecasting cannot be conducted and proper planning will be hard to achieve. Forecasting and care requests are thus closely related, as previously mentioned, and an improvement suggestion is therefore to use forecasting when demand is unknown or uncertain and to complement forecasts with known demand as soon as it is recognized.

Suggestion for waiting list prediction

It was found in the analysis that there is a lack of long-term thinking which contributes to "firefighting" in order to fulfill the waiting time goals as determined by the care guarantee. During the course of the thesis, a method for predicting the waiting list situation was developed, which was found useful by the authors. This method is also believed to be helpful as a support for the PPC process at the outpatient gynecology clinic. It is therefore suggested that the clinic use the method in the PPC process. The method will here be described and then the suggested uses of the method as a support for the PPC process will be described.

The outpatient clinic currently registers weekly production in terms of appointment slots offered, and weekly capacity in terms of appointment slots available. The latter is based on the number of specialists available. The clinic also keeps track of the number of patients waiting each week. The patients waiting are divided into four categories depending on how long they have been waiting.

If a forecast is made on the inflow of care requests each week, then the excess or shortage production each week can be obtained by subtracting the inflow from the appointments offered. Accumulating the excess or shortage production over a period will produce the total change in the waiting list in that period. Thus the changes in queue for a given production plan and forecasted demand is obtained. This procedure is described by Figure 25.

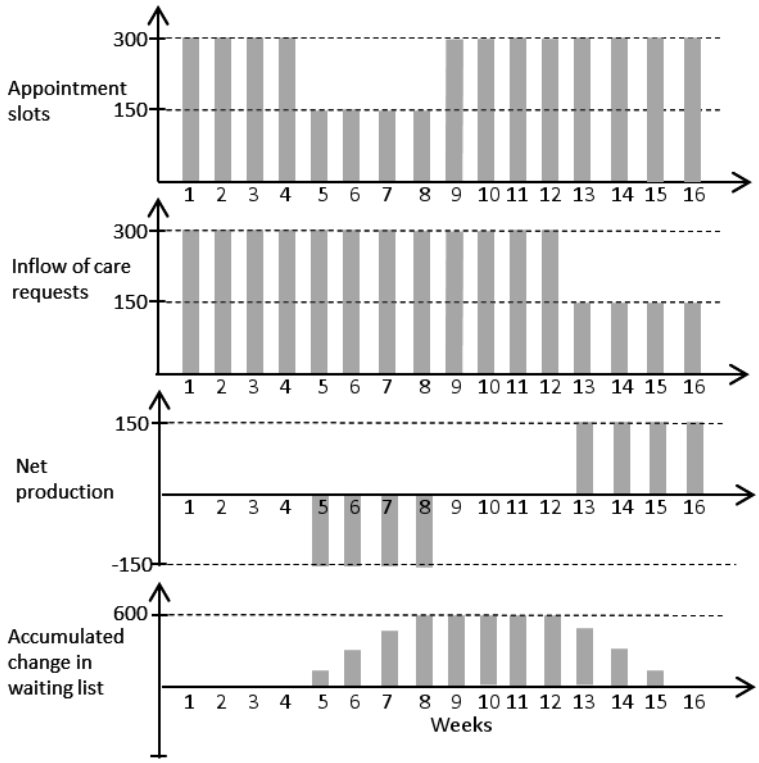


Figure 25: Calculating expected queue development. The two topmost diagrams show the capacity in terms of appointment slots and the inflow of care requests. The difference between these is the net production. The net production will lead the waiting list to develop as shown in the bottom diagram.

Combined with the present state of the waiting list, this accumulated change will provide a predicted development of the waiting list in terms of total number of people waiting. However, this does not provide any knowledge of how long patients have waited. This can be obtained if the waiting time of the patients on the waiting list is modelled. The clinic uses four waiting time categories for presenting the waiting list: shorter than 30 days, between 30 and 60 days, between 60 and 90 days and longer than 90 days. Under the somewhat simplified assumption that the waiting list is conducted in a first-in-first-out manner, production will always go to the latest category that there are patients in. New care requests will always add new patients to the first category.

