

Increased productivity using Lean methodologies in a public hospital

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"Progress cannot be generated when we are satisfied with existing solutions"

Taiichi Ohno

Abstract

Although the expenditure has recovered since the economic crisis, Portugal was forced to reduce costs with the National Health Service (NHS), that provides universal coverage to all residents. The economic recession had another effect: the emigration of the younger population, in a country already recognized by its ageing population. With health expenses prone to increase, in a NHS characterized by the accumulated debt of its hospitals, it is crucial to revert the tendency.

This project emerges with the goal of increasing the efficiency and productivity of the services delivered in the Hospital da Senhora da Oliveira in Guimarães, both in the Operating Room (OR) and in the External Appointments' service, using Kaizen methodologies.

Benefiting from the tool Value Stream Mapping (VSM), the current situation was mapped in both services, analyzing the patient's course. All improvement opportunities that were found were described in order to develop solutions. Afterwards, the implementation of those solutions is portrayed in each service. The lever of all the process is the cultural change promoted in the organization.

Implementing simple tools like Daily Kaizen and 5S that have an immeasurable impact, foundations are created to promote change. These serve as leverage for the acceptance and implementation of other tools as Standard Work and SMED. The defined solutions have demonstrated their success, improving several indicators. In the Medical Appointments Service, they allowed for the increase of the charging rate of user fees and the increase of the occupation rate. In the OR, the result was the improvement of the starting time, the reduction of the cleaning time and consequent decrease on the turnover time and the decrease of cancellations due to problems with managing materials.

Despite the increase on the number of publications on the subject in the last few years, the application of Lean methodologies in the healthcare sector appeared with a delay when compared to other service provider industries and examples of successful applications are scarce. This dissertation, although using known methodologies, intends to fill that absence, providing an example backed up by promising results that can be incorporated by other healthcare institutions.

Resumo

Aumento da produtividade num hospital público utilizando metodologias Lean

Embora a despesa tenha recuperado desde a crise económica, Portugal viu-se forçado a reduzir custos com o Serviço Nacional de Saúde (SNS), que proporciona cobertura universal a todos os residentes. A recessão económica teve outro efeito: a emigração da população jovem, num país já reconhecido pela sua população envelhecida. Com os gastos com a saúde propensos a aumentar, num SNS caracterizado pela dívida acumulada dos seus hospitais, é crucial reverter a tendência.

Este projeto surge com o intuito de aumentar a eficiência e a produtividade dos serviços prestados no Hospital da Senhora da Oliveira em Guimarães, tanto no Bloco Operatório como na Consulta Externa, usando metodologias Kaizen.

Beneficiando da ferramenta Value Stream Mapping (VSM), a situação atual foi mapeada em ambos os serviços, analisando o percurso do paciente. Todas as oportunidades de melhoria encontradas foram descritas para, posteriormente, desenhar soluções. De seguida, retrata-se a implementação dessas soluções em cada um dos serviços.

Implementando ferramentas simples mas de impacto incomensurável como Kaizen Diário e 5S, criam-se fundações para promover a mudança que servem de alavanca para a aceitação e implementação de outras ferramentas como Standard Work e SMED. As iniciativas definidas demonstraram o seu sucesso, atingindo melhorias em várias frentes. Na Consulta Externa, permitiram o aumento de taxas cobradas e o aumento da taxa de ocupação. No Bloco Operatório, resultaram na melhoria da hora de arranque, na diminuição do tempo de limpeza e consequente diminuição do tempo de turnover e na diminuição dos cancelamentos por problemas com material.

Apesar do aumento do número de publicações sobre o assunto nos últimos anos, a aplicação de metodologias Lean no setor da saúde apareceu com atraso quando comparado com outras indústrias providenciadores de serviços e os exemplos de aplicações com sucesso são escassos. Esta dissertação, apesar de utilizar metodologias conhecidas, pretende combater esse problema, providenciando um exemplo apoiado por resultados promissores que pode ser incorporado por outras instituições de saúde.

