Master's degree thesis

LOG950 Logistics

Resource efficiency within the outpatient clinic

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Molde University College
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Preface

This master thesis is the final part of the Master of Science in Logistics at Molde University College. The research has been conducted between December 2017 and May 2018 and represents the conclusion of our academic program and completion of the MSc degree in Logistics. We have learned much from the thesis work, and it was exciting to be hands-on with the project group's work, and to work closely with the polyclinics at Molde hospital. As graduates, these experiences are valuable for us going forward.

We would like to thank our supervisor, Birgithe Eckermann Sandbæk, for her extraordinary guidance, cooperation, and excellent support throughout this project. You introduced us to the interesting field of health logistics, and included us in this very interesting project, which we are very grateful for. You have made yourself constantly available and accessible to us, and our good discussions and your valuable feedback, based on both your first-hand experiences and research, have had a significant and positive impact on this thesis. Without you this thesis would not be what it is, and we could not have hoped for a better or more patient supervisor than you, thank you!

We would also extend our gratitude to the SNR project management group, who welcomed us to work with them in this project and have provided us with both data and insights which have made this study possible. We want to extend a special thanks to Head of Section at Otorhinolaryngology, and Head of Section at Audiology, at Molde Hospital, for welcoming us into their departments, sharing their knowledge with us, and making the study possible at the departments.

We also want to thank all the participants at the respective departments for participating in the data collection, or otherwise providing us valuable information, despite your busy schedules and amidst all the other activities you had to carry out.

Molde, 22.05.2018

Benjamin Hjelen & Jannik Weum

Summary

This thesis used logistical theoretical frameworks rooted in production planning to gather and evaluate efficiency at the outpatient clinic based on time consumption.

The study has gathered primary data from the outpatient clinic prospectively by using an app, which, to the best of the author's knowledge, is the first study of its kind at the doctor's level. In addition, the study has used secondary data obtained from the health trust's own registry, as well as information gathered through process mapping work at the outpatient clinic.

The thesis has evaluated and answered the following research questions:
RQ1: Investigate if the data available at the hospital is adequate for efficiency work.
RQ2: Identify differences between the hospital's data and collected primary data.
RQ3: Consider additional factors that affect the clinic's efficiency.

RQ1: The currently available data at the hospital is not optimal as a foundation for efficiency work. PAS and Oplan does not capture all relevant activities, and therefore excludes significant time consumptions. Using current data as foundation for decision making would lead to suboptimal efficiency work.
RQ2: The primary data found significant differences compared with the hospital's own data. The time captured in the hospital's systems does not accurately reflect actual time consumption.
RQ3: Current efficiency limitations are primarily located in surroundings rather than in core activities. There are many factors that affect support functions to the point that the structure around the doctors is not good enough to adequately support efficient operations.

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1.0 Thesis Background

A considerable health care commitment in the county of Møre and Romsdal is currently underway, which includes the construction of a brand new regional hospital. The hospital is called (in Norwegian) “Sjukehuset Nordmøre og Romsdal” (hereby referred to as SNR), and will be constructed at Hjelset, near the city of Molde, scheduled to be completed by 2022 (Sykehusbygg 2018). SNR will be a merging of the current hospitals located in Molde and in Kristiansund. In that regard, a project group has been established and tasked with evaluating, planning, and facilitating the overall process related to SNR. Molde University College has been engaged as part of the project group, and our thesis is part of the scientific contribution from our University to the project, where our goal is to evaluate efficiency and identify areas of improvement within the outpatient clinic.

Efficiency is a central term in this thesis, and, unless otherwise stated, it is defined in terms of throughput as well as waiting time reduction, while improving department organization (Testi, Tafani and Torre 2007).

Polyclinic and outpatient clinic are used interchangeably in this thesis.
Consultation and appointment are used interchangeably in this thesis.

As with most recent hospital projects in Norway, budget limitations have led to clear size boundaries, and while SNR was originally planned to be roughly 78,000 sq m it has been shrunk to approximately 60,000 sq m (Sykehusbygg 2018). In comparison, Molde and Kristiansund Hospital is approximately 55,000 and 22,000 sq m, respectively (Helse Møre og Romsdal 2016). Some of the existing area in Molde is leased and not currently used, and parts of the current capacity in Kristiansund will continued to be utilized for daycare/polyclinic locally besides SNR, but in any case, SNR will in terms of sq m be smaller than the merging hospitals combined. Although looking at sq m in isolation may be too superficial to evaluate whether the proposed project will be either efficiency or effective, health care activities are space, demanding and forecasts predict higher demand for future health care services, therefore the decision to effectively downsize is curios as it will likely cause challenges down the line (see section 3).

Because of the size restrictions of SNR, the project group’s primary concern in the preliminary work has been to identify and plan for how to best utilize the available space within the hospital. A goal from central management has tasked the group with preparing suggestions on how the hospital can perform with eight hours of efficient operation at daycare and polyclinic each day (Helse Møre og Romsdal 2017). The definition used by SNR of efficient is defined as the physical rooms being utilized for eight hours a day, where utilization is expressed as the physical presence of a patient within the room. Thus, a key challenge is how to merge the existing services into the new facilities and still provide the same (preferably better) services and quality of services as today, with limited space and the necessity to utilize each room for eight hours daily. In this regard, efficiency is drawn from room/space utilization, rather than utilization of the human resources, such as the doctors. A curiosity is that access to qualified human resources will likely be the primary challenge in the future, as import of specialist from abroad will be necessary to meet estimated demand (Gjessing 2014). It begs the question whether physical space utilization should be the primary focus in terms of evaluating efficiency, or whether a focus on process management to facilitate higher utilization of the human resources is favorable. Additional space can be used to increase flexibility, and to optimize, the scare human resources available, while space limitations on the other hand decrease the flexibility and optimization options of the human resources. Also, according to Little's Law, waiting time will grow exponentially when close to full utilization, thus building smaller indirectly causes additional waiting time (Little and Graves 2008).

SNR has been the root for a long-lasting conflict in the region, where political and economic incentives, public opinion and city disputes has raged on for several years (KSU 2017). It is a project which has sparked widespread emotions in the region, and it is also a project which will impact the people living here for years to come, as the hospital quite obviously provides important services in our lives.

Structurally this thesis consists of two parts: the first is a general introduction to the thesis, and the second is our research paper. The paper is based on primary data collected from the Otolaryngology polyclinic (ear, nose, and throat) at Molde Hospital, secondary data from the Health Trust's database, and process mapping and other meetings at the polyclinics (See 4.2). The paper investigates time-usage and workflow within the clinic and aims at better understanding and evaluating efficiency in terms of time usage.

1.1 Purpose of Study

Norwegian politics and ideology is built on that of a welfare model, which advocates equal opportunity and access for all. The health care system is an important part of the welfare state and offers equal access to treatment and services in all stages of life for everyone. However, to be able to do so into the future, the system must be efficient, agile and effective in order to meet and handle future demand. Especially a growing and quickly aging population poses challenges in this space (See 3.2).

Initiatives to create such a system is already underway, with strategic level reforms such as the coordination reform, which the main objective to move certain treatments from hospitals to municipalities primary care services instead (Norwegian Ministry of Health and Care Service. 2009). While this work is important, a challenge uncovered in the work with SNR is an existing gap between the strategic level and operational level, as a clear tactical level with proper mandate and tools able to effectively implement the strategic initiatives in practice is largely missing. Furthermore, part of the problem is poor access to data within health care which adequately reflects what actually happens on day to day basis. The purpose of this thesis is therefore to provide a foundation by analyzing and mapping how the time is consumed within a polyclinic. The study also aims at uncovering potential limitations in the immediate supporting structure, and overall this might lead to better knowledge and foundation for where to focus efforts in further improvement work.

1.2 Research Area

In general, a limited amount of research has focused at the outpatient clinic. In health care services, the research has mostly examined production or production processes in the context of the overall hospital settings, and not at the outpatient level, and the studies has been primarily triggered by the scarce availability of human resources, ICU beds, operating rooms, and equipment (Dobrzykowski et al. 2014).

At the outpatient level, research has examined the effects of joint scheduling on performance (White et al. 2011). Also, a study from Utrecht in the Netherlands, assessed efficiency in an ear, nose, and throat clinic with focus on patient flow, considering particularly scheduling, appointment rules, and patient batching (Stek 2015). Another study looked at minimizing cost of capacity and repeal the performance constraints through a general resource planning model in health care and increase efficiency by optimizing the queuing network (Bretthauer and Cote 1998). Some simulations on how to optimize management of the scarce nurse resources available has been conducted, concerning scheduling problems and the workforce decisions (Wright et al. 2006). This has been an important area, because studies have found that shortage of the nurses have a negative effect on the quality of the care (Buerhaus et al. 2007). Equipment has also been researched, by looking at the benefits of pooling equipment (Pasin et al 2002). Some has also developed mathematical modeling on how to optimize waiting time, with intent to understand patient planning problems in the operating theater (Guinet and Chaabane 2003).

While some earlier research has been conducted at the outpatient clinic level, the focus of the research has been on scheduling, capacity planning, optimization, and control. To the best of the authors knowledge, there has not been conducted a study on time consumption within the outpatient clinic at the doctor's level, with intent to better understand the production process from a time allocation perspective. Currently, the only data available in this space is the hospital's own registry, which does not account for, or explain, how time is consumed when patients are not physically present.

1.3 Research Gap

As mentioned, within Norwegian health care, data on activity-based time consumption at doctor's level is practically nonexistent. The intention of the study is to provide a better insight on how time is spent throughout the day, both while patients are present, and when they are not. The data available within the hospital is simply a byproduct of the accounting systems and does not provide any information of how time is spent when patients are not present, as the registrations are tied to payments for treatments of patients. Therefore, this thesis aims at contributing to filling the gap of data shortage in this space, and the overall research problem is:

Resource Efficiency within the Outpatient Clinic

This research gap is quite large, and a single master thesis, given the timeframe, cannot realistically singlehandedly fill the gap. However, the research aims at forming the foundation for new and more detailed research within this area. The aim of the study is to use the understanding of how time is spent to build a bridge between the operational realities and strategic and tactical decision makers. Ultimately, the goal is to identify areas of improvement, which can lead to faster services for patients, better frameworks for staff, reduced cost, and overall a more efficient polyclinic.

1.4 Research Questions

The goal of the thesis is to identify important factors that affect efficiency at the outpatient clinic. In this regard, good data is the foundation in efficiency work, therefore the first two research questions encompass this, while the third research question consider other elements.

This thesis contribution to the literature with these research questions:
RQ1: Investigate if the data available at the hospital is adequate for efficiency work.
RQ2: Identify differences between the hospital's data and collected primary data.
RQ3: Consider additional factors that affect the clinic's efficiency.

Answering **RQ1** aims at understanding the data foundation currently available at the hospital for efficiency work. Answering **RQ2** aims at understanding potential differences between registered and actual time consumption at the clinic. Answering **RQ3** aims at understanding other important elements in the efficiency work beyond the information available in the data.

2.0 Theoretical Framework

In this section: **2.1** discuss the cultural aspect of improvement work in health care, **2.2** goes into the shift in focus that is taking place and the adoption of new theoretical frameworks in health care, **2.3** introduces the production planning framework followed by the concept of cost drivers in **2.4**, before technology is considered in **2.5**, and alternative frameworks are mentioned in **2.6**.

2.1 Improvement Culture

Although a change seems to be underway, there is not a long tradition for improvement work in health care. Traditionally a 'work harder' response has been the way to address performance gaps (Hayes, Batalden, and Goldman 2015). Working harder produce more immediate gains, but those gains will in the long term come at the cost of the health of the process, otherwise known as the capability trap (Repenning and Sterman 2001). Also, overwork is associated with longer wait times and lower quality, as studies in medical literature has found that 1 percent of overwork in cardiothoracic surgery increase the length of stay by six hours, and that 10 percent overwork increase the likelihood of mortality by 2 percent (Green 2009). Given the traditional response to performance gaps, a natural skepticism is present among staff in health care when presented with change and discussing efficiency measures, as the expectation is simply that another request to achieve more out of the same is about to be presented (Hayes, Batalden, and Goldman 2015). This thesis does not advocate a 'work harder' response, and this section aims at describing how production processes can achieve a smarter working process.

However, a skepticism towards change is not a distinctly Norwegian phenomenon, as it occurs in health care services all around the world. It is also nothing new, as the Griffiths report, a project on quality improvements dating back to 1983, stated that the cultural transformation only succeeded on a superficial level (Broadbent, Laughlin and Shearn 1992). And in the 90s, students of management and organization theory could only be stunned by the lack of effort to improve quality and absorb experience from other industries observed in health care (Davies and Nutley 2000). This skepticism has sadly developed into a large extent of reluctance to implement supply chain management principles in health care operations (Baltacioglu et al. 2007).