Movement between the waiting time categories can be roughly modelled as follows: every week, patients who entered the waiting list four, eight or twelve weeks ago are moved to the next waiting time category. Thus a waiting list prediction method which corresponds to the waiting list diagram in Figure 14 can be designed. The mechanism is illustrated in table 1.

Table 1: Waiting list prediction method. In this example, 100 patients request care each week for the first four weeks. With the approximation that four weeks equal 30 days, in week 5, the patients who entered the system in week 1 will have waited 30 days and thus enter the next waiting list category. In week 9, they will have waited 60 days and once again change category.

Week	Care requests	Patients waiting			
		<30 days	30-60 days	60-90 days	>90 days
1	100	100	0	0	0
2	100	200	0	0	0
3	100	300	0	0	0
4	100	400	0	0	0
5	**0**	**300**	**100**	**0**	**0**
6	0	200	200	0	0
7	0	100	300	0	0
8	0	0	400	0	0
9	**0**	**0**	**300**	**100**	**0**

By the FIFO assumption, each patient treated should be the one with the longest waiting time. Thus it is easy to obtain the proportion of patients treated within 60 days, the main performance indicator for fulfillment of the care guarantee.

This waiting list prediction method would in the simplest, aggregated form not require any additional data. It relies only on data currently registered for the production plan and for waiting list documentation and could be implemented through a simple spreadsheet. With more detailed forecasting, the method could be further developed to predict the development of queues for different types of appointment.

The waiting list prediction method has potential uses at several points in the planning process. This subsection describes the three suggested main functions of the prediction method, and suggested areas of use at the resource planning and control level, patient group planning and control level and to support feedback to the upper planning functions.

The first main function of the waiting list prediction method is to predict how the waiting list will develop for a given production plan and care request forecast. Thus it can predict whether the care guarantee will be met or not. The second main function is that it can be used in a backwards manner to find what capacity plan would be necessary to reach a particular desired waiting list situation. The third main function is to predict the effect of special efforts, such as the extra evening receptions. An example of the third use has been presented in this report, in Figure 22.

At the resource planning and control level, the first main could be used together with some one-year forecast, such as the demand the previous year, and the production plan for the next year, to predict the general development of the waiting list the coming year. However, the usefulness of the prediction depends on how realistic the plan is. The second main function could be used to set a capacity level that would allow a desired waiting list development. At this level, the second main function could also serve to give input into the resource planning side, to emphasize what the situation will be with the capacity allocated.

At the patient group planning and control level, where the planning horizon is 8 weeks and the specialist and appointment schedules are made, the method could be used to predict more detailed changes in the capacity supply, and also adapt it to the actual demand seen. This could be used to motivate the unit to focus on the waiting list issue, in case it is headed in the wrong direction. As the development of the waiting list can be visualized for several months ahead, depending on the accuracy of the forecast and production plan, this would help allow early responses to waiting list increases. The third main function can be used to see how extra capacity could affect the waiting list situation, and ensure that such measures as evening receptions are conducted at an appropriate time.

The two above paragraphs include some examples on how the waiting list prediction could be one contribution to bridging gaps between the four worlds of healthcare. At the resource planning and control level, the method could act as a bridge between the care, cure and control worlds, as it gives the clinic an opportunity to show hospital management the effects of their resource allocation, in a way that is linked to the fulfillment of strategic goals. Similarly at the patient group planning and control level, the method could act as a link between care and cure worlds, by stimulating commitment to solving the waiting list situation by all staff. In a bigger picture, it could act as a link between strategic and operational goals, as it connects the strategic goals set by the community with the planning conducted at the operational level, thus helping bridge together community, control, cure and care.

6.3 Evaluation of improvement suggestions

The improvement suggestions provided regarding the PPC process and supporting measures in terms of forecasting and care requests have now been presented. This section includes a critical evaluation of the improvement suggestions and highlights the difficulties relating to realization and implementation of the suggestions.