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Acronyms and Symbols

HSOL	Hospital da Senhora da Oliveira
KBS	Kaizen Business System
KI	Kaizen Institute
KPI	Key Performance Indicator
MCDT	Complementary Means of Diagnosis and Treatment
NHS	National Health Service
OR	Operating Room
SMED	Single Minute Exchange of Die
TPS	Toyota Production System
VSM	Value Stream Mapping

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Chapter 1

Introduction

This dissertation project describes the application of the Kaizen philosophy in the healthcare sector, result of the agreement between Hospital de Guimarães and Kaizen Institute (KI). Even though lean and its early proof-of-concept clearly stems from “the industry of industries”— the auto industry — lean has now spread to all kinds of industries and application areas. (Netland and Powell, 2016)

The healthcare sector is a very particular one, where waste is easier to detect but harder to measure. Compared to manufacturing processes, healthcare service processes are subject to more noise or uncontrollable factors, such as sociological and personal factors (Gijo et al., 2013). Both in the operating rooms (OR) and in the medical appointments’ service, where this project is developed, waste is even more detrimental for clients. The main goal of this project is to improve those services, increasing not only the productivity but also the quality of the service offered.

KI offers consulting and training services for business performance improvement, operational excellence and growth. It was founded in 1985 by Masaaki Imai in Switzerland and in 1999 KI Portugal was born in Oporto.

1.1 Project’s Motivation

Portugal’s National Health Service (NHS), funded mainly by general taxes, covers all residents. Anyone who needs medical care, including tourists and irregular migrants, can access the NHS according to the Basic Health Law put into practice in 2019. Data from 2017 shows 2.3% of the population reported unmet needs for medical care, due to cost, distance or waiting times. Despite decreasing since 2014, it was still above the EU (European Union) average of 1.8%. Financial barriers are the leading cause of these unmet needs, with notable differences in accessibility between low and high-income groups.

Portugal was affected by a severe economic recession and had to resort to an international loan agreement between 2011 and 2014. Measures to recover from the crisis lead to changes in the healthcare sector in order to contain costs and improve its efficiency. Another outcome of the recession was the emigration of the younger population, including health professionals. In 2019,

the percentage of people with more than 65 years in Portugal was 22.36% compared to 20.46% in the EU (Statista, 2020). Aligned with the ageing population, the number of economically active people decreased. Public health expenditure is prone to increase within the years, which brings up one question: Is the NHS sustainable?

Another key factor that threatens the NHS sustainability is the accumulated debt NHS hospitals have, despite significant capital injections by the government. (OECD Publishing, 2019)

Moreover, there is a growing pressure on public services around the world to increase their efficiency by adopting concepts and methodologies more commonly associated with private enterprise and manufacturing (Radnor et al., 2012). This project, which intends to increase the productivity of the OR and the medical appointments service of the Guimarães' Hospital, uses Kaizen methodologies to customize their processes.

As Graban (2008) stated, 'hospitals do many wonderful things, but an administrator at a prestigious university hospital lamented that "we have world-class doctors, world-class treatment, and completely broken processes."' The continuous improvement of the services provided by the hospital allows not only for the improvement of the service level but also for cost reductions.

To guarantee the continuous improvement of the hospital, along with its sustainability, there's a need to cut costs and deliver higher value for money. It is aligned with those efforts that the project reported in this dissertation arises.

1.2 Project Description

Hospital da Senhora da Oliveira (HSOL), in Guimarães, provides healthcare services to approximately 350.000 inhabitants of Guimarães, Fafe, Cabeceiras de Basto, Vizela and Mondim de Basto. It started operations in 1991. In 2002 it was transformed into an anonymous society (SA) of exclusively public capital, alongside other hospitals of the country. This change was intended to increase the quality of the service provided, facilitating the control of the expenses. Despite the new alteration, the Hospital remained part of the National Healthcare System (NHS). A new juridical modification, in 2005, stated that the SA hospitals were now to be public business entities (EPE). In 2007, Hospital Senhora da Oliveira was fused with Hospital S. José de Fafe creating "Centro Hospitalar do Alto Ave, EPE", with headquarters in Guimarães. That transformation only lasted until 2015, when Fafe's Hospital stopped being integrated into the group. The designation of the hospital returned to Hospital da Senhora da Oliveira.

Its vision is to be an example providing healthcare services, both nationally and internationally, with perspectives of sustained and persistent growth.

The hospital's structure comprehends four different services: clinical production area, aid and support area, support instruments, and commissions of technical support (Appendix A). The first one reunites six different areas: surgical, MCDT (complementary means of diagnosis and treatment), medical, women and child, emergency, and management of transverse services. The medical appointments' service and the OR, where this dissertation project focuses its efforts, are part of the last one.