A potential enabler to overcome these cultural challenges could be a rework of the incentives to participate in improvement work and supply chain management principles. Currently, there are poor incentives, both on department and individual levels, to incentivize participation. While financial motivators can have some effect, it is likely not the best motivator to drive change in health care (Phipps-Taylor and Shortell 2016). However, studies show that rewards do increase the intrinsic motivation of individuals (Pierce et al. 2003). Therefore, it is important to consider which motivators that are appropriate, as the current motivators for working either harder or smarter in health care is largely lacking. In fact, lack of provision of additional resources when faced with increased job demand has shown to induce defensive strategies among recipients of change, and likely contributes to both lack of 'buy-in' and resistance to the proposed change (Hayes, Batalden, and Goldman 2015).

2.2 Shift in Focus

Logistical frameworks in health care has become more prominent as operations management within health care services has received considerable attention in scientific literature over the past decades (Mahdavi et al. 2013). This development is likely related to the challenges in the sector concerning rapid population growth combined with significant aging and prolonged life (Brecht et al. 2010). The development of the internet has changed the service industry significantly, as many services are now available on-demand and with a high degree of flexibility. Information is widely accessible, and people are therefore less willing to accept long waiting times and are more aware of the types of care that they should receive (Visser 2010). These developments are also impacting the health care sector, and proper logistical solutions to increase flexibility and efficiency is necessary to support the industry to adapt to meet future demand, which also explains the increased focus on logistical frameworks.

Although the scientific focus and adaptation of logistics has increased, the rate at which health care quality has improved has been slower than most would want (Hayes, Batalden and Goldman 2015). There are many potential approaches, but this thesis will present the production planning framework, and touch briefly on why alternatives, such as Lean and Agile, cannot simply be implemented and instantly solve all problems. A higher level of quality cannot be achieved by further stressing the current systems, thus one must instead look at ways to change, adapt and rethink current processes (Hayes, Batalden and Goldman 2015).

2.3 Production Planning

To manage both cost and quality it is important to understand the production processes. Without a fundamental understand of how, why and by who a process is carried out, and the overall design of the given process, it becomes next to impossible for an organization to influence and control the quality and performance in an effective way.

Production planning is all about managing and arranging *processes* to achieve the greatest amount of output from a given amount of input. A process can be described as something being transformed through a set of actions, and one can argue that all work is process work (Iden 2013). This means that production planning can be used in any area which performs some process. A manufacturing firm uses labor, equipment, and components to transform to products that gives value to the end customer. A service firm does not produce goods, but rather use human capital, information, and knowledge to transformed into services that gives value to the end customer. Health care can be defined as a service, as there is no production of goods, but rather use of human capital, through nurses, doctors, and other staff, as well as medication and consumables to transform into health care services, which gives value to the customer i.e. patient. There are differences between production processes in manufacturing and services, and these differences also illustrate why health care can be defined as part of the service industry. The differences can be summed up as:

- Intangible (Bateson 1977)
- Inseparable (Carman og Langeyard 1980)
- Heterogeneous (Parasuraman, Zeithaml og Berry 1985)
- Perishable (Kotler 2005)

Most forms of treatments at the outpatient clinic is intangible, meaning the benefit or outcome of the treatment has no physical form and cannot be touched. On the other hand, a production process in a manufacturing firm will result in a tangible, physical, product which can be touched. A health care service process is also inseparable, as the treatment is produced and consumed simultaneously, and require the presence of the patient to be completed. In manufacturing, the production of the product usually does not require the presence of the customer, and many steps in production are carried out by automated systems entirely separated from the customer. Health care services are also heterogeneous, or variable, as when, why, to who, how many and what type of process required to carry out in treating a patient is neither fixed or predictable. In manufacturing however, a predetermined demand drives the production process, and carry out the processes in rather predictable and repetitive tasks to produce the product. In health care the patient can be in all stages of life, which means the same illness or treatment can require to be carried out differently dependent on the receiver. In manufacturing the production of the product is carried out the same way, regardless of which stage of life the end customer is in. Lastly, health care services cannot be stored or kept with the intention of later use, nor can the patients requiring these services keep or store the illnesses for later service, they are perishable. However, in manufacturing, goods and equipment can be kept for later use, or production halted or rearranged on demand, as for most manufacturing processes the product is nonliving and nonperishable. This means that planning must be approached differently in health care services than in manufacturing.

To do proper production planning and acquire process design overview can be very difficult, and especially in the complexity of health care operations. To be able to understand the process, a greater partnership with, and participation of, the health care workforce is necessary, as they must be centered in the prioritizing, testing and implementation of new work (Hayes, Batalden and Goldman 2015).

Figure 2-1 *Overview outpatient process-map* represents a generic overview of the overall steps in the production process at the outpatient clinic.

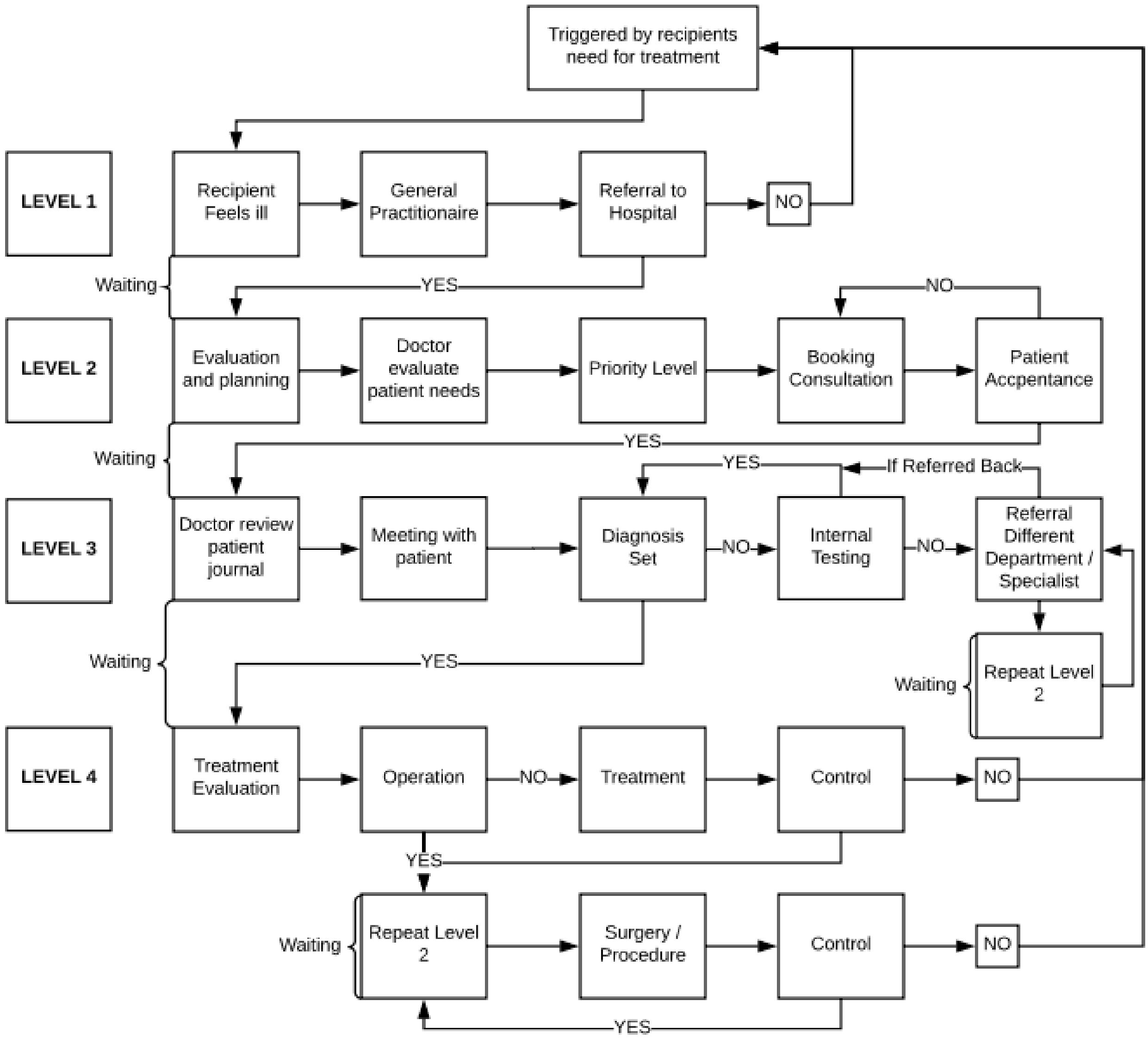

Figure 2-1: Overview outpatient process-map (developed for the purposes of this thesis)

In production theory this design is considered a pull system, as the unit (patient) is pulled to where it is needed, when it is needed, to fulfill the process (Heizer and Render 2004). Four primary levels can explain the process; recipient need, evaluating and planning, diagnosis, and treatment. Each level represents various stages in the production process. Note that necessary transport, disruptions, and unexpected waiting, are not included in the model, and that especially disruptions can occur in most of the steps. Initially the process is triggered by a need experienced by the recipient. This need initiates level 1, which is a consultation with a general practitioner, who decides whether referral to the hospital or specialist is necessary. If necessary, an exchange of information between the general practitioner and the clinic takes place. This triggers level 2, which is internal planning and evaluation of when to receive the patient at the clinic, and the step ends with a proposed schedule for consultation. Coordination between the clinic and patient is not always straightforward, and the schedule for consultation is continuously changed as requests for rebooking are received. Once a consultation time is set, level 3 begins, which is the physical interaction with the patient at the clinic. This eventually leads to level 4, which is the actual treatment of the patient, including operations when necessary, including planning and scheduling associated with these. The process is complete when the recipient has received the necessary treatment, and no longer feels a need for additional treatment, and is then idle until a new need triggers level 1 once again.

Figure 2-1 briefly illustrates how the planning and evaluation step is a central piece of the overall process, as it is revisited many times over. The model only scratches the surface of the underlying complexity of operations, as planning and scheduling objectives in the service industry is often considerably more complicated compared to that in manufacturing (Pinedo 2005). A particularly challenging aspect of production planning in this area is high variation and high uncertainty, as when, why, and how many patients need care at any given time is difficult to predict. Variation can to some degree be managed by proper planning and oversight. However, it is important that the variation is naturally caused, and not by some systematic bias. Research on many U.S. hospitals showed that surgeons with admitting privileges requested elective surgeries at convenient times which caused artificial peaks in demand at those times (Litvak and Fineberg 2013). Models suited for planning with uncertainty and high variation do exist (Mula et al. 2005). In the airline industry, another branch of the service industry, complex scheduling models are already widely used, and fundamentally these approaches could also be applied to the health care setting (Lothatepanont and Barnhart 2004).

2.3.1 Job Design

Job design describes the core function of human resources in a given role, and the clear responsibilities, tasks, and relationships with other parts of the organization. Proper job design is the cornerstone of a well-functioning production process. Many studies have examined job design and found a strong relationship between effective job design and employee performance (Shafiq and Hamza 2017). The job design in health care can be challenging, as it is not always clear if an activity should be carried out by the doctor, nurse, or secretary. Also, restricted access to personnel is likely a contributor to blurring the lines between responsibilities, as fewer individuals are required to carry out a broader range of activities (Texmon and Stølen 2008). Also, the distinction between direct and indirect patient-related activities is not always clear, and perhaps a solid definitional distinction is necessary to be able to separate various activities to support better job design. Uncertainty in responsibilities affects the job design, and thus weakens the link to employee performance, which in turn lowers efficiency.

2.4 Cost Drivers

Part of the benefit of production planning is the ability to identify how expenses are incurred throughout the production process when performing activities, otherwise known as identifying the cost driver. There are several approaches to identify cost drivers, such as Porter's structural cost drivers (Porter 1985), the ABC approach (Kaplan and Cooper 1997) and the AIM&DRIVE approach (Anklesaria 2008). While different in their approaches, they all focus on the activity which accounts for the largest portion of cost. This is in line with the Pareto Principle, a widely accepted theory in literature, otherwise known as the 80-20 rule, which is applied in business, finance, and economy, that states that 80 percent of total cost is derived from only 20 percent of the activity (Brynjolfsson, Hu and Simester 2011). Therefore, examining how time is spent at the outpatient clinic is a valuable step in the efficiency work, as a time focus is also indirectly a cost focus.

2.5 Technology

The choice of technology is important in the design of the production process for the organization. The technological framework can significantly affect how time is spent in the organization, and some of these points are elaborated in section 4.