PPC process improvement

Implementation of the suggested PPC process is of course not as simple as moving boxes around on a diagram. It will require changes in the way people work, and might not be popular with everyone. A few obstacles exist, the scarcity of specialists which in turn is caused both by a general shortage of doctors and the low prioritization of the outpatient clinic, the large gap between the care and cure categories in terms of physicians' and nurses' schedules and poor sense of community, the sense of

permanence of the waiting list situation, the current manner of using separate scheduling of physicians and nurses, the lack of current production plan overview and coherence. To implement the suggested PPC process would thus require overcoming these obstacles. In order to understand how the obstacles should be overcome is too great a task to study in this thesis. Instead, a recommendation will be made for further research in the area of change management and implementation recommendations for the gynecological outpatient clinic.

Forecasting

What forecasting method to use will not be further elaborated upon in this thesis. There is forecasting software available for hospitals but the implementation and adaption to the gynecological outpatient would still need careful consideration and that is why this evaluation of forecasting method is left for another time.

Care requests

The core activity of the outpatient clinic is the creation of specialist health care services. Activities that do not directly contribute to the core activity still need to support the core process in such a way that it allows it to work more efficiently or effectively, so that the total value increase will be greater than if resources had been spent on the core process. Administrative tasks are often criticized for taking too much time from more important activities. Data collection and administration are such tasks. Much of the data described above is already being collected by the department, and supplementing the missing parts is a requirement for the implementation of a good production planning process, and is motivated by the prospects of creating a sustainable waiting list situation.

Another comment about the mapping and registration of demand is that an exact number of patients who seek care at the outpatient clinic might not be possible to predict even if the demand is mapped and registered. It is because there is a variation in incoming patients caused by the unpredictable fact of knowing who will become ill. The mapping and registration of demand is intended to help predict the future demand by decreasing the span of variation in incoming patients. However, it is likely that there is a span of variation that statistically cannot be decreased if the variation itself is not decreased.

Waiting list prediction

There is certainly no shortage of spreadsheets and similar tools in the Swedish healthcare system and it is important to give the waiting list prediction a clear place in the planning process in order to ensure that it is used as intended. This includes specifying at which points in the planning process it should be used, at which levels, and by which persons.

6.4 Summary

To summarize the findings of the study Table 2 was created. The problem areas found from the analysis are linked to the improvement suggestions presented in the

improvement suggestions (section 6.1). The third and last research question has now been answered.

Table 2: Relation between problem areas and the improvement suggestions that can resolve the issues

	Improvement suggestion			
Problem areas	PPC process improvement	Improved forecasting	Information quality of care requests	Waiting list prediction
No adaptation of specialist allocation to production plan	X			
Lack of a method for short term-planning	X			
Lack of adapting capacity requirements regarding schedules	X			
Little forecasting conducted and little use of it in planning		X		
Lack of consideration to true demand when scheduling appointment slots			X	
Poor realization of when to act				X

The first improvement area found was that there are no adaptions of specialist allocation to the production plan, which caused a focus on capacity prioritization instead of materials prioritization. By changing the PPC process and concentrating on the patients referrals first and then allocating specialists the process will allow for planning with prioritization of the patient.

The lack of a method for short term planning was realized to be a second improvement area. Since there did not exist a short term planning method the rough annual level production plan was the one to follow. However, a method on such high control level is difficult to realize without making any plans for shorter terms. By introducing a short term planning method, as the suggested theory of constraints, the production planning could be better adapted to meet real demand and real supply.

The third improvement area found was that the scheduling procedure contributes to prioritization of capacity, giving the clinic no room for adapting capacity to requirements. By changing the scheduling procedure and in particular the way off-day requirements are handled the PPC process will allow for planning with prioritization of the patient.

The little forecasting conducted and little use of it in planning resulted in poor goal setting and poor realization of the goals. Improved forecasting usage and choice of method could facilitate the setting and realization of future goals. By using forecasting at lower control levels could further reduce the risk of setting poor goals or realizing poorly.

The fifth improvement area found was that the true demand is not considered when scheduling appointment slots. It caused poor fit between capacity demand and supply

since no consideration was taken to the specialist required by the patient's medical condition. By improving the data collection of care requests by medical condition, the specialist need can be further understood and adapted to fit with the demand. If this is realized more appointment slots will be given to the requested type of specialist and the match between the demand and supply will be improved.