The access to the External Appointments service is asked for by the patients' assigned doctor or by the hospital's doctor after the patients' hospital discharge.

Imaging, Pathology and Immunohemotherapy are also part of this service, where the patient can realize the necessary exams or analysis asked by any medical specialty.

The different medical specialties are distributed by three buildings:

- External Appointments I: Cardiology, Orthopedy, Podiatry, Pediatrics and Neonatology
- External Appointments II: Anesthesiology, Chronic Pain, Physiatry, Ophthalmology and Psychiatry
- External Appointments III: General Surgery, Vascular Surgery, Dermatology, Gastroenterology, Gynecology, Immunoallergology, Internal Medicine, Neurology, Obstetrics, Oncology, Otolaryngology, Pulmonology and Urology

This project intends to increase the occupation of the appointments' rooms, improving the management of the waiting list and reducing waste (Muda) for a better customer experience.

The OR has an installed capacity of six rooms: five for programmed surgeries of multiple specialties and one for emergencies.

The capacity of the OR service changed multiple times during this dissertation project due to the special conditions the all world is living in and suffering from. COVID-19, at its peaks, reduced the capacity to just one room for programmed surgeries and one for emergencies.

The motivation behind this project is to increase the OR's productivity.

1.3 Objectives

The main motivation behind this project was to increase both the OR and medical appointments rooms' occupation, while improving the service level offered by the hospital. To achieve those goals, the following objectives were defined:

- Reduce the starting time of the OR;
- Reduce the turnover time between patients in the OR;
- Increase the charging rate of user fees;
- Improve the planning and scheduling of medical appointments and exams;
- Improve the patient's flow;
- Create and cultivate a culture of continuous improvement.

1.4 Methodology

The project is divided in four main phases: planning, solutions design, implementation and evaluation.

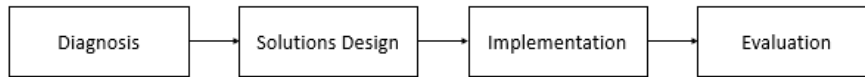


Figure 1.1: Methodology used

The diagnostic phase was realized by resorting to the Value Stream Mapping (VSM) tool to analyze the initial situation, allowing to identify the main problems and improvement opportunities.

When fully understanding the current situation (as is), it is possible to picture the future status (to be). Solutions are designed to guarantee the future vision is reached.

Working alongside the client, these solutions are then implemented in the third phase.

The results obtained with the implementing phase are then evaluated in the last phase for a better understanding of the fulfillment of the goals initially proposed.

1.5 Structure

This dissertation is composed of six chapters. The present chapter intends to introduce the project, what it intends to achieve and the methodology used to reach those goals.

The next chapter presents the theoretical context that serves as the foundation of this project, detailing the methodologies and concepts applied.

Chapter 3 characterizes the initial situation, identifying and describing the root causes of the problems that were found.

The solutions for those problems are described in chapter 4, where a vision of the future situation is detailed.

Chapter 5 presents the results obtained until the delivery date of this dissertation.

The final chapter exhibits the main conclusions, as well as the challenges and lessons learned.

Chapter 2

Literature Review

2.1 Kaizen Philosophy

After World War II, Toyoda Kiichiro, then president of the Toyota Motor Company, saw the need to catch up with America to assure the survival of the automobile industry of Japan. Taiichi Ohno, Toyota's engineer, had a challenge: how to build a diversified line of products with the limited equipment Toyota possessed at the time. Instead of using batch production, he designed a system of integrated production that used one-piece flow, demonstrating that a trade-off between quality and productivity does not need to exist (Netland and Powell, 2016). Aligned with other practices, Toyota Production System (TPS) was born to defy the premise that bigger batches mean lower costs.

TPS, which ultimate goal is the absolute elimination of waste, is based in two pillars: just-in-time (JIT) and autonomation (automation with a human touch). The lack of the necessary capital resources to support high inventory levels was solved with the implementation of a just-in-time pull system. JIT means "to produce the necessary units at the necessary quantities at the necessary time". A company establishing this flow throughout can approach zero inventory. With autonomation, Toyota intended to create a built-in automatic checking system against small abnormalities. With this prevention mechanism, defective products were not produced. That was not the only advantage. While the machine is working properly, employees are liberated. Consequently, one worker could attend multiple machines, increasing production efficiency. Furthermore, autonomation came as a facilitator of improvement. Stopping the machine creates awareness and, through the total comprehension of the problem, improvement measures can be taken. (Ohno, 1988)

Lean, based on TPS, is a methodology that accentuates customer needs, to improve quality and reduce costs through continuous improvement and employee involvement (Grabau, 2008).