Most of the activities in health care cannot be automated and are carried out by personnel at various stages through the treatment process of a patient. For these processes to be completed efficiently, effectively, and safely a considerable amount of information is necessary throughout the organization. This is in logistics and supply chain management defined as information flow, and is a key part of quality, planning and control between suppliers, buyers and the end customers (Harrison and Van Hoek 2011). Lack of information can be a serious operative disruptor, as tasks come to a halt until any confusion is resolved. This is especially true in health care, where limited and lacking information can be directly attributed to patient's safety. The technological framework is the basis of a well-functioning flow of information, and the backbone of efficient operations.

Research on information technology in health care has become prevalent, particularly because of substantial investments in new medical technology and because of pressures for adoption of technological change in health care (Dobrzykowski et al. 2014). A problem with efficiency work in health care is that the data available is not good enough, and for instance, capturing the variability of operations has proven troublesome because of lack of standardization of information (Mahdavi et al. 2013). Some studies have used RFID technology in health care to generate higher quality data with great success (Amini et al. 2009). This could potentially be the way to pursue higher quality data, as reliable data is the foundation for all efficiency work and research.

2.6 Other Improvement Concepts

There are various improvement concepts, which all have their advantages and disadvantages in terms of application and limitations. For instance, within logistics lean is an important theoretical concept, but studies have examined its implementation in health care and found it to be a challenging area to implement lean thinking (Kaplan et al. 2014). Another study found that at the outpatient clinic the assembly line approach is impossible to implement because neither the work processes nor the work stations involved are standardizable (Becker and Scholl 2004). Some may argue differently, as for instance, some patient groups at ear, nose and throat at Molde Hospital has been pooled and received “batch education,” which is a form of standardization. However, lean might not be the easy remedy for making both efficiency and effectiveness improvements in health care (Waring and Bishop 2010)**.** The variation in health care is problematic to lean theory, as standard, repeatable, and predictable, activities are the cornerstone of this approach. Measures such as color-coded hoses for oxygen and nitrous oxide at the operating rooms and various checklists, are examples of successful implementation of lean principles. Lean can be a useful tool in efficiency measures, but not alone.

3.0 Case Description

The outpatient clinic is part of the Norwegian Health care system and in this section; **3.1** introduces how the challenge of aging will affect health care, **3.2** briefly introduce the Norwegian Health care system, **3.3** highlight some of the challenges the system faces going forward, **3.4** present some cost related considerations, **3.5** present some considerations on the development of direct patient contact, and **3.6** touch on the hospital’s current computer systems.

3.1 Aging Population

The world population is rapidly growing, and the United Nations predicts that it will reach 9.7 million by 2050 (UN 2015). In Norway, the population has steadily increased since 1950, and is predicted by Statistics Norway (hereby SSB) to reach 6 million by 2031, and 7 million before 2060, up from 5.25 million in 2017 (SSB 2017b). At the beginning of 2016, 16.3 percent of the Norwegian population consisted of immigrants, including Norwegian-born to immigrant parents, and by 2018, the share had increased to 16.8 percent (SSB 2017c). Net immigration is currently the most important factor for national population growth in Norway and show that the global population and demographic changes also impacts the Norwegian population (SSB 2017c).

Globally, the United Nations predict that the number of persons aged 60 or above will double by 2050, and triple by 2100 (UN 2015). In Norway, one out of nine is currently aged 70 or above, but this is by SSB predicted to increase to be one out of five by 2060

(SSB 2017b). While the population is growing, the life expectancy in Norway has also been steadily increasing over the last century and was in 2015 80.4 years for men and 84.2 years for women, respectively (Folkehelseinstituttet 2014). Mortality rates has been steadily decreasing for both men and women, and besides accidents most deaths now happen at the later stages in life (Folkehelseinstituttet 2014). Thus, the health care system must prepare a greater demand both in terms of overall number of patients as the population increases, but also a spike in demand for services for the elder as the population rapidly ages.

Indications are that people spend more years living with illness and disability (GBD 2015 DALYs and HALE Collaborators 2016). It is also little evidence to suggest that the elderly today is experiencing their later years in better health than their parents (WHO 2015a). In sum the concerns of compression of expansion of morbidity provides challenges for health care, as it is difficult to plan for the unknown (Jagger 2000). Either way, the health care sector faces increased demand and strain, and must prepare to receive the aging population (Etzioni, Liu and Maggard 2003).

In Figure 3-1 below a visual illustration provided by SSB on the forecasted change in the composition of the Norwegian population has been included. Worth noting is that 2040 is still early in the predicted aging cycle, which as mentioned is expected to continue towards 2100, but there are no published forecasts of the population pyramid further into the future than this yet.

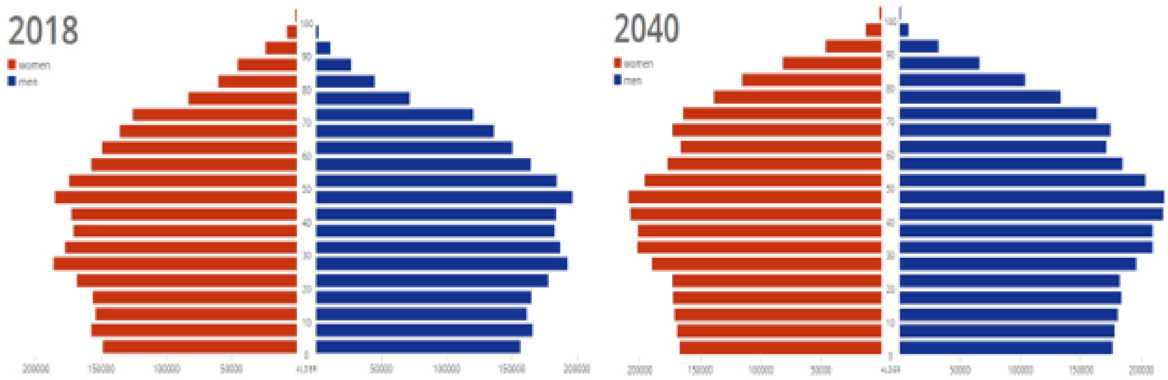

Figure 3-1: Norwegian population pyramid 2018 and 2040 (SSB 2018c).

3.2 Norwegian Health Care System

The Norwegian health care system is centrally controlled by the government, which governs policies, while provision of services is decentralized to local authorities at the municipal level. The system is primarily funded through taxes, as it is allocated funds in the national budget. This structure is based in the Norwegian ideology of welfare, which provides equal access to health services for all Norwegian inhabitants. A consequence of this is that there are few private hospitals in Norway, and limited need for privately held health insurances.

The government has supreme command of the Norwegian health care system and oversees all through the Ministry of health- and care services. The ministry is charged with ensuring the quality and accessibility of services provided to the public, and manage this through laws and policies, appropriations, and in cooperation with agencies, authorities and health care professionals at various levels (Regjeringen 2013).

Norway has historically consisted of 19 counties but is currently in the process of reorganizing the governance model and reducing the number of counties through merging (Stortinget 2013). Regardless, the health care system for the entire country is governed by four regional health authorities, West, Southeast, Mid-Norway, and North, which are subject to the Ministry, and these provide services in somatic and psychiatric hospitals, as well as ambulance services for their respective regions.

While somatic and psychiatric hospitals, and ambulance services, are governed by the government, the municipalities have responsibility for primary health care, meaning nursing and care services for all individuals in need, regardless of age or diagnosis (Regjeringen 2013). These responsibilities encompass various homecare services, nursing homes, daycare for elders, homes for mentally disabled persons, and school health services amongst other.

3.3 Public Health

There are many common conditions connected with old age, such as, but not limited to, hearing loss, cataracts and refractive errors, diabetes, and dementia (WHO 2015a). Although aging is an important concern, the wellbeing of the overall general public is also a driving factor for health care demand. Cardiovascular diseases are connected to unhealthy lifestyles, and the Norwegian Institute of Public Health classifies tobacco use as major importance to public health (Grøtvedt 2017). Tobacco use in Norway, in terms of smoking, has since 2000 roughly halved (WHO 2015b). On the other hand, snus (lip borne tobacco) use has strongly increased, and in 2016 one in four in the age group 16-24 used snus daily or occasionally (Grøtvedt 2017). The average Norwegian drinks more than six liters of pure alcohol a year, not including tax-free or import (legal or illegal), and the alcohol consumption is tied to liver diseases and accidental injuries which also drive health care demand (SSB 2018a). Furthermore, poor diets and high sugar intake has led to overweight and obesity, in which one in four middle-aged men and one in five women in Norway are obese with a body mass index of 30 kb/m2 or higher (Bøhler et al. 2017).

The consequences are that in 2017 Norwegians received over 7 million treatments at the hospital, split amongst little under 2 million individuals (SSB 2017d). The clear majority of the treatments consisted of outpatient consultations, as shown in figure 3.

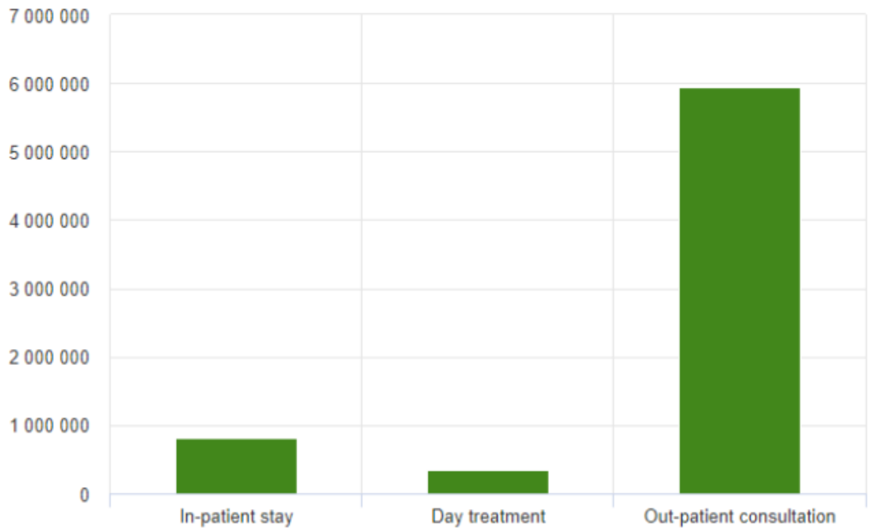

Figure 3-2: Overview of treatments in Norway in 2017(SSB 2017d).

Of all the treatments at the outpatient clinic, 91 percent were planned, however, only 12 percent of the outpatient consultations led to an immediate additional form of treatment (SSB 2017d). In other words, it is a low rate of continuation between the planned visits and continued treatment for the patients, as each patient received on average 3-4 treatments. While explaining the low rate of continuation is outside the scope of this text, it is interesting as it indicates many revisits to the hospital and could point to poor internal alignment. This could perhaps be attributed to how efficiency is inherently measured in health care, as rapid consultations to treat as many patients as quickly as possible seems to be the primary objective. Paradoxically, this will likely not lead to fewer total interactions between medical staff and the patient, because most of a patient's lead time comprise of waiting between treatments (Modig and Åhlstrøm 2016).

In any case, this thesis focuses on the outpatient clinic because consultations at the outpatient clinic represents a significant part of total activity, thus measures targeted there is likely to have a great impact on cost and efficiency overall in the sector.

3.4 Health Care Cost

From a standpoint of social cost, repeated visits to the hospital represent a tremendous expense, as time off from work, inability to return to work, transport cost, and other cost, reoccur. A questionnaire carried out by SINTEF in 2011, conducted on companies in the Confederation of Norwegian Enterprise (NHO), found that sick leave cost the company, on average, NOK 13000 each week an employee is absent (Hem 2011).

As aging has become a well-known global concern, it has sparked debate and interest amongst researchers, health care professionals, policymakers, and politicians alike. Columbia University's School of Public Health, in collaboration with the University of Southern California's Center for Health Policy & Economics, has developed a global aging index which estimates how well countries adapt to the increased proportion of older people (Mailman Columbia 2017). The index hardly includes all countries but found that in the sample Norway is the country coping best with the aging population. While a positive finding, they use criteria for evaluation such as well-being, security, productivity, and equity, which does not give much sense to the preparedness of scaling for future demand, which is perhaps Norway's biggest challenge.

Looking at cost, the total health care cost in Norway was 326 billion NOK in 2016, which equaled roughly 10.50 percent of BNP (SSB 2018b). In terms of BNP, the share is in line with the expenditure in the other Scandinavian countries, and slightly above average for the OECD-countries (SSB 2017a). However, high petroleum revenues and low population conceals the fact that based on expenses per capita, Norway is the fourth biggest spender on health care amongst the OECD-countries (OECD 2016). The challenge is therefore how to accommodate for future demand without incurring was cost increases too, as the current performance comes with a sizeable price tag.