The sixth and last great improvement area found was that no realization of when to act causes firefighting at the end of the year. The poor realization of when to plan for extra receptions put pressure on the entire outpatient clinic to perform once the "fire alarm" has been set off. By the usage of a waiting list prediction the future waiting list level could be predicted and thus used as a decision support to realize that action should be taken early on, most preferably in proactive state, to reduce the risks and pressure from the firefighting behavior.

All problem areas found relate to the matching of demand and supply. It is when demand outweighs supply that waiting lists occur. By improving the matching of demand to supply the waiting lists levels can be controlled and sustained, if the matching can be achieved on both short and long term.

7 Discussion

Some improvement suggestions on the production planning process at the gynecological outpatient clinic in Skövde have now been presented. The suggestions are based on addressing the problem areas found in the analysis of the current situation that were found to have the largest improvement potential related to the PPC process and, in extension, to the waiting list situation. The improvement suggestions presented are independent of one another and could be put in to practice separately. However, none of the solutions presented resolves all issues found alone. Instead, the largest improvement potential on the PPC process will be reached once all of the PPC issues found are addressed, thus suggesting all improvement suggestions to be implemented.

Whether it is feasible or not to implement all improvement suggestions at once and how the implementation should be conducted are two important topics to discuss to understand the value of this thesis to the gynecological outpatient clinic at Skaraborg's hospital. Thus, based on the evaluations of the presented improvement suggestions the implementation potential will be further discussed in this section to highlight the contribution to the fulfillment of the purpose as being *to provide improvement suggestions concerning the production planning process at the gynecological outpatient clinic at Skaraborg's hospital in order to enable the clinic to sustain waiting lists within target levels.*

The solutions presented address all issues found in the analysis of the current situation and are perceived as implementable. Therefore the solutions are considered suitable. The solutions presented were also considered to have synergies when implemented together. Better forecasting requires good quality of data. With more extensive gathering of care request data, the clinic would have a good source of input to the forecasts. Production planning can then be based on the known demand for the coming period, and on forecasted demand when it is not known. The prognosis created by the forecast could then be used as a basis for the scheduling of staff. The better the data, the better the forecast and the better the schedules (from a capacity matching perspective) would thus provide the best prerequisites for matching capacity demand to supply and having as few patients as possible put on the waiting lists.

By having managers viewing the prognosis and the staffing situation, proper productions goals should be possible to create and reach. Proper production goals might relate to the waiting list levels. If the prognosis shows that the queues will be increased during the summer then the managers could decide to increase the capacity and set higher production goals for a time to make sure that the waiting list levels are kept within proper levels.

There are of course other potential improvement suggestions that this thesis has not provided. Perhaps smaller improvement suggestions, related to one specific issue of the ones found in the analysis of the current situation, also had been suitable to reach improvements. The issues could be rated from worst to least bad issue and the solutions could be implemented according to the order from worst to least bad issue. The risk of

such solution strategy might be poor understanding of how different issues relate to each other and how the implications should be considered when trying to implement the next solution on the list. Therefore a solution with an entire system overview perspective might be favorable.

Even if the presented improvement suggestions would be considered as unsuitable for any reason, this master's thesis has provided a mapping of improvement potentials, in terms of the different issues found in the analysis of the current situation, which could be used for further improvement suggestions. The thesis should thus be of great value to the gynecological outpatient clinic at Skaraborg's hospital when improving the PPC process to gain control of the waiting list situation.

The gynecological outpatient clinic at Skaraborg's hospital treats many different medical conditions, have patients demanding care from referrals, revisits and consultant referrals as most outpatient clinics. However, unlike many other outpatient clinics the gynecological in Skövde also have patients seeking care through an on-call service, by showing up at the door, as cytology patients and as group of patients how will eventually seek care at other counties because of the long waiting lists at Skaraborg's hospital. The department operates at three different locations and the specialists also have many other duties. These are facts that separate the gynecological outpatient clinic at Skaraborg's hospital Skövde from other outpatient clinics, as the dermatological one studied in this thesis.