Kaizen, a Japanese word, refers to the concept of continuous improvement. It does not intend to be mistaken as innovation or disruption and elevated costs. On the other hand, Kaizen is about small and subtle improvements. It is a low-cost low-risk process that assures incremental progress and sustainable changes in the long term.

At the beginning of the 21st century, Toyota Motor Company surpassed General Motors and became the world leader in automobile production, expanding and elevating the Kaizen concept for its key role in the company's success (Imai, 2014). Kaizen's methodology is based on five fundamental principles (Kaizen, 2020):

- Create customer value

Value is what the customer is willing to pay for. Using a market-in approach to make informed decisions based on what the customers want and offer them that in the best way possible, improving customer experience.

- Create flow efficiency

Flow efficiency can be obtained through the elimination of three Ms: Muda (waste), Mura (unevenness) and Muri (overburden).

The concept of Muda primarily originated from Taiichi Ohno's production philosophy in the early 1950s. He defined, in the industrial context he was inserted, seven sources of Muda: overproduction, waiting, inventory, motion, transportation, over-processing and defects. All the activities that do not add value to the process are considered Muda. Fujio Cho, former President of Toyota, defined waste as "anything other than the minimum amount of equipment, materials, parts, space and worker's time, which are absolutely essential to add value to the product". Eliminating waste is the most effective way to increase productivity and decrease costs.

Although Muda has gained bigger awareness, comprehending all three concepts allows for a greater understanding of Lean (Netland and Powell, 2016). Mura is the variation in a process that is not caused by the final customer, for example highs and lows in the planned production due to the production system or the irregular work rhythm. Leveling production using JIT can eliminate this irregularities, avoiding work spikes and long waiting times for workers. Muri means to overburden equipments or workers, demanding a faster rhythm for a longer period than expected. While in equipments it can provoke defects and failures, in people it can result in safety issues.

- Be Gemba oriented

Gemba is the place where value is added. Problems should be identified and solved there, at their root cause. Central to Kaizen is genchi genbutsu (go and see for yourself). Going to the Gemba means going to the place where the action really happens, to be able to thoroughly observe the reality of the processes.

- Empower people

Respect for people is a fundamental principle of the Kaizen philosophy. Kaizen recognizes that people are not the problem, processes are. It intends to improve every day, everywhere, with everyone, training all employees and encouraging people to think and share their own

improvement ideas, systematically. It is in management's biggest interest to create the best possible conditions for everyone to do the best possible work.

- Be scientific and transparent

As important as identifying problems, is knowing how to explain and substantiate one's findings, supporting them with data. Visual Management is a basal tool of Kaizen, that highlights problems and allows for a quicker reaction to them.

KI developed Kaizen Business System (KBS) a set of improvement principles, models, tools and processes, that intends to bring long-term value to all companies, through growth, quality, resource and flow efficiency, and respect for people. It brings together three different models: Growth, Change and Operations, that are used by KI according to the project. The following figure provides a broad view of this system's components.