In the Euro Health Consumer Index of 2016, Norway was ranked 3rd, with long waiting times as the primary drawback. The report states: “The poor accessibility of Norwegian health care must be more or less entirely attributed to mismanagement, as lack of resources cannot possibly be the problem” (Björnberg 2016). The Norwegian health Directorate has also raised similar concerns, as waiting lines increased more than what to be expected from the population increase alone in the period 2003 to 2013, indicating some lack of control may be present (Kalseth et al. 2014).

As the share of the population close to, or in, retirement will increase to 22.4 percent by 2040, up from 16.4 percent in 2016, the time to find adequate solutions is quickly running out (Helsedirektoratet 2017). Thus, an increased focus on how to better utilize the existing resources is necessary, as continuously increased spending is not a long-term feasible option.

3.5 Direct Patient Contact Time

Over the past two decades a trend that doctors spend less time on direct patient contact has developed. In a study conducted in Norway, 1600 doctors were selected to complete a questionnaire every second year from 1994 to 2014 (Rosta and Aasland 2016). The study looked at the time spent on directly patient related work. The main finding of the study was that the time doctors at the hospital spent on patients had decreased, and especially between 2000 to 2014. General practitioners did not experience the same drop-off and remained high at 70 percent of total time spent on direct patient contact. However, at the hospital, chief senior consultant went from 46 percent to 35 percent of time spent on direct patient contact. For senior consultant physicians it went from 54 percent to 46 percent, and physician assistants went from 57 percent to 47 percent (Rosta and Aasland 2016). Important to note is that total working time was practically unchanged for the period. Some of the contributing factors pointed to in the study was weaknesses in the electronic information systems (IT), increased documentation requirements, decrease in doctor’s productivity, and structural change in the health sectors organization (Rosta and Aasland 2016).

A recent study shows that the total number of doctors in Norway has increasing by over 100 percent from 1994 to 2014, while the number of patients has only increased by 17 percent (Bratlid 2018). The doctors state they experience less time for direct patient contact, but with the disproportionate growth this should not be the case. Studies show that doctors at the hospital spend four times as much time on hospitalized individuals than on those receiving a polyclinic consultation (Bratlid 2018). While it is documented that doctor's, experience having less time for direct patient contact, this can possibly be explained by the fact that there are fewer patients per doctor, and that each doctor does in fact spend less time on direct patient contact. On the other hand, the patient receives more time with a doctor, but split amongst several doctors and this trend can have negative effects on both continuity and the quality of care (Bratlid 2018).

An interesting point is that while the doctors experience, and likely spend, less time with patients, they still work the same number of hours per week as previously. The question is then which activities are carried out during the remainder of the time and are these activities truly value adding for the doctors to carry out. Rosta and Aasland's study pointed on that the doctors are required to do more office work, that could normally be carried out by a secretary. On the other hand, a transition of responsibilities has moved more tasks over to the nurses instead of the doctors, which could also affect the measured time doctors spend with patients. Curiously, from 2003 to 2013, the number of nurses increased by 13.7 percent, while the number of doctors increased by 40.7 percent (Bratlid 2018).

This further stress the necessity to understand how doctor's time is allocated, and which activities that do tie up so much of the doctor's time, to create the foundation for organizational and structural change, and such research should preferably use objective quantitative methods rather than qualitative (Frich 2016). This thesis is meant to be a contributor to that work.

3.6 Systems Challenges

The cornerstone in efficiency work is good data and good information flow, an outdated computer system in health care is a hurdle in the current system. Many of the challenges mentioned in this section were identified in the process mapping conducted at the polyclinic.

When discussing efficiency at the clinic it is also important to consider the frameworks in which the participants operates. Therefore, section will briefly touch on some observations, but is not meant to be a comprehensive or exhaustive review of the computer systems.

Disconnected Systems

The various systems used at the hospital are not interconnected, which presents challenges for both internal and external use. The separated systems can be referred to as the "silo mentality," where each branch operates as if independent rather than as an interconnected part in a larger system, which makes the overall system slow and inefficient (McCartney 2016). Separated systems lead to poor information flow and lack of transparency, which means low synergy and lack of coordination between departments. Lack of process overview leads to a focus on internal performance in each separate unit rather than a focus on the overall system performance.

For example, referrals to the hospital are received through the EPJ (Electronic Health Record) system, but booking consultations are done in PAS (Patient Administration System). As these two systems are not electronically connected to one another, physical mail is necessary to use by the hospital to respond to electronically received referrals.

Lack real time Data

As systems are not interconnected, the access to real time data is also lacking, which causes coordination problems. Limited access to administrative information, such as work schedules, affects the speed of consolation bookings made by secretaries, for instance. This is also particularly challenging for operation booking, which require numerous staff members.

Internal Communication

The effect of lack of system coordination and lack of real time data is amplified as the internal communication is mostly limited to physical interaction, phone calls or the use of pagers (a small radio device). These methods often require waiting or movement, either by locating the individual or finding the nearest phone, which can be deemed inefficient.

This can also be reflected in the lack of alters, such as no notification of patient presence, which means that the doctor needs to physically check the waiting area whether the patient has arrived.

System Upgrade

A new system, called (in Norwegian) “Helseplattformen,” is currently in development, and is scheduled to be implemented and operative by 2022 (Helse Midt-Norge 2018). It is primarily an upgrade of the EPJ and PAS systems, rather than a comprehensive ICT rework. However, this still represents one of the largest technological undertakings in upgrade the computer systems ever done in the region. The overhaul is still in early development, the authors hope that this study will be a contribution to the ongoing development process and shed light on important considerations that cause inefficiencies today.

4.0 Data and Methodology

This section covers data and methodology: **4.1** presents the overall approach, **4.2** present the data collection process and **4.3** covers descriptive statistics.

4.1 General Approach: Case Study

The case study approach is used in this thesis, as it is the preferred approach in explanatory studies, where “how” or “why” are central questions in the research (Yin 2009). This study explores the activities carried out at the outpatient clinic, and the goal is to uncover how time is spend within the clinic, and to some degree also understand why activities are carried out the way that they are.

Parts the framework in this thesis originates from a previous thesis which did a similar data collection and study in homecare services, rather than at the outpatient clinic (Slyngstad 2016).

Table 4-1: Research construct

Level of analysis	Production process
Unit of analysis	Time spent on activity
Research approach	Empirical

	Quantitative Qualitative Inductive
Overall theoretical framework	Production Planning (See 2.3)
Empirical data	Primary data collection (See 4.2.1)
Theory development	Applied to outpatient clinic and concluded to connect the theoretical framework to the recorded activities and respective research

Empirical research seeks to gain new knowledge through collection or analysis of primary data. The study is both a quantitative and a qualitative study, quantitative as it uses data as basis, but also quantitative study as it is used in attempt to explain beyond only looking at available data. Using a combination of the two can lead to the best result, as evaluating based on data alone would be too superficial as other factors are also important, but the data is still important to understand the entirety. The process mapping carried out at the hospital, along with numerous meetings and discussion with staff, would be considered as part of the qualitative part.

Furthermore, the research is inductive, which means that the authors did not have assumptions about the results before the research commenced. Considering that the authors have no prior affiliation to the hospital, nor a background in health care, as well as the limited research available on this topic in general, they had no preconceived opinion of what the study could uncover, or the respective time distributions amongst activities or reasons for those. This is also reflected in the limited affiliation with the data collection process, which left no possibility for the authors to have assumptions about the data or findings before this thesis began.

4.1.1 Validity

Some argue the validity of the case study approach as a method because of concerns with the ability to generalize the results derived from it (Yin 2009). This case study has been carried out in close collaboration with the project management group, who represents the Central Norway Regional Health Authority. The state-owned authority chose the outpatient clinics used in this study. As the clinics are regional pilots for the overall SNR project this case study should be comparable to other similar studies of the same nature.

Also, the data collected has been relatively superficial, not aimed at investigating detailed tendencies within this particular clinic, which makes the findings more generalizable.

4.2 Data Collection

The data used in this thesis originates from two different sources: primary data collected by the employees at the outpatient clinic using an app, and secondary data obtained from the hospital. In addition, qualitative information was gathered through process mapping at the clinic.

Primary Data:

The primary data was collected at Molde Hospital, from the Otorhinolaryngology (ear, nose, and throat) and audiology departments, in cooperation with the respective doctors and audiologist. The collection process was done in one week by the doctors (week 3 in 2018) and three weeks by the audiologists (week 3, 4 and Monday to Wednesday in week 5 in 2018). Unless otherwise stated "participants" refers to both doctors and audiologist who participated in the collection.

The data collection was carried out by the participants, who used a time tracker app installed on their own devices (see appendix A1). The app allowed the participants to record which activity they performed, and the time associated with the respective activity, throughout the day. The participants would simply click on the appropriate activity to start recording time usage on it, and either click on the next activity as tasks switch or click stop to indicate a halt in activity. For instance, when starting preparations before a consultation, such as reading the patient's journal, the activity patient preparation would be clicked to start recording the time-consumption. Once the preparations concluded the activity would either be stopped, by clicking stop, or the next activity would be selected to start recording time for that activity instead. The registrations proceeded into the data systems of the app provider, and once the collection process was completed an excel file with all the registrations were provided to the authors.

Since the app required physical interaction, the data naturally contained errors. The errors were predominantly obvious mis clicks, either by selecting the wrong activity, or prematurely stopping an activity, or not stopping an activity. Therefore, one error often led to multiple registrations of little or no duration, which was removed from the data. In total, 6.2 percent of all registrations were removed from the dataset. Also, for the purposes of this study only fully registered days were included in the data analysis, thus days with just some hours registered were entirely excluded. Some lunch breaks had been registered as an activity and were also excluded. These were deliberate decisions to avoid unnecessary skewness.

The doctors registered 685 activities, from which 74 registrations were removed, and after exclusions 533 registrations were used in the analysis. These registrations represent in total 156.5 hours, which equals 63 percent of the total work hours during the registration period (see appendix A2).

The audiologists registered 1806 activities, from which 80 registrations were removed, and after exclusions 1720 registrations were used in the analysis. These registrations represent in total 469 hours, which equals 92 percent of the total work hours during the registration period (see appendix A2).

Secondary Data:
The secondary data was obtained from the health trust's own registry (Registertdata) and included data from PAS and Oplan from 2016, 2017, and 1. Jan to 9. Feb (PAS), and 1. Jan to 13. Feb (Oplan) 2018. The data made available included only data and time, including start and end time, and type of activity (see appendix A3). In addition, data on no shows in 2017 and early 2018 were provided by the reception at ear, nose and throat.

Process Mapping:
A process mapping was carried out at the ear, nose, and throat polyclinic. This included several meetings and discussions with leaders and staff at the department, with aim at understanding how the clinic is run, and how tasks are carried out and fit together, as well as uncovering challenges.

4.2.1 Primary Collection Process

When deciding on the appropriate approach to collect the data, it was important that the process was not too disruptive to the participants. As data had to be anonymous, the authors could not participate in the process, which ruled out direct observation. Alternatively, it could have been done by neutral observers, such as medical students, but this was before the study commenced, by both the authors and the participants, perceived to be more disruptive than to use the app. Since the app had previously been successfully been applied in homecare services, it was decided to use the app (Slyngstad 2016).

The collection had to be done in ordinary and representative weeks. Also, because of the busy schedules of the participants, the data collection could not be extended.

In a general meeting with the doctors it was revealed that some technical difficulties were experienced during the collection process. The app requires internet connection to work properly, and as the hospital consist of tick concrete internet connection is limited in certain areas. The doctors also reported that in certain parts of the day, especially during emergencies or operations, access to the mobile device to register were limited.

4.2.2 Primary Data Variables

In dialog with the participants a range of variables were identified which encompassed most of daily activities. Because of the time limitations a choice had to be made between broad activities, which would cover as much of the total activity as possible in a holistic view, or specific activities, to pinpoint a specified area of interest and go into detail. As no comparable data exists at the doctor's level at the outpatient clinic, the decision was that a holistic approach would be best. Although both approaches have merit, the chosen approach gives better grounds for further research and has the potential to uncover areas to further investigate that otherwise may not have be considered.

This study used 14 variables in the data collection at the hospital. Table 4-1 show the overview of the activities registered.