The variety of demand sources and appointment categories creates an extra need for forecasting. This led to the suggestion of improved forecasting and waiting list prediction. Even an environment where the appointment categories and patient demand sources are fewer, more extensive use of forecasting might still be helpful to understand the future demand and enable early reactions to prevent increased waiting lists. However, this argument might be unsuitable in relation to what such forecasting would demand in resources to be implemented and operated. A more proper argument for why more extensive use of forecasting could be valuable for other outpatient clinics could instead be the creation and realization of production goals by usage of the forecasts on multiple control levels in the PPC system.

As specialists are first required at the more urgent duties (surgery etc.), and capacity is allocated higher in the hierarchy, the department is left with two options for adapting capacity to demand: increased over-time and stricter control of doctor's schedules. The former is expensive and the latter will mean a change in expectations on the specialists and a decrease of their influence over their own schedules, which will hardly be well-received by a profession already highly burdened by overtime.

In order for the gynecological outpatient clinic to realize the improvement suggestions, change is required. Some changes are easier to implement than others. An experience from the dermatological outpatient clinic was that a very long process was required to reach the current state of planning, which is considered successful. Considering the

current state at the gynecological outpatient clinic, it can be expected that improving PPC will be a long process there as well. Therefore, a follow-up project could be conducted, in which a plan for the implementation of the improvement suggestions could be established, along with a guide for how to anchor the changes in the organization. Change management theory can provide many insights in how to do this. It should however be noted that a temporary "champion" cannot sustain change in the long term, as it has to be incorporated into the everyday processes. Therefore, clear goals and expectations should be discussed early on to confirm the realization potential and to understand what means are necessary to enable the change in PPC process.

This study was conducted on a limited segment of the healthcare system, which lacked much influence over the planning process as a whole, most significantly in the allocation of resources. This might have restricted the possibilities of changing the PPC process. Also, conducting this type of study on a limited segment may carry with it some risk of sub optimization, if care is not taken to make sure the performance of associated units is not affected. In this study, the capacity allocated to the other units was regarded as given, and the risk thus avoided. However, it is possible that with a more holistic perspective, coordination between the units could open opportunities for freeing up resources. For these reasons, the authors suggest that similar future studies consider a more extensive part of a hospital, for example an entire women's health unit.

Nevertheless, the PPC framework of Vissers et al. (2001) was found to provide a good foundation for understanding the PPC process and identifying issues, even at the low planning levels focused on here. Many issues could be described as failings of the horizontal and vertical control functions. Weaknesses in the horizontal control functions included the scheduling of specialists, nurses and patient appointments, and the lack of adaptation of capacity to capacity requirements. Weaknesses in the vertical control function included the great gap between production plans and actual production, and the lack of adjustment of plans, which impairs the information flow to upper planning levels. The assumption of specialists as bottleneck resources turned out to be true in this case, and the planning done at the clinic could largely be described in terms of the planning levels in Vissers et al. (2001). However it should be noted that the framework augmented with forecasting, and with the resource and patient flows considered separately, such as in in Figure 11, also closely resembles the MRP II-framework.

Studies investigating the use of PPC principles in healthcare are not abundant. Plantin and Johansson (2012) attempted an introduction of a PPC system at a surgery department, including an outpatient clinic. Similar to the case at the gynecology outpatient clinic, it was found that production was based on the availability of capacity. This suggests that the issues seen are common at outpatient clinics. In Plantin and Johansson (2012), a leveled scheduling approach with weekly production goals was attempted and seemed successful. At the gynecology outpatient clinic, the production plan sets weekly production goals, but as shown, the plan has no effect on production. This shows the importance of providing the clinics with the right tools to achieve the production goals. In general, the approach taken in Plantin and Johansson is to introduce

a PPC system through small steps, which seems to be a fruitful approach for the outpatient to consider in the improvement of the PPC process.