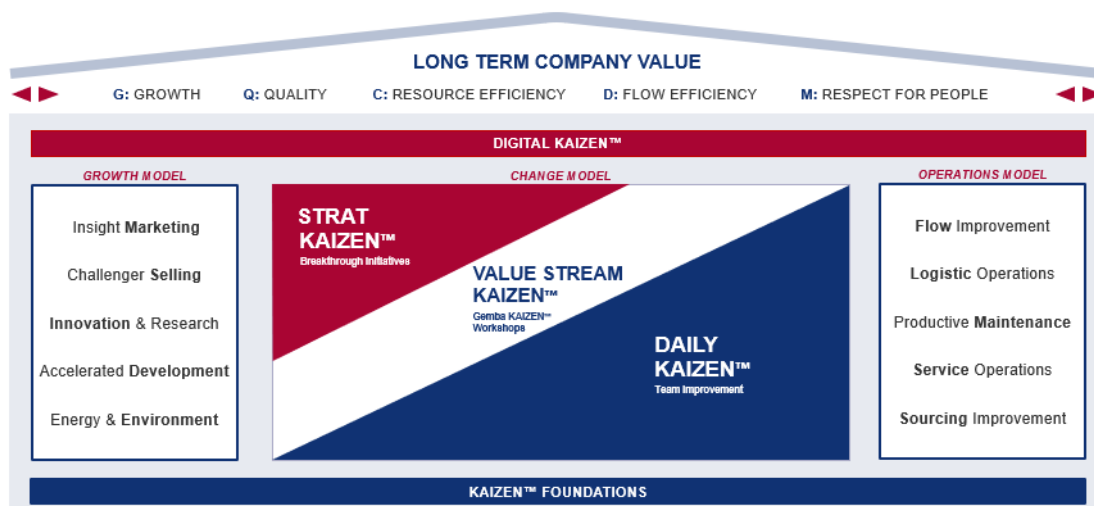


Figure 2.1: Kaizen Business System

The Growth Model emphasizes earnings and revenue, focusing on five areas: market effectiveness, sales effectiveness, focused innovation, product development and low environmental impact.

The Operations Model, also known as QCD (quality, cost, delivery) Model pretends to improve these three dimensions working on multiple areas: flow improvement, logistics operations, productive maintenance, service operations and sourcing improvement. TFM (Total Flow Management), the methodology used for flow improvement within all of the supply chain, is based on pull-flow principles. Pull-flow means organizing all your supply chain in terms of an optimal material flow, by eliminating Muda (Coimbra, 2014). TFM divides itself into three pillars: production flow, internal logistics flow and external logistics flow. The production flow has five domains: line and layout design, border of line, standard work, single-minute exchange of dies (SMED) and low-cost automation. Both standard work and SMED are tools of great importance for the development of this project.

The Change Model intends to motivate and engage people, creating a continuous improvement culture consisting of three different capabilities: Strat, Value Stream and Daily Kaizen. The first focuses on breakthrough initiatives, developing top management teams, and better strategy execution. The second uses Kaizen Events to shift paradigms in key-value streams. The last one, Daily Kaizen, has a special significance in this project. Daily Kaizen develops people to assure the sustainability of improvements. It is by creating routines that are practiced daily that it becomes possible to evolve to a target condition that will last in the long term. Visual Management plays a big role when creating team boards that allow to understand a team's performance, through KPIs (Key Performance Indicators). The goal of these boards is to debate the status quo and solve day-to-day problems.

2.2 Lean in Healthcare

Womack and Jones (1996) defined Lean through five principles. The introduction of these principles sped up the evolution of lean thinking and placed customer value and waste reduction at its center. (Joosten et al., 2009)

1. Specify value from the customer's perspective.
2. Identify the value stream.
3. Create flow.
4. Establish pull.
5. Seek perfection through continuous improvement.

These same five steps can be followed in healthcare. Specifying value from the customer's perspective is understanding what is valued by the patient. Not having to wait and a good service level are two examples. Identifying the value stream allows for a greater understanding of the current patient journey and exposes waste. Creating flow is only possible when understanding demand. Despite being a difficult sector to predict, demand for healthcare processes can be predicted by grouping patients by the processes they require. Establishing pull means the necessary resources for a patient journey are provided only when needed (Westwood et al., 2007). These four initial principles serve as the basis for the final one, providing the required conditions to obtain sustainable improvements. Striving for perfection is the humility of recognizing there is always room to improve.

It is important to recognize the complicated nature of hospital activities. A hospital is expected to deal with thousands of specific clinical diagnoses, most of them arriving without previous notice. In manufacturing terms, it would be like a car retailer having to provide a car from a thousand different models made up from thousands of basic model types, modified by a mix of options drawn from a catalog of several thousand options. To complicate things even more, half of the

cars would have to be delivered with no notice, 24 hours a day, every day of the year (Ben-Tovim, 2017).