Table 4-2: Activities used in primary data collection

N	Activity	Registered by
1	Patient presence	Doctor
2	Administrative tasks	Doctor
3	Pre-op evaluation	Doctor
4	Operation:	Doctor
5	Post-op evaluation	Doctor
6	Polyclinic control	Doctor
7	Professional specialization	Doctor

8	Ward	Doctor
9	Patient presence - hearing	Audiologist
10	Patient presence - adjustment	Audiologist
11	Service & documentation	Audiologist
12	Patient preparation	Both
13	Patient out / post work	Both
14	Other	Both

The variables used in the primary data collection were defined as follows:

Patient presence (doctor): When the patient is present at the doctor's office.

Administrative tasks (doctor): Salary, invoicing, work schedules and alike.

Pre-op evaluation (doctor): Preoperative evaluation.

Operation (doctor): Both time spent at operating room and operating room for minor procedures.

Post-op evaluation (doctor): Postoperative evaluation.

Polyclinic control (doctor): Patients present for a control.

Professional specialization (doctor): Dedicated time for research and training. Distinguished from the other variable to avoid unnecessary inflation of it.

Ward (doctor): Time spent at ward rounds.

Patient presence - hearing (audiologist): Patient physically present for a hearing test.

Patient presence - adjustment (audiologist): Patient physically present for hearing aid adjustment.

Service / documentation (audiologist): Patient related. Includes service on hearing aids, either received by mail or patients dropping in, prepare required paperwork to send patient's hearing aids to service/repair and document this is the patient's journal, order new hearing aids to those who have lost the old ones and document this in the patient's journal.

Patient preparation (both): Patient specific work before the physical presence of the patient, predominantly journal review.

Other (both): Doctors registered activities such as evaluating patient referrals, follow up on patients and test-results, various meetings, and phone calls. Audiologists registered activities such as cleaning/clearing, online education, purchasing (hearing aid to general storage, not directly to patient), and various phone calls.

Patient out / post work (both): Patient leaves the doctor's office, and doctor begins documentation, ends when patient related afterwork is concluded.

4.2.3 Variables Limitations

The downside with a holistic view is that the chosen variables are quite broad and generic. This limits the ability to pinpoint root causes or break down the variables in their smaller components. For example, the other variable contains elements that can be considered both value-adding and non-value adding, but it is not possible to distinguish between the distribution of them data. On the other hand, the data does provide a good holistic overview, and a foundation from which comparisons can be made with the hospital's own data.

4.2.4 Weaknesses in Primary Data

The main weakness with the primary data is the relatively small sample. Although it was done in just some weeks, the sample consist of data from many participants, and therefore still offer quite a lot of data given the limited period. The data is susceptible of some risk related to weekly variation, but the collection process was planned in close collaboration with the hospital to reduce the risk as far as possible, and in hindsight the reports were that the week(s) were normal.

Since the authors had not direct influence on the data collection process, some lack of control is present. On the other hand, this means that the process included few disruptors, and the participants could work as closely to normal as possible, which increase the data quality. The study is the first of its kind, and the data presented is very interesting as a pilot.

Since only full registration days were included in the analysis, the amount of no registered activity is rather limited. This was partly done because there is no way to distinguish between whether no registered activity is a mistake or indicates waiting time. Therefore, total waiting time may perhaps be understated in the study, but this would require much more specific investigation to uncovered.

4.2.5 Weaknesses in Secondary Data

PAS is primarily an accounting system used to register various commission codes necessary for the clinic to receive financial compensation from the Norwegian Health Economics Administration (HELFO) for performed treatments. Since the system was not intended to capture how time is distributed among various activities at the clinic the data is not optimal to use as a foundation for efficiency work. However, it is the only data available at the hospital, and the data is also currently used for these purposes. The aim of this study is to highlight some of the differences, based on the primary data collection. PAS registrations are manually registered and likely contains errors, but it is uncertain how many that are present in the dataset.

4.3 Method: Descriptive Statistics

Descriptive statistics is used as the method of analysis in this thesis. Descriptive statistics can be described as basic statistics, using various formulas (some briefly presented in the sections below), organization and visual presentation to make the data easier to interpret. The authors have predominately used Microsoft Excel to analyze the data in this thesis.

Given the nature of the data gathered and received, and the goal of creating a foundation for further research, it was natural to present the data in the most transparent way possible, especially given that this data does not exist elsewhere, and descriptive statistics achieve this.

Although this study did not intend to use simulation as the method of analysis, the authors have, in hindsight, discovered that the data quality available at the hospital today is not good enough to perform a meaningful simulation.

4.3.1 Central Tendency

Central tendency uses different measures, such as mean and median, to describe the middle formation of the data to better understand potential trends in the dataset.

The **mean** value, statistically expressed as μ, or otherwise known as average, is the most commonly used measure of central tendency, and is expressed by the formula,

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} xi$$

The mean uses the sum of the whole data set, and divides it by the number of observations, expressed as *n*. This tell us something about the size of the sample and the population, as well as something about how it behaves. While the most used measure, it is not always the most suitable because it uses all values and divides by *n*, which makes it is susceptible for extreme values (very large or very small) present in the data that make the mean under- or overrepresented.

The **median** value on the other hand is not susceptible to extreme values, as it looks strictly at the center data of the sorted dataset. It tells us what the middle value is in an odd numbered dataset, or the average of the two centered values in an even numbered dataset. While the median tells us something about the middle formation of the data, it does not account for how the rest of the dataset is comprised.

4.3.2 Statistical Dispersion

Statistical dispersion can be described as the opposite of central tendency, as measures such as variance, standard deviation, min, and max values tells us more about the spread in the dataset.

The **variance**, statistically expressed as σ^2, tells us something about the consistency of the data as it describes the spread of the data, found by the formula,

$$S^2 = \frac{1}{n-1}\sum_{i=1}^{n}(xi - \bar{x})^2$$

The **standard deviation**, statistically expressed as σ, describes how the data is spread around the mean value. It tells us how the overall dataset is distributed, found by the formula,

$$S = \sqrt{S^2}$$

4.3.3 Percentage

When there are multiple data sets or activities it is necessary to somehow convert them to make them comparable to one another. As the study includes many different activities, and different datasets, it becomes easier to compare them when using percentage. With *n* different activities and time spent on an activity expressed as t_n, the total time on all activities is expressed by t, found by the formula,

$$t_n = \frac{t_n}{t} * 100$$

4.3.4 Distribution Measures

When analyzing data, it is very important to know how the overall dataset is distributed. Disregarding the distribution of the data can in certain circumstances give both misleading or confusing results. Interquartile range, skewness and kurtosis are measures that, when combined with other statistics, can tell us which tests are appropriate to apply to analyze the data.

Interquartile range (IQR) is a measure of variability based on dividing the data set into quartiles by rank-ordering the data and then divided into parts. Unless otherwise stated the IQR range used is the 25th and 75th percentile.

Skewness describes asymmetry in the dataset. There is mathematical theory available on data distribution, and from the gaussian function the dataset is expected to be normally distributed around the mean, shaping a bell curve. When perfectly normally distributed the skewness value will be zero, but most empirical studies are not perfectly distributed as some type of skewness is normal. However, the type of, and severity of, asymmetry in the data, and the cause of it, is relevant information when analyzing data. The formula can find skewness:

$$Skewness \approx \frac{1}{n}\sum_{n=1}^{n}\left(\frac{x-\bar{x}}{s}\right)^{3}$$

A positive skewness value means that the data is skewed to the left, and that the mass of the data is centered to the left, while a negative value means it is skewed to the right, with the mass of the data centered to the right.

Kurtosis describes how the distribution is spread between the minimum and maximum value in the dataset. Like skewness, in a normal distribution the kurtosis value will be zero. The formula can find kurtosis:

$$Kurtosis \approx \frac{1}{n}\sum_{i=0}^{n}\left(\frac{x_{i-\bar{x}}}{s}\right)^{4} - 3$$

5.0 Summary

There is not a long tradition for application and use of logistical theories and efficiency measures in health care, but the research in this field has strongly increased during recent years. However, the rate at which health care quality has improved has been slower than most would want. From 1994 to 2014 the number of doctors in Norway has more than doubled, while the number of patients has only increased by about 17 percent. During this time, each doctor has experienced spending less time with patients, while patients spend more time with doctors in total. In Norway, outpatient consultations represent most of the activity within the hospital and is a cost driver to the Norwegian health care system. However, an overview of how time is spent at the outpatient clinic, as well as research done directly at the outpatient level, is practically non-existent. Therefore, this thesis aims at contributing to a better understanding of how doctor's time is spent at the outpatient clinic.

Previous studies in health care has found the data available is not good enough to be used in efficiency work in regard to capturing variability of operations for instance. Therefore, this study also aims at investigating whether the data available within the hospital's own registry is sufficient to be used as foundation for efficiency measures and related work, how that data compares to reality and which other potential factors that affect efficiency at the clinic.

The next section contains the research paper.

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7.0 Paper: Resource Efficiency within the Outpatient Clinic

8.0 Abstract

Introduction:

There is a need and desire to improve efficiency in health care. However, the data currently available is limited, especially at the doctor's level at the outpatient clinic. This study has collected primary data and aims at creating a platform for further research in this area.

Methodology:

This study gathered primary data prospectively at the outpatient clinic during week 3, 4, and 5 in 2018. It also uses secondary data from the health trust's own registry from 2016, 2017 and early 2018. In addition, information gathered through process mapping work at the clinic is included in the study. Descriptive statistics was used to analyze and present the data and findings.

Results:

43 and 25 percent of the time related to consultations is spent either before or after the patient's presence with doctors and audiologists, respectively. 15 and 9 minutes of the median time registered in PAS related to consultations is likely patients waiting for doctors and audiologist, respectively. 28 and 11 hours of waiting / idle time was caused by no shows in 2017 and 2018, respectively. Potentially 16 percent of all available registrations in PAS may be misregistration.

Conclusion:

There is considerable uncertainty tied to the data registered in PAS. Compared with the primary data PAS / OPlan does not capture all activities, and therefore also not a considerable part of total time consumption, for both doctors and audiologist. Furthermore, the time captured in PAS / Oplan does not accurately reflect the actual time consumption for the respective registrations.

Keywords: Outpatient, Polyclinic, Efficiency, Time, Activity

9.0 Introduction

Limited health care resources face practically limitless demand, as the population is both growing and aging quickly. Furthermore, patient's expectations grow, and health care services must meet this growing and changing demand with limited access to additional resources. To cope, health care services must adapt, and become more efficient. The cornerstone in efficiency measures is good data and detailed understanding of the processes in the organization, an overview which is hard to obtain with the currently available information in health care.

In the county of Møre and Romsdal two of the currently hospitals are about to be merged into a new regional hospital, which is in construction. A project group has been established and tasked with evaluating, planning, and facilitating the overall process. The goal of the group is to increase efficiency in the new hospital and have chosen an outpatient clinic as pilot in this work. Molde University College has been engaged in this work, and this paper is part of the scientific contribution from the University to the project based on knowledge gained from the pilot clinic.

Efficiency is a central term in this thesis, and, unless otherwise stated, it is defined in terms of throughput as well as waiting time reduction, while improving department organization (Testi, Tafani and Torre 2007).

Polyclinic and outpatient clinic are used interchangeably in this thesis.
Consultation and appointment are used interchangeably in this thesis.

10.0 Literature

At the outpatient level, research has examined the effects of joint scheduling on performance (White et al. 2011). Also, a study from the Netherlands, assessed efficiency in an ear, nose, and throat clinic with focus on patient flow, considering particularly scheduling, appointment rules, and patient batching (Stek 2015). Furthermore, one study examined how actively pre-assessing patient charts and pre-specifying management plans could reduce weekly clinic attendance by 40 percent (Healthcare Improvement Scotland 2012). Also, one study examined how electronic health records may help efforts to improve efficiency in care delivery (McAlearney et al. 2010).

One study gathered data retrospectively from the general practitioners by mapping time consumption through self-filled questionnaires at the end of the day (Den Norske Legeforening 2017). Another study did a similar data collection but targeted the doctors in the hospital setting (Rosta and Aasland 2016). However, this study is, to be best of the authors knowledge, the first prospective study which maps time consumption at the doctor's level at the outpatient clinic through data collection using an app (see appendix A1).

11.0 Methodology

The Data

The objective of this study was to investigate efficiency at the outpatient clinic in terms of time consumption at the doctor's level, as research on this area is scarce and the data gathered in this study is practically non-existent in previous research. The benefit of doing a prospective study rather than a retrospectively study is that data collection is not reliant on memory of actions carried out, and captures the sequence of actions, as data is continuously gathered.

The data used in this thesis originates from two different sources: primary data collected by the employees at the outpatient clinic using an app, and secondary data obtained from the hospital. In addition, qualitative information was gathered through process mapping at the clinic.