As the thesis was conducted, the four worlds framework of Glouberman and Mintzberg (2001) was found to have a good foundation in reality, as the divide between the care and cure worlds became apparent several times. Also, with the same terminology, it appears that the community and control worlds are not able to provide the care and cure worlds with the resources and tools necessary to achieve the goals they set. The point was raised by some of the hospital staff that the medical relevance of the care guarantee can be questioned, as it is perceived to interfere with more medically urgent procedures. Although evaluation of the clinics goals was not a part of this study, this further reinforces the sense that there is a gap between those who set the goals and those who produce the healthcare services. Overcoming the divide and uniting in the interest of the patient appears to be a big challenge for healthcare, not only regarding PPC.

The purpose of this thesis was to provide suggestions allowing the clinic to keep waiting lists within target levels. There is a difference between keeping waiting lists within target levels and reducing the waiting list. Waiting list reduction can be conducted in several ways, including capacity surges or through clearing the waiting list from patients who no longer desire care or could be better treated elsewhere. This has been successfully conducted previously at the clinic and other units at the hospital. However, such measures have only temporary effects unless low waiting list levels can be sustained. A way to sustain the waiting list over time is required to achieve long-term benefits. The suggestions provided here should give the clinic opportunity to, maintain their waiting lists over time, through granting them opportunities to adapt capacity to production needs in response to predicted behavior of the waiting list. The suggestions would be especially effective in combination with waiting list reduction efforts.

8 Conclusions

Waiting times constitute a huge problem in Swedish healthcare today. The introduction of policies such as the care guarantee and the queue billion has put pressure on healthcare providers to reduce waiting times for patients, which requires new ways of organizing production. The medical conditions treated at the gynecology outpatient clinic are not the most medically urgent, but constitute reductions in the quality of life of the patients. Shortening waiting times is thus a desirable goal to increase patient satisfaction. The approach taken in this study was improvement of the production planning and control process, which has shown potential to improve waiting times.

The outpatient clinic studied experienced long waiting times and did not fulfill its tactical or strategic goals. Although attempts had been made to improve the situation, they did not get lasting results. The waiting list for first visit patients followed a clear pattern, strongly related to restricted supply of specialists due to Swedish vacation seasons. The outpatient clinic was for medical reasons the lowest prioritized unit within the women's health department, which led to an unstable supply of specialists, which constituted a bottleneck resource. Thus the PPC process depended solely on the availability of resources, contrary to recommendations from literature. The inability to influence capacity led to a sense of permanence regarding the waiting list situation, which led to a short-sighted firefighting approach. This was reinforced by the inability to forecast and predict the development of the waiting list.

An improved PPC process was suggested, in which the capacity planning is conducted based on the capacity requirements created by patient demand. This can be partly achieved through better coordination between planners, and through better adaptation of individual scheduling requests to the needs of the department. Improved forecasting in combination with better knowledge of demand would allow the clinic to foresee the capacity requirements and the development of the waiting list. This would provide the clinic ability to react in time.

This study was intended to enable the clinic to achieve reasonable waiting list levels in the long term. It identified several problem areas and provided suggestions on how to achieve a long-term sustainable production planning and control process. The implementation of these ideas is left to the clinic, and there are certainly many challenges on the way there.

References

Aujalay, N. (2012) Vårdköer – endast i en planekonomi ? *Sjukhusläkaren*. 25 October. [online]. Available from: http://www.sjukhuslakaren.se/2012/10/25/vardkoer-endast-i-en-planekonomi/.

Bryman, A. & Bell, E. (2011) *Business Research Methods*. Third edit. OXFORD: Oxford University Press.

Conway, T. & Willcocks, S. (1997) The role of expectations in the perception of health care quality: developing a conceptual model. *International journal of health care quality assurance incorporating Leadership in health services*. 10 (2-3), 131–140.

Dawson, D. et al. (2004) Is patient choice an effective mechanism to reduce waiting times? *Applied Health Economics and Health Policy*. 3 (4), 195–203.

Derrett, S. et al. (1999) Waiting for elective surgery: Effects on health-related quality of life. *International Journal for Quality in Health Care*. 11 (1), 47–57.