Although the precise date of the first application of lean in healthcare is uncertain, de Souza (2009) states it dates back to the early 2000s, having appeared with a ten-year delay when compared to other industries that provide services. Costa and Filho (2016) corroborates de Souza (2009) findings, while finding some evolution in research in the area. First, due to the expansion of lean healthcare to more countries and also due to the existence of studies that demonstrate the concept applied in the hospital as a whole and not just in a specific area as in previous reviews. Ramori et al. (2019) identified key trends in the use of lean business models in the healthcare industry: the number of publications on the subject has increased in recent years and the research studies were published mainly in healthcare related journals rather than lean journals. Both demonstrate an increasing interest of the healthcare industry in lean methodologies, with the latter indicating a growing enthusiasm by healthcare researchers.

Multiple authors recognize Lean's value in healthcare. Graban (2008) acknowledges Lean's capability to prevent delays and improve employee satisfaction, while contributing to patient safety. Lean is not a cost-cutting initiative, but a quality one. The focus has to be on patient quality and safety. If one does right regarding quality, "the costs will take care of themselves". Houchens and Kim (2014) adds that healthcare services can be delivered more efficiently and with higher quality, by transforming waste into value for the customer.

Bielaszka-DuVernay (2011) and Westwood et al. (2007) provide examples of two different hospitals that successfully applied Lean methodologies to optimize their processes, improve quality and reduce costs.

ThedaCare, a community health system now composed of seven hospitals and multiple clinics, resorted to Lean methodologies to reconfigure clinicians' roles and all processes. The initiative was first launched in a medical-surgical unit in 2007 with plans made to have it in place in all inpatient units in ThedaCare hospitals by 2012. In the two acute care units where changes were implemented, Lean allowed for significant cost savings and quality improvements. Cost per case decreased 15-28% and average length-of-stay diminished 10-15%. Quality-wise, 95% of patients rated their satisfaction level as "excellent" in 2010, compared with 68% in 2006, before Lean was implemented (Bielaszka-DuVernay, 2011).

In order to improve the non-elective trauma patient pathway, Bolton Hospitals NHS Trust started applying a lean approach in summer 2005. In July 2006, it was already possible to observe the improvements obtained using fewer resources than previously required. Overall mortality for adult trauma patients reduced 37% and the length-of-stay decreased 32% (Westwood et al., 2007).

2.2.1 Value Stream Mapping

"Whenever there is a product for a customer, there is a value stream. The challenge lies in seeing it." Rother and Shook (1999) first defined Value Stream Mapping (VSM) as all the activities, value-adding or not, from the reception of a customer's request until the delivery of the product or service.

VSM is a Lean tool that allows for a visual representation of all the processes in the material and information flow. The first step is to design a current state value stream map of a process. The main advantage of VSM is the level of detail it creates, allowing it to identify waste and come up with improvement solutions. When fully understanding a process, it is easier to make suggestions and contribute to its improvement, then originating a future state value stream map to be implemented. As the future state map becomes reality, a new one should be drawn. That is continuous improvement (Rother and Shook, 1999).

Regarding its application in the healthcare sector, Jimmerson (2009) recognizes VSM's significance as a provider of more scientific and compassionate time with patients and more patients being served. Nowak et al. (2017) assumes that VSM has a positive effect on the process and outcome quality on a time dimension, being able to reduce non-value-added time such as waiting time, thus increasing value for the patient. Toussaint and Berry (2013) demonstrate the usefulness of VSM in perioperative services at 8 member hospitals of the New York City Health and Hospitals Corporation. Interdisciplinary teams mapped the current and target state and analyzed how to diminish the gap between them. After developing and implementing solutions, metrics were defined to evaluate their performance. Results included an increased percentage of on-time starts from a baseline of 50% of the total to a mean of 70%, an increased number of operating room cases per month from 329 to 351, a decreased operating room turnaround time from a mean of 60 minutes to less than 40 minutes, a decreased percentage of rescheduled cases due to late starts from 21% to a mean of 4.4% of total cases and a decreased same-day surgery cancellations from 7% to less than 3% of total cases.

2.2.2 Muda

No worker, particularly in healthcare, appreciates having his or her time wasted. Identifying and eliminating Muda is the recognition of the value in a worker's time well spent, contributing to a safer healthcare environment (Jimmerson (2009)). It is only when identifying waste that it becomes possible to tackle it. While the seven sources of Muda were primarily defined for the automobile industry by Taichii Ohno, it is pertinent to understand their application in the healthcare sector through the table below. After, a brief explanation of each one of the Muda allows for a better comprehension of the examples given.