Primary Data:

The primary data was collected from the Otorhinolaryngology (ear, nose, and throat) and audiology departments, in cooperation with the respective doctors and audiologist. The collection process was done in one week by the doctors (week 3 in 2018) and three weeks by the audiologists (week 3, 4 and Monday to Wednesday in week 5 in 2018). Unless otherwise stated "participants" refers to both doctors and audiologist who participated in the collection.

The data collection was carried out by the participants, who used a time tracker app installed on their own devices. The app allowed the participants to record which activity they performed, and the time associated with the respective activity, throughout the day.

The participants would simply click on the appropriate activity to start recording time usage on it, and either click on the next activity as tasks switch or click stop to indicate a halt in activity. For instance, when starting preparations before a consultation, such as reading the patient's journal, the activity patient preparation would be clicked to start recording the time-consumption. Once the preparations concluded the activity would either be stopped, by clicking stop, or the next activity would be selected to start recording time for that activity instead. The registrations proceeded into the data systems of the app provider, and once the collection process was completed an excel file with all the registrations were provided to the authors.

Since the app required physical interaction, the data naturally contained errors. The errors were predominantly obvious mis clicks, either by selecting the wrong activity, or prematurely stopping an activity, or not stopping an activity. Therefore, one error often led to multiple registrations of little or no duration, which was removed from the data. In total, 6.2 percent of all registrations were removed from the dataset. Also, for the purposes of this study only fully registered days were included in the data analysis, thus days with just some hours registered were entirely excluded. Some lunch breaks had been registered as an activity and were also excluded. These were deliberate decisions to avoid unnecessary skewness.

The doctors registered 685 activities, from which 74 registrations were removed, and after exclusions 533 registrations were used in the analysis. These registrations represent in total 156.5 hours, which equals 63 percent of the total work hours during the registration period (see appendix A2).

The audiologists registered 1806 activities, from which 80 registrations were removed, and after exclusions 1720 registrations were used in the analysis. These registrations represent in total 469 hours, which equals 92 percent of the total work hours during the registration period (see appendix A2).

Secondary Data:

The secondary data was obtained from the health trust's own registry (Registertdata) and included data from PAS and Oplan from 2016, 2017, and 1. Jan to 9. Feb (PAS), and 1. Jan to 13. Feb (Oplan) 2018. The data made available included only data and time, including start and end time, and type of activity (see appendix A3). In addition, data on no shows in 2017 and early 2018 were provided by the reception at ear, nose, and throat.

Process Mapping:

A process mapping was carried out at the ear, nose, and throat polyclinic. This included several meetings and discussions with leaders and staff at the department, with aim at understanding how the clinic is run, and how tasks are carried out and fit together, as well as uncovering challenges. Furthermore, studies have shown that process mapping can increase transparency of activities between 5 and 27 percent and was therefore considered a valuable addition to the data (Klotz et al. 2008).

Variables:

The main variables listed below were formed by merging the variables used in the data collection process as appropriate to the data analysis as follows (see appendix A4):

Patient treatment (doctor): When the patient is present at the doctor's office. Includes polyclinic control.

Administrative tasks (doctor): Salary, invoicing, work schedules and alike.

Operation (doctor): Time spent at operating room. Includes pre-op evaluation and post-op evaluation.

Other (doctor): Activities such as evaluating patient referrals, follow up on patients and test-results, various meetings, and phone calls. Includes ward.

Professional specialization (doctor): Dedicated time for research and training. Distinguished from the other variable to avoid unnecessary inflation of it.

Patient presence - treatment (audiologist): Patient physically present.

Service / documentation (audiologist): Patient related. Includes service on hearing aids, either received by mail or patients dropping in, prepare required paperwork to send patient's hearing aids to service/repair and document this is the patient's journal, order new hearing aids to those who have lost the old ones and document this in the patient's journal.

Other (Audiologist): Activities such as cleaning/clearing, online education, purchasing (hearing aid to general storage, not directly to patient), and various phone calls.

Patient preparation (both): Patient specific work before the physical presence of the patient, predominantly journal review.

Patient out / post work (both): Patient leaves the doctor's office, and doctor begins documentation, ends when patient related afterwork is concluded.

Descriptive Statistics:

Descriptive statistics can be described as basic statistics, using various formulas, organization, and visual presentation to make the data easier to interpret, and is used as the method of analysis in this paper. The authors have predominately used Microsoft Excel in this work. Given the nature of the data gathered and received, and ambition of creating a foundation for further research, it was natural to present the data in the most transparent way possible, especially given that this data does not exist elsewhere, and descriptive statistics achieve this.

12.0 Results

App and PAS data for Doctor

In total there were 156.5 hours registered by the app and 98.0 hours registered by PAS in Table 12-1.

Table 12-1: Main group variables doctor data from app and PAS week 3 in 2018

		Minutes	Hours		Observations
Group	Activity	Median, IQR	Total	Percentage	N
App	**Patient preparation**	6 (3-11)	14,1	9,0 %	98
	Patient treatment	14 (9-22)	43,9	28,0 %	139
	Patient out / post work	5 (3-9)	19,6	12,5 %	131
	Other	12 (6-27)	21,4	13,7 %	62
	Administrative tasks	14 (5-35)	14,2	9,0 %	33
	Operation & evaluation	17 (8-55)	21,5	13,7 %	33
	Professional specialization	15 (9-31)	21,9	14,0 %	37
	Total	10 (4-18)	156,5	100,0 %	533
PAS	**Treatment**	30 (26-30)	14,7	15,0 %	24
	Control	26 (16-38)	56,3	57,4 %	106
	Examination	34 (20-43)	27,1	27,6 %	46
	Total PAS	29 (17-39)	98,0	100,0 %	176

In the app, patient treatment represents the largest time-consuming activity (28.0%), with a median and interquartile range (IQR) 14 minutes (9-22). Patient out / post work represent 12.5 percent of the time spent with median (IQR) 5 (3-9). Both Patient preparation and administrative tasks represent 9.0 percent of the time spent each. However, the median (IQR) for patient preparation and administrative tasks were 6 (3-11) and 14 (5-35), respectively. Combined, patient preparation, patient treatment, and patient out / post work, represent 49.5 percent of time spent in total. The median (IQR) of operation & evaluation was 17 minutes (8-55). The median (IQR) of other was 12 minutes (6-27). Professional specialization was the second largest time-consuming activity (14.0%).

In PAS, the total median (IQR) was 29 (17-39). Control was the largest time-consuming activity (57.4%) with median (IQR) 26 (16-38). Examination was the second largest contributor (27.6%) with median (IQR) 34 (20-43). Treatment represent the remainder (15.0%) with median (IQR) 30 (26-30).

App and PAS data for Audiologist

In total there were 469.0 hours registered by the app and 204.5 hours registered by PAS in Table 12-2.

Table 12-2: Audiologist data from app and PAS week 3, 4, and 5, in 2018

		Minutes	Hours		Observations
Group	Activity	Median, IQR	Total	Percentage	N
App	**Patient preparation**	3 (1-6)	31,2	6,7 %	384
	Patient presence - treatment	22 (15-33)	239,5	51,1 %	544
	Patient out / post work	5 (3-8)	48,2	10,3 %	399
	Other	18 (7-31)	80,1	17,1 %	181
	Service & documentation	12 (6-25)	70,0	14,9 %	212
	Total	10 (4-23)	469,0	100,0 %	1720
PAS	**Treatment**	14 (11-15)	10,5	5,1 %	39
	Control	33 (22-46)	193,1	94,4 %	322
	Examination	55 (55-55)	0,9	1,0 %	1
	Total PAS	31 (20-44)	204,5	100,0 %	362

In the app, patient presence – treatment represent the largest time-consuming activity (51.1%) with median (IQR) 22 (15-33). Patient out / post work represent 10.3 percent of the time spent, with median (IQR) 5 (3-8). Patient preparation represent 6.7 percent of time spent, with median (IQR) 3 (1-6). Combined, patient preparation, patient presence – treatment, and patient out / post work represent 68.1 percent of time spent in total. Service & documentation represent 14.9 percent of time spent, with median (IQR) 12 (6-25). Other represent 17.1 percent of time spent, with median 18 (7-31).

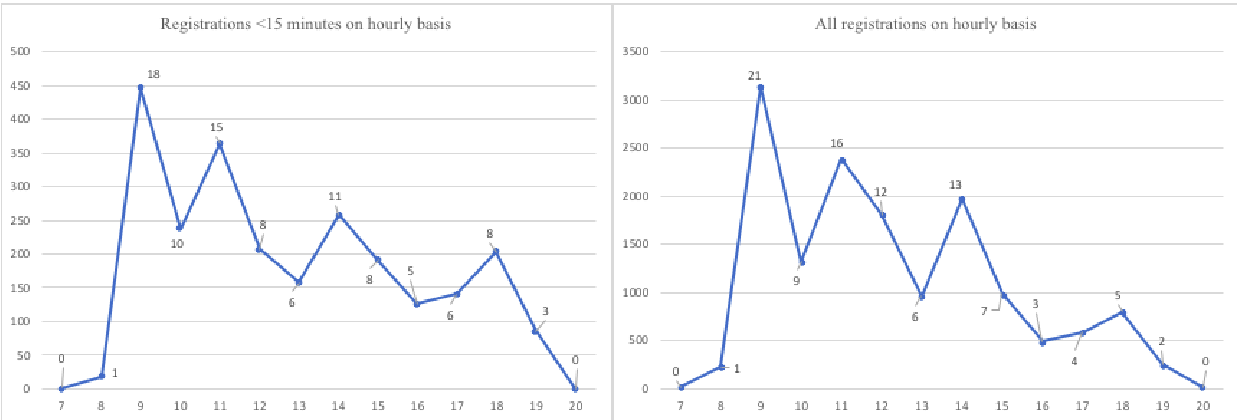
In PAS, the total median (IQR) was 31 (20-44). Control represent the largest time-consuming activity (94.4%) with median (IQR) 33 (22-46). Treatment represent the remainder (5.1%) with median (IQR) 14 (11-15). In addition, it was one examination, with a duration of 55 minutes.

No Shows

In 2017, in total 169 patients were no shows at the ear, nose and throat polyclinic (see appendix A5). During the first three months, and 2 first weeks of April 2018, there were 68 patients were no shows at the polyclinic in total.

PAS registrations with duration <15 minutes

In PAS for ear, nose and throat during the period 2016, 2017, and from January 1st until February 9th in 2018, there were 14 939 total registrations in PAS, of which 2437 registrations had a duration less than 15 minutes (Figure 12-1).



*Numbers inside the figure indicate percentage. To the left, the percentage of total registrations with a duration <15 minutes, and to the right the percentage of total registrations. Represented on hourly basis. Derived from PAS.

Figure 12-1: Registrations with duration of <15 minutes compared to total registrations

The activity level peaks at 09:00 am and gradually decrease until ordinary closing time at 16:00 pm. On Tuesdays there are extended opening hours until 20:00 pm, thus the registrations between 16:00 pm and 20:00 pm represents only Tuesday evening, which is the reason that the activity level at 16:00 pm does not decrease to zero.

The number of registrations recorded with a duration less than 15 minutes is highly correlated to the overall activity level, as illustrated in the figure. The distribution of registrations less than 15 minutes shows a higher occurrence of short registrations comparatively to the total activity level between 16:00 pm and 20:00 pm than during ordinary opening hours. Within ordinary opening hours the registrations less than 15 minutes systematically correlate to the peaks in overall activity, notably at 9 am, 11 am, and 14 pm.

From Process Mapping

The process mapping carried out at the department revealed amongst other findings:

- Patients are registered at the clinic's reception upon physical arrival and departure to/from the clinic, and these registrations are done manually by the secretaries.
- Secretaries spend up to three hours daily on manually sending mail with appointment information and practical information to patients and/or general practitioners, and the heavy workload leads to the secretaries occasionally being unable to fill doctor's schedules with patient appointments.
- No system in place to notify doctors of patient's arrival, or lack thereof.
- Poor coordination and transparency due to poor and outdated computer systems.

13.0 Discussion

Doctor

43 percent of the time related to consultations was spent either before or after the patient's physical presence. This relationship was derived from the combination of patient preparation (14.1 hours), patient treatment (43.9 hours), and patient out / post work (19.6 hours), whereof 43.9 hours of the total 77.6 hours represent patient's presence. In week 3, the app captured approximately 79 percent (139 of 176) of the patients registered in PAS. The app captured approximately 63 percent (156.5 of 248) of the work hours during the registration period. Since many of the missing hours (91.5) were during operations or emergencies the app captured comparatively more of the consultation activities. Therefore, the share of registered patients compared to the share of registered work hours coincide quite well, which indicate that the app produced reliable results, and that the 43 percent finding is an accurate depiction of reality. Furthermore, previous studies have found similar findings, in that the electronic patient journal (EPJ), used for preparation and documentation, can be time consuming for the doctors (Rosta and Aasland 2016).