Glouberman, S. & Mintzberg, H. (2001) Managing the Care of Health and the Cure of Disease - Part I: Differentiation. *Health Care Management Review*. 26 (1), 56–92.

Gustavsson, S. (2013) *The Customer in Focus Patient Roles in Designing and Improving Health Care Processes*. Licentiate thesis: Chalmers University of Technology.

Hanning, M. (1996) Maximum waiting-time guarantee — an attempt to reduce waiting lists in Sweden. *Health Policy*. 36 (1), 17–35.

Hanning, M. & Spångberg, U. W. (2000) Maximum waiting time — a threat to clinical freedom? *Health Policy*. 52 (1), 15–32.

Hans, E. et al. (2012) 'A Framework for Health Care Planning and Control', in *Handbook of healthcare system scheduling*. Springer US. pp. 303–320.

Hansson, S. O. (2014) Medical Ethics and New Public Management in Sweden. *Cambridge Quarterly of Healthcare Ethics*. 23 (03), 261–267.

Health Consumer Powerhouse (2015) *Euro Health Consumer Index 2014*. [online]. Available from: http://www.healthpowerhouse.com/.

Hesselius, P. (2014) Förbud ger inte kortare köer i sjukvården. *Dagens Samhälle*, December 11. [online] Available from http://www.dagenssamhalle.se. (Accessed 16 June 2015).

Hoel, M. & Sæther, E. M. (2003) Public health care with waiting time: the role of supplementary private health care. *Journal of health economics*. 22 (4), 599–616.

Jonsson, P. & Mattsson, S.-A. (2009) *Manufacturing planning and control*. London: McGraw-Hill.

Kosnik, L. (2006) 'Breakthrough Demand-Capacity Management Strategies to Improve Hospital Flow, Safety, and Satisfaction', in *Patient Flow: Reducing Delay in Healthcare Delivery*. Los Angeles, CA, USA: Springer Science+Business Media, LLC. pp. 101–122.

Lifvergren, S., Chakhunashvili, A., Gremyr, I., Bergman, B., Hellström, A. (2009) A Large Scale Implementation of Six Sigma at the Skaraborg Hospital Group. *Proceedings to the EurOMA Conference.* 1-9.

Litvak, E., Buerhaus, P.I, Frank, D., Long, M.C., McManus, M.L., Berwick, D.M. (2005) Managing unnecessary variability in patient demand to reduce nursing stress and improve patient safety. *Journal on Quality and Patient Safety.* 31 (6), 330–338(9).

Lövtrup, M. (2008) Villkoren för kömiljarden klara. *Läkartidningen,* December 11. [online] Available from http://www.lakartidningen.se. (Accessed 16 June 2015).

Nguyen, V. T. et al. (2014) 'The Misalignment between Hospital Planning Frameworks and their Planning Environment – A Conceptual Matching Approach', in Bernard Grabot (ed.) *Advances in Production Management Systems: Part II*. 2014 pp. 675–682.

OECD (2013) *OECD Reviews of Health Care Quality: Sweden 2013*. [online] Available from: http://www.oecd-ilibrary.org. (Accessed 16 June 2015)

Plantin, A. & Johansson, M. I. (2012) 'Implementing production planning processes in health care - a case study of a surgery clinic', in *Proceedings of PLAN Research and Application Conference*. 2012 Lund: Chalmers University of Technology. pp. 125–139.

Risberg, S. (2014) Oförenliga krav. *Läkartidningen,* December 15. [online] Available from http://www.lakartidningen.se. (Accessed 16 June 2015).

Roth, A. V & van Dierdonck, R. (1995) Hospital Resource Planning: Concepts, Feasability, and Framework. *Production and Operations Management*. 4 (1), 2–29.

SFS 2014:349. *Förordning om vårdgaranti. (Statute on care guarantee)* Stockholm: the Swedish Ministry of Social Affairs.

Smeds, S. (2011) Visionen som kapat vårdköer. *Läkartidningen,* March, 4. [online] Available from http://www.lakartidningen.se. (Accessed 16 June 2015).