Table 2.1: Examples of Muda in Healthcare

Muda	Examples of Healthcare Wastes (Westwood et al. (2007))
Transportation	Central equipment stores for commonly used items instead of locating items where they are used
Inventory	Waiting lists
Motion	Not having basic equipment in every examination room
Waiting	Waiting for doctors to discharge patients
Overproduction	Requesting unnecessary tests from Pathology
Overprocessing	Duplication of information
Defects	Repeating tests because correct information was not provided

Transportation refers to moving materials unnecessarily, while motion alludes to unnecessary people motions, which includes, for example, things not within reach. Inventory applies not only to materials, but also to information. It can describe too much work in progress or stock information. Waiting encompasses waiting for people, equipment or information. Overproduction is not just producing more than needed, but also sooner than needed. Overprocessing adds needless steps to the process. Defects embrace rework due to faulty processes or faulty information. (Westwood et al., 2007)

2.2.3 Daily Kaizen

Daily Kaizen comprehends four levels: daily management, standardization, training and coaching, and advanced problem solving.

Daily Kaizen Level 1 is about aligning team efforts and motivate the team towards the right targets. Daily management includes daily Kaizen meetings and 5S. The next section will approach and explain the 5S methodology, along with examples of its application in the healthcare sector. The combination of both these tools allows for critical information to be visible to all team members. This information, depicted in team boards, is used for meetings that allow to coordinate people, monitor progress and improve daily by identifying problems and discussing solutions. Team boards usually include a standardized schedule to facilitate the meeting, an attendance sheet, a work plan, KPIs (Key Performance Indicators) and a PDCA (Plan-Do-Check-Act) improvement cycle.

Defining the right KPIs is a step towards success. They should be simple, measurable, relevant and essential. These characteristics guarantee the existence of a small number of indicators, easy to understand, with a defined calculation method and pertinent to the team's success. KPIs should reflect customer needs and provide information on team performance, so team members can anticipate problems and react when the performance is not the expected. On the other hand, when performance is better than expected, KPIs allow for the recognition of the team's work. It is important to define the right frequency for performance control.

A PDCA cycle supports the follow-up of all the team's initiatives to change their work for the better. In the planning phase, a responsible and a date for the action are defined. Next is the implementation phase, followed by the check phase, where the impact of the action is verified. If the action was successful, it moves on to the act phase. It is the repeated daily practice of PDCA that develops the capabilities of individuals and teams to continually improve their work and improve the performance of the system as a whole (Netland and Powell (2016)).

Christie Clinic in Illinois provides a good example of the application of Daily Kaizen (Toussaint and Berry, 2013). Each day starts with a team meeting for the staff of the otolaryngology department. The huddle, which includes physicians, has improved internal communications and teamwork. In less than 1 year, waiting time for appointments decreased by 28%, departmental capacity improved by 10% with no increase in headcount, and patient satisfaction increased from 4.3 to 4.7 on a 5-point scale.

Level 2 refers to standardization practices. It emphasizes the importance of having a standard that works as a universal language. It facilitates comprehension and communication, while creating a basis for how the work should be done.

Standard Work, a improvement tool, fits in this level. It observes and evaluates work methods to identify difficulties and opportunities to work on. Having standards is not Standard Work, following those standards is. The tool is composed by five steps:

1. Define improvement goals

These goals should be SMART: specific, measurable, achievable, realistic and timely.

2. Study

Study the current situation by observing. It includes the following steps: list all tasks of the process, identify wastes and create a Spaghetti diagram that uses a continuous line to trace the path through a process. Gathering and summarizing all this information concludes the study.

3. Improve

At this stage, waste should be eliminated. The ones that are impossible to eliminate should be reduced and concentrated in other entities. A solution is presented, tested and its results verified.

4. Normalize

A standard is created to support the improvements obtained with the previous step. It should specify which work should be done by which worker. Normalization prevents performance variations between workers.

5. Consolidate

Create a training plan and execute it to train all workers with the new standard.

Its objective is to maximize the teams' performance, by providing the best combination of people and tasks. More than a sequence, standard work is a cycle. After following all steps and consolidating the new standard, new improvement goals should be defined. No matter how good the solution, settling for it and believing nothing can be improved is never the answer. Improvement is continuous.