Roughly half of the time patients spent at the clinic was waiting for a doctor. In week 3, PAS state median consultation time as 15 minutes longer than the physical presence registered in the app, 29 and 14 in PAS and the app, respectively. The process mapping revealed that PAS register start- and end time as when the patient physically arrives at and departs from the reception at the clinic. The app register patient treatment start- and end time as when the patient arrives at and departs from the doctor's office. Thus, PAS includes the patient's waiting time at the clinic, i.e. time between arriving at the reception and entering the doctor's office, and time after the doctor's office before leaving from the reception. In other words, the discrepancy of 15 minutes is likely median waiting time.

Looking at the median for patient preparation and patient out / post work, it equals 11 minutes combined (6 and 5, respectively). This is quite close to the median waiting time of 15 minutes. The explanation may potentially be that patients wait while the doctor performs these tasks. However, neither patient preparation nor patient post work are fixed activities and may be carried out at other times besides directly before or after the patient's physical presence. Therefore, solid conclusions cannot be drawn from this. The process mapping also revealed that there is no system in place which notifies doctors of the patient's arrival (or lack thereof), and this may contribute to unnecessary waiting time for both the patients and for the doctors. Realistically, the doctors cannot spend their days continuously checking the waiting area for arrivals, and thus it is natural that excess waiting occur to avoid unnecessarily going back and forth looking for patients.

The process mapping revealed that a standard consultation is scheduled for 30 minutes and control varies from 15 to 30 minutes dependent on the case. In the available PAS data, the actual median times were 30 minutes and 25 minutes, respectively, and thus it seems as if the scheduled and actual time coincide quite well according to PAS. However, in the app the IQR of patient treatment was 9-22 minutes, meaning that even the 75th percentile is notably below the median time (29 minutes) in PAS.

Combined, other and administrative tasks represent 22.7% of the total registered time. In fact, administrative took as much time overall as patient preparation does (both 9.0%). In addition, professional specialization (which includes academic meetings and internal education) was the second largest activity (14.0%), but this is a contractually stipulated activity with allocated time.

Approximately 25 percent (12.7 of 16.4 hours) of the time doctors spend on operations and minor procedures are not registered in PAS / Oplan (see appendix A6). The operation variable used in the collection registered both time at the operating room and minor procedures (see appendix A4). The authors isolated the operation time by comparing the operation time registered in the app with the registered operation time in Oplan. 12 hours in the app overlapped, but in OPlan only 9 hours was registered related to those operations. The remaining time (4.3 hours) registered in the app was therefore minor procedures, but also there only 3.7 hours were registered in PAS. The process mapping revealed that PAS/ Oplan only register the time of the principle / responsible doctor. Therefore, time spent by doctors who support the operation/procedure, and typically is only present parts of the time, is not registered. Thus, the systems capture only 75 percent of the time associated with these activities, and in addition the time consumption related to preoperative and postoperative evaluation has still not been accounted for.

Audiologist

25 percent of the time related to consultations was spent either before or after the patient's physical presence. This relationship was derived from the combination of patient preparation (31.2 hours), patient presence - treatment (239.5 hours), and patient out / post work (48.2 hours), whereof 239.5 hours of the total 319.8 hours represent patient's presence. The app captured approximately 92 percent (469 of 510) of the work hours during the registration period, which supports that this finding accurately depicts reality. The number of observations in patient presence – treatment (544) in the app is higher than the number of patients registered in PAS (362). The reason is that PAS does not separate hearing test and adjustment, while the app did, and some patients do both hearing test and adjustment during the same consultation. The authors have not altered the number of observations in patient presence – treatment by, for instance, attempting to identify which hearing test and adjustments are connected and merge them.

Roughly a third of the time patients spent at the clinic was waiting for an audiologist. In the collection period, PAS state median consultation time as 9 minutes longer than the physical presence registered in the app, 31 and 22 in PAS and the app, respectively. Following the same logic as presented in the doctor's section, the median waiting time for the patients at the audiology department is likely 9 minutes.

Looking at the median for patient preparation and patient out / post work, it equals 8 minutes combined (3 and 5, respectively). This is very close to the median waiting time of

9 minutes. The explanation may potentially be that patients wait while the audiologist performs these tasks. However, neither patient preparation nor patient post work are fixed activities and may be carried out at other times besides directly before or after the patient's physical presence.

PAS underrepresented time consumption for audiologists by 56 percent (204.5 of 469 hours). Since PAS only register based on patient arrival and departure, it neglects time spent on other activities. 32 percent of the time, which is not captured by PAS, is spent on service & documentation and other. Service & documentation encompass activities such as purchasing, inventory management, stock keeping of hearing aids (with associated parts and accessories), and various service tasks and documentation. A discussion should be had on whether these activities are the audiologist's core competencies, and whether it is appropriate that they carry out these tasks. It is likely room for improvements in this area which can relieve and release time at the audiology department

High variation makes planning in this space challenging without better data. Consider this example: the app registered in total 1720 activities from 68 different work days, which equals on average 25 daily activities per audiologist. The median time of all activities combined in the app was 10 minutes, and with 25 activities on average per day, it equals little over 4 hours, notably less than the 7.5 hours for the full work day. However, if those 25 activities each last for 23 minutes instead (the 75^{th} percentile) the time it takes to complete them increase to 9.5 hours, or in other words require 2 hours overtime.

Optimizing human resources becomes very challenging, if possible, when the time consumption is misrepresented in the data, and it does not encompass the full scope of activities, as shown in the data from both the doctors and the audiologists. Furthermore, planning without a full overview of time consumption can lead to overwork. Increased job demand without provision of additional resources has shown to induce defensive strategies among recipients of change, and likely contributes to both lack of 'buy-in' and resistance to the proposed change (Hayes, Batalden, and Goldman 2015).

PAS registrations <15 minutes (ear, nose, and throat)

Approximately 16 percent of all registrations for the doctors in 2016, 2017 and early 2018 combined had a duration of less than 15 minutes (hereby "short registrations"). As mentioned, standard consultations are scheduled for 30 minutes and controls varies from 15 to 30 minutes. The process mapping revealed that some controls, especially of children, are typically very quick, but do require physical meetings at the hospital. Except from that, it was not expected to see many short registrations in PAS. Therefore, a secretary in the reception of the clinic were presented with a random sample of dates and times and asked to investigate those registrations. The secretary found that the registrations were mistakes. Because of confidentiality rules, the authors could not investigate this issue in more detail. However, the preliminary finding basically leaves two options: either the short registrations are correct, and the scheduled consultation times are too long, or the short registrations are incorrect, and the PAS data includes a considerable portion of mistakes.

Short registrations are closely correlated to peaks in overall activity. This could simply be because during peak hours there are a higher frequency of consultations that are in fact short. However, during peak hours the secretaries are under higher pressure, and there are more disruptors occurring as they are registering data, and this could lead to more mistakes during peak hours. However, a study from the US examined variation and found that admitting privileges led to artificial peaks in demand, and underutilization of health care resources during demand valleys (Litvak and Fineberg 2013). Ear, nose, and throat has clear peaks in overall activity, especially at 9:00 am, and there could be some admission biases present, either from doctors or secretaries. Therefore, clearer routines and rules of appointment planning may lead to smoother operations.

22 percent (555 of 2437) of the short registrations occurred during the extended hours from 16:00 pm to 20:00 pm. The process mapping revealed that, as far as possible, cases presumed to be fast and easy are scheduled for the evening shift. Also, 59 percent of the registrations in PAS are controls, which is more likely to be shorter (see appendix A7). Worth mentioning again is that the IQR of patient treatment in the app was 9 minutes (25th percentile), which is well within this category. These considerations support that the registrations could be correct.

On the other hand, of the 2437 short registrations, 106 had a duration of zero minutes, and 237 lasted for 3 minutes or less. A consultation should take more than 3 minutes from start to end. Also, as mentioned, the random sample test did find mistakes. Thus, there are mistakes in the data, but how many remains an unanswered key question. The main point is there are considerable uncertainty tied to the reliability of the PAS data as presented.

Regarding these short consultations, a debate should probably be had about whether it is necessary to have the patient physically come to the hospital when it takes <15 minutes. The process mapping revealed that there are systems in place to do consultations over the phone, but they are not being used. One reason mentioned is uncertainty about how the clinic is reimbursed by the Norwegian Health Economics Administration (HELFO) for consultations over the phone.

No Shows

Thus far in 2018, an estimated 11 hours of waiting / idle time for the doctors has been caused by no shows. On average approximately one patient has daily not shown for the appointment in 2018. While there were fewer on average in 2017, there were still 169 no shows in total. Because there is no system in place to notify the doctor of a patient’s arrival (or lack thereof), the doctor ends up continuously checking the waiting area for the delayed patients. The process mapping revealed that between 5 to 15 minutes are dedicated to the patient past the scheduled time, before the appointment is considered forfeit. Accounting 10 minutes for each of the 68 patients equate to more than 11 hours, and throughout the year of 2017 this equated to 28 hours in total.

The process mapping revealed that during that time doctors would do outstanding tasks. However, occasionally there would be no outstanding tasks appropriate to carry out at that time, and thus the no show could create idle time for the doctor. Furthermore, not knowing whether the patient is delayed or is not showing causes uncertainty, which makes it challenging for the doctor to be productive, especially if there is still a chance that the patient will arrive late.

There are standard practices used within the service industry to plan under uncertainty and limit the negative effect of no shows by deliberately overbooking (Wangenheim and

Bayón 2007). These practices could potentially be adopted in ear, nose, and throat, but require better data.

Process mapping

This section includes important findings revealed in the process mapping.

The secretaries spend up to three hours daily on sending out mail, including appointment- and practical information to patients, as well as confirmations to the general practitioner who referred the patient. The system used to book appointments (PAS) is not electronically connected to the system that receives the referral (EPJ). Therefore, the referrals are electronically received, but the responses must be printed and sent by mail. This is a cumbersome activity, and it was reported that just folding letters and putting them in envelopes could take up to an hour daily. According to head of department, mailing cost the hospital an estimated NOK 3 million annually. That is just the direct cost, not accounting for the cost associated with the time spent by secretaries and opportunity cost of performing other activities instead.

Secretaries are occasionally unable to fill the doctor's schedules with patient appointments. This is caused by limited resources, poor computer systems, a wide range of tasks and responsibilities and cumbersome activities (such as mailing). This combination makes the reception appear to be a bottleneck to the clinic's overall efficiency and should be investigated further.

Patients have no real alternative than to call the clinic to change appointments. The secretaries report phone calls as a significant disruptor to other tasks, especially because the phones have no silent mode. This could lead to more misregistration in PAS. While email is also available, because of all other tasks the response rate there was admittedly worse than desired, so most patients would call. Thus, the system facilitates a reported disruptor in the bottleneck.

Poor computer systems cause many problems. For instance, mailing could be done much faster and more cost efficient electronically. Electronic email solutions, such as DigiPost, is already available and used by, amongst others, Vestre Viken Hospital Trust, which is part of another Regional Health Authority in Norway (Digipost 2018). However, the computer systems also cause internal inefficiencies. For instance, systems are not interconnected, so test results at the audiology department are printed and physically brought to the reception at ear, nose, and throat, where it is scanned and put in electronic folders. Not only are this costly and cumbersome activities in both departments, but it contributes to making the already suboptimal computer systems even harder to manage and maneuver. Such separated systems can be referred to as the "silo mentality," where each branch operates as if independent rather than as an interconnected part in a larger system, which makes the overall system slow and inefficient (McCartney 2016).

PAS includes no quality control check. As mentioned, there were 106 registrations in PAS with a duration of zero minutes. PAS includes no warning, as for instance, to ask whether it is correct that the consultation about to be registered lasted for zero minutes. This could perhaps contribute to improving the data quality registered in PAS.

General practitioners do not provide all the necessary information in their referrals to the hospital, such as lacking phone numbers or not attaching MSRA-results. Not providing phone numbers occurs more often with referrals of children, as parent's phone numbers are not listed. If the clinic needs to contact the patient, time is spent on looking up phone numbers, or finding the right contact person, rather than solving the problem.

Lack of planning transparency limits operation scheduling to four weeks ahead. Booking operations can be especially challenging, as several staff members of various responsibilities are needed, in addition to booking the operation room, at a time the patient is available. Because access to staff schedules far ahead is limited, operations are scheduled on rather short-term basis. Since information is sent by mail, and the lead time on letters can be up to two weeks, the clinic experiences many cancellations of operation appointments.