Sveriges Kommuner och Landsting (2014) *Ny patientlag den 1 januari 2015* [online]. Available from: http://www.skl.se (Accessed 16 June 2015).

Västra Götalandsregionen (2015a) *Årsredovisning 2014 Skaraborgs Sjukhus*. [online]. Available from: http://www.vgregion.se/sv/Skaraborgs-sjukhus/Skaraborgs-sjukhus/Om-sjukhuset1/. (Accessed 16 June 2015).

Västra Götalandsregionen (2015b) *Välkommen till Skaraborgs Sjukhus* [online]. Available from: http://www.vgregion.se/sv/Skaraborgs-sjukhus/Skaraborgs-sjukhus/Om-sjukhuset1/ (Accessed 3 June 2015).

Vissers, J. M. H. et al. (2001) A framework for production control in health care organizations. *Production Planning & Control*. 12 (6), 591–604.

De Vries, G. et al. (1999) Design requirements for health care production control systems. *Production Planning & Control*. 10 (6), 559–569.

Appendix A: Interviews

One semi-structured interview was conducted with a business developer at the Women's health unit. The interview resulted in information about the organizational structure of the women's health department as well as the working procedures at the women's department.

- What does the production planning process at the gynecological outpatient clinic look like?
- What does the organizational structure of the gynecological outpatient clinic and the women's health unit look like?

Several unstructured interviews were conducted with an assisting nurse at the gynecological outpatient clinic who is responsible for the booking of patients. Most of the information about the current PPC process was provided by this interviewee. Some of the questions asked were:

- What does the production planning process at the gynecological outpatient clinic look like?
- What patient groups and demand for specialists does the outpatient clinic have?
    - What specialists?
    - Are there also "general" physicians?
    - How many patients for every group in every week demand specialized care?
- Revisits
    - Is it possible to find out how many revisits are planned for a given time period?
    - When do patients appear on the revisiting appointment list?
    - How many revisits occurred for each week in every patient group in 2014?

Several unstructured interviews were also conducted with a secretary at the gynecological outpatient clinic who is responsible for keeping and adding data into the current production plan. All quantitative data about the waiting lists and production at the gynecological outpatient clinic was provided by this interviewee. The same questions were asked as to the assisting nurse:

- What does the production planning process at the gynecological outpatient clinic look like?
- What patient groups and demand for specialists does the outpatient clinic have?
    - What specialists?
    - Are there also "general" physicians?
    - How many patients for every group in every week demand specialized care?
- Revisits

    - Is it possible to find out how many revisits are planned for a given time period?
    - When do patients appear on the revisiting appointment list?
    - How many revisits occurred for each week in every patient group in 2014?

One short unstructured interview was held with the secretary who is responsible for the scheduling of midwifes and nurses at the gynecological outpatient clinic. The interviewee confirmed information provided from previous interviews about the staff scheduling process.

One semi-structured telephone interview was conducted with the physician currently responsible for the physicians' schedules at the women's health unit.

- Is it more difficult to schedule physicians for the gynecological outpatient clinic than other clinics?
- How are physicians' requests for off-time handled?

One semi-structured telephone interview was also conducted with the process manager of gynecology who is responsible for setting production goals for the gynecological outpatient clinic.

- What are the issues with the production planning at the gynecological outpatient clinic?

Two orientation meetings were held with the manager of the gynecology unit at Skaraborg's hospital. The meetings were held to make sure the thesis were progressing in a wanted direction. Some questions about the PPC process and routines at the outpatient clinic were asked also during these meetings.

One semi-structured interview was conducted with the manager of the dermatology unit. The aim of the interview was to gain knowledge about the PPC process currently used at the dermatology outpatient clinic. The information was then both used as material to find problem areas of the PPC process at the gynecological unit and also acted as a great source of information to understand the differences between the two outpatient clinics in terms of prerequisites for different PPC process solutions. The prepared questions for this interview were:

- What are your work responsibilities?
- What does your current scheduling process look like?
- Why did you change the scheduling process?
- What did the process look like before the change?
- What problems did you face during the change?
- What improvements have been achieved?