With the implementation of the previous two levels, training and coaching follow. This level tackles workers lack of motivation, poor work relationships and lack of commitment. It consists in training leaders, so they are prone to improvement and can help their team work correctly, safely and consistently. Teaching intends to accelerate workers' training and sharing of knowledge, while coaching raises awareness for a greater sense of responsibility. "Coaching is unlocking people's potential to maximize their own performance. It is helping them to learn rather than teaching them." (Whitmore, 2002)

The last level of Daily Kaizen, level 4, introduces structured problem solving to guide teams in the search and identification of the root causes of a problem. 3C (case, cause, countermeasure), is a problem resolution tool that consists in four steps:

1. Case: define the problem and a goal to be achieved.
2. Cause: identify the root causes.
3. Countermeasure: define actions to solve the case.
4. Confirmation: verify if the defined goals are being achieved.

2.2.4 5S

5S is a Lean methodology used to organize work spaces and increase productivity. It involves everyone, allowing to motivate the team. It is an abbreviation of the five Japanese steps:

1. *Seiri*: Distinguish the necessary and unnecessary items at the Gemba and keep only the first.
2. *Seiton*: Straighten the necessary items in a simple and visual way.
3. *Seiso*: cleaning and inspecting the workplace so all the existent problems become visible.
4. *Seiketsu*: Create standards to assure the sustainability of the new conditions.
5. *Shitsuke*: Keep the discipline in order to satisfy and improve standards.

5S is a low-cost methodology that exposes Muda in the workplace. In fact, a lack of 5S in the Gemba should be considered a visual indicator of inefficiency and insufficient self-discipline (Imai, 2014). The benefits it can provide together with the easiness and little investment necessary for its application contribute to the utilization of 5S methodologies in the healthcare sector. Kanamori et al. (2015) and Ishijima et al. (2016) are two examples of the application of 5S in resource-poor facilities, the first in Senegal and the second in Tanzania. (Kanamori et al., 2015) demonstrates that the application of 5S improved the quality of healthcare services and motivated the staff. Ishijima et al. (2016) indicates that practicing the 5S approach has a positive influence on reducing patients' waiting time at health facilities. Other benefits of this application include reducing lead-time of health services provision that lead to an improvement in job satisfaction among health workers.

2.2.5 SMED

SMED or Single Minute Exchange of Die, a technique pioneered by Shiegho Shingo, is used to reduce changeover or setup time. This time may include tool changes, material changes, or changing to a different product or configuration. SMED can dramatically reduce setup time and cost, allowing companies to decide between reducing batch size or increasing production (Liker and

Meier, 2005). It is based on the direct observation of the setup tasks and must be applied at the Gemba.

SMED is not an exclusive tool of the industrial sector. The most known applications are in the change of reference in a production line or in the change of tires in automobile competitions. Despite that, SMED can also be used in the healthcare sector, for example, in the change of patients in an operating room, providing multiple advantages: reduced waiting times, improved service level, reduced necessity of investing to improve capacity and increased flexibility.

The methodology has a structured sequence of five steps. The starting point before applying SMED is usually described by an absence of standardized work, a variable setup time and no distinction between internal and external work. The first refers to tasks that can only be realized when the process is at a standstill, while the latter can be performed with the process running.

1. Work Study

Going to the Gemba to register and classify all the work elements as internal or external. For every professional, film and measure the time of each task. Identify waste and list all the necessary tools for each task. A Spaghetti diagram can be very useful to visually identify movement and transportation Muda. All these steps facilitate the comprehension of the current preparation work.

2. Separate Internal and External Work

Distinguish between the work that can be done previously, during and after the setup time is over to define the best work sequence.

3. Transform Internal Work into External Work

The goal of this step is to work with team members to reduce the number of internal tasks.

4. Reduce Internal Work

Reduce or eliminate the internal work that was not possible to transform into external in the previous step.

5. Reduce External Work

External work does not affect setup time. However, it consumes resources and needs to be improved by reducing transportation and movement, improving storage and/or implementing 5S to work spaces.

These steps are visually demonstrated in the figure below. Initially, the situation is unknown. The setup time is known but it is not possible to describe the activities that it comprehends, nor if they are internal (I) or external (E). The first step divides the setup time in all its tasks, ones longer than others, and distinguishes them in internal and external. Step 2 brings all external activities or to the beginning or to the end. Since external tasks can be done with the process still functioning, step 3 focuses in transforming internal into external work. Step 4 continues to work on internal