Ear, nose, and throat has already implemented efficiency measures, such as redesign of processes. Originally, patients with sleeping disorders would get an appointment at the clinic, but the doctors would need to do a CPAP-test before evaluating further action. Realizing that the original appointment was not value-adding, the order was changed. Currently, if a patient reports of sleep disorder they will immediately receive the equipment necessary to perform a CPAP-test, with associated information, and setting up an appointment when results are available. Furthermore, many of the treatments at the clinic require control some time later. Originally, controls would be automatically scheduled for the patient at fixed times in the future. However, many of the controls proved unnecessary, as it was simply a confirmation that nothing needed to be done. Realizing that this was not value-adding, many controls are no longer automatically scheduled. Instead, the patients are now informed to contact the clinic if necessary and provided with all necessary practical information and symptoms to be aware of before leaving.

14.0 Research Summary

Limitations of the Study

The study focused on the outpatient clinic and have therefore not accounted for inefficiencies caused by other departments or external sources. For example: time spent looking up phone numbers to patients because the general practitioner had not provided the information. While this is clearly an inefficiency caused by an external source, its duration could not be pinpointed in this study. This is in part because of the limited number of variables used, the scope of the study, and the limited time the participants had available to do the collection. While, one hand, the broad variables limited the ability to identify root causes, it in turn gave a holistic overview.

Confidentiality limited the access to data in PAS, and any analysis based on patient or treatment specific information could not be done. However, by looking at general time usage the result became more generalizable and comparable to other studies in the future.

Suggestions for further Research

The supporting structure around the doctors appears as a bottleneck. However, the secretaries at the reception were not part of the data collection, and perhaps a similar study targeted at better understand how time is allocated within the reception could provide valuable insights.

This study created a broad platform to continue work from, and it could be interesting to repeat a similar data collection, but with a narrower approach looking at a particular area more closely with aim at finding root causes. Furthermore, investigating inefficiencies, such as waiting or unnecessary communication, with other departments or external parties, could also be beneficial in this context.

No shows seem to be a recurring problem, and perhaps investigating why patients do not show for their appointments could provide valuable insights and potentially create a foundation for how to manage appointment booking and scheduling.

Currently, specialized resources are used to complete tasks which could be potentially be carried out by other functions, and perhaps the link between core competencies, job design and actual responsibilities is a potential area to investigate further.

Managerial Implications

As mentioned, the supporting structure appears as a bottleneck. Thus, evaluating how these resources can be relieved, or how processes the respective processes can be either redesigned or rearranged, could positively contribute to the overall efficiency of the clinic.

No shows are a negatively impact efficiency at the clinic, both through directly through increased waiting / idle time, but also indirectly by causing repeated activities, such as booking another appointment. Having clear routines, a system to properly inform the doctor, and systematic activities to perform during a no show, could neutralize some of the negative impact it currently has. Ideally, reducing the number of no shows rather than make routines for how to handle them, would be preferable. While achieving zero no shows is unrealistic, there are potentially steps which may be effective to reduce the occurrence, such as changing (or adding) the SMS (Short Message Service) notification to one day rather than three days ahead of the consultation.

As this study shows, the hospital has limited access to data optimal for efficiency work. Although the necessity for changes with the computer systems is obvious, there are potentially steps that can currently be taken to ensure better data. Currently, there are many disruptors, such as phones with no silent-mode, in the environment where the registration takes place, as well as lack of post-registration quality control. Evaluating the registration process could potentially find short-term solutions until a system upgrade is implemented.

Efficiency work is a dynamic process, and continuous work and engagement on solving these types of issues is what eventually drives long-term efficiency in any organization.

15.0 Conclusion

The currently available data at the hospital is not optimal as a foundation for efficiency work. PAS and Oplan does not capture all relevant activities, and therefore excludes significant time consumptions. Furthermore, the captured time does not accurately reflect actual time consumption. Using current data as foundation for decision making would lead to suboptimal efficiency work. The first step should be to ensure access to better data, which includes better data quality control and clear routines for data registration.

Current efficiency limitations are primarily located in surroundings rather than in core activities. Support functions should be the focus of the efficiency work, as the structure around the doctors is not good enough to adequately support efficient operations.

In addition, it seems necessary with clear routines on how to handle no shows to reduce the negative effect on efficiency and potential idle time related to these occurrences.

Competing Interests

The authors declare no competing interests.

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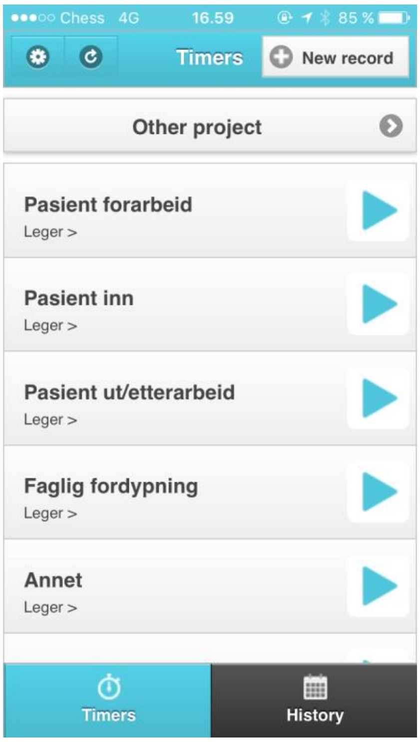
17.0 Appendices

Appendix A1: The App

The app used in the data collection is called Yast, which is a time tracker software made available for both iOS and Android systems. A predetermined number of activities were implemented in the app, and staff would select one of the predetermined activities by clicking on it in the interface (picture available interface below) when commencing the listed activity. The activity time would run until either unclicked to stop, or another activity was clicked, indicating the previous activity concluded and a new has commenced. All participants could, in case of mistakes, leave comments tied to the registrations if necessary.

More information about Yast is available through the links below:
App Store: https://itunes.apple.com/us/app/yast-time-tracker/id399012730?mt=8
Google Play: https://play.google.com/store/apps/details?id=com.yast.yastmobile&hl=en

Visual example of how the app interface looked to the participants, where the square box with the blue triangle on the right is the start / stop button for the respective activity (to the left of the activation button):



Appendix A2: Calculation of documented work time

Group		Monday	Tuesday	Wednesday	Thursday	Friday	Weekly Total
Doctor	**Week 3**	6	6	6	6	5	29
Audiologist	**Week 3**	5	5	6	6	4	26
	Week 4	5	6	5	5	6	27
	Week 5	6	4	5			15
							68

This data in the table was provided directly by the head of department at ear, nose and throat, and the head of department at audiology. The data was provided as presented in the table.

Doctors

Doctors work for eight hours daily (lunch deducted) and had a total duration of 232 hours (29 x 8) for the week. In addition, four doctors worked for four additional hours during the extended opening hours on Tuesday, for an additional 16 hours (4 x 4). The total actual hours were therefore 248 hours. In the app, 156.5 hours were used in analysis (after exclusions), which represent approximately 63 percent of the total time.

Audiologist

Audiologists work for seven and a half hours daily (lunch deducted) and had a total duration of 510 hours (68 x 7.5) for the weeks. In the app, 469 hours were used in analysis (after exclusions), which represent approximately 92 percent of the total time.

Appendix A3: PAS & Oplan full overview 2016, 2017, and early 2018

		Minutes	Hours		Minutes							Observations
Group	Activity	Median, IQR	Total	Percentage	Average	Max	Min	Variance	Std dev	Skewness	Kurtosis	N
PAS	**Treatment**	30 (24-44)	1099,3	12,7 %	42	665	0	2349,03	48,47	5,72	48,44	1559
	Control	25 (17-37)	5081,5	58,6 %	32	704	0	868,52	29,47	6,29	80,52	9487
	Examination	31 (21-48)	2492,3	28,7 %	38	480	0	805,90	28,39	4,24	36,65	3935
	Total	28 (19-41)	8673,1	100,0 %	35	704	0	1018,98	31,92	6,10	71,64	14981
Oplan	**Pre-op**	23 (15-30)	547,2	24,4 %	24,1	95,0	0,0	162,46	12,75	0,89	1,60	1363
	Operation	45 (22-75)	1332,3	59,3 %	58,7	563,0	1,0	3127,07	55,92	2,92	13,73	1363
	Post-op	15 (10-20)	365,8	16,3 %	16,1	215,0	0,0	123,10	11,10	5,95	83,35	1363
	Total time of operation	85 (57-123)	2245,4	100,0 %	98,8	615,0	8,0	4325,81	65,77	2,32	9,22	1363

Appendix A4: Full output from App

		Minutes	Hours		Minutes							Observations
Group	Activity	Median, IQR	Total	Percentage	Average	Max	Min	Variance	Std dev	Skewness	Kurtosis	N
Doctor	**Patien preparation**	6 (3-11)	14,1	9,0 %	8,6	80	1	102,86	10,14	4,13	25,19	98
	Patient presence	15 (9-22)	40,5	25,9 %	19,4	201	1	590,25	24,29	5,45	35,53	125
	Patient out / post work	5 (3-9)	19,6	12,5 %	9,0	110	1	216,28	14,71	5,36	33,62	131
	Administrative tasks	14 (5-35)	14,2	9,0 %	25,7	161	1	1127,02	33,57	2,60	8,02	33
	Other	11 (6-27)	19,6	12,5 %	20,3	94	1	473,73	21,77	1,77	1,77	58
	Pre-op evaluation	16 (8-17)	2,6	1,7 %	15,8	45	1	169,51	13,02	1,26	2,05	10
	Operation	31 (9-100)	16,4	10,5 %	54,8	192	3	3178,65	56,38	0,99	0,19	18
	Post-op evaluation	30 (20-35)	2,4	1,5 %	29,0	56	4	368,00	19,18	0,21	0,58	5
	Polyclinic control	12 (6-15)	3,4	2,2 %	14,6	56	1	220,55	14,85	2,04	4,37	14
	Professional specialization	15 (9-31)	21,9	14,0 %	35,4	249	1	2765,36	52,59	2,78	8,36	37
	Ward	18 (13-32)	1,8	1,2 %	27,0	66	7	704,67	26,55	1,76	3,26	4
	Total	10 (4-18)	156,5	100,0 %	17,6	249	1	741,29	27,23	4,27	23,40	533
Audiologist	**Patient preparation**	3 (1-6)	31,2	6,7 %	4,9	64	0	44,14	6,64	4,51	28,09	384
	Patient presence - adjustment	23 (15-34)	178,3	38,0 %	26,7	109	0	308,94	17,58	1,54	3,72	401
	Patient presence - hearing	22 (16-29)	61,1	13,0 %	25,7	157	0	345,14	18,58	3,28	17,89	143
	Patient Out / post work	5 (3-8)	48,2	10,3 %	7,3	75	1	61,33	7,83	4,17	25,83	399
	Other	18 (7-31)	80,1	17,1 %	26,6	239	0	1058,85	32,54	3,49	16,00	181
	Service & documentation	12 (6-25)	70,0	14,9 %	19,8	134	0	464,06	21,54	2,26	6,53	212
	Total	10 (4-23)	469,0	100,0 %	16,4	239	0	385,42	19,63	3,41	21,06	1720

Appendix A5: No Shows in 2017 and early 2018

	2017	2018
Month	Polyclinic	Polyclinic
January	11	21
February	15	20
March	7	19
April	5	8
May	15	
June	5	
July	12	
August	18	
September	14	
October	29	
November	22	
December	16	
Total	169	68

Only two first weeks of April in 2018 registered.

Appendix A6: Oplan data from week 3 2018

		Minutes	Hours		Observations
Group	Activity	Median, IQR	Total	Percentage	N
Oplan	**Pre-op**	27 (25-30)	417,1	29,5 %	15
	Operation	41 (22-53)	762,0	54,0 %	15
	Post-op	15 (11-21)	233,1	16,5 %	15
	Total time of operation	86 (73-100)	1412,1	100,0 %	15

Appendix A7: Combined PAS activity 2016, 2017, and early 2018

		Minutes	Hours		Observations		
Group	Activity	Median, IQR	Total	Percent	N <15	Percent of N <15	N
PAS	**Treatment**	30 (24-44)	1099,3	12,7 %	189	7,8 %	1559
	Control	25 (17-37)	5081,5	58,6 %	1813	74,4 %	9487
	Examination	31 (21-48)	2492,3	28,7 %	435	17,8 %	3935
	Total	30 (19-51)	15859,9	100,0 %	2437	100,0 %	14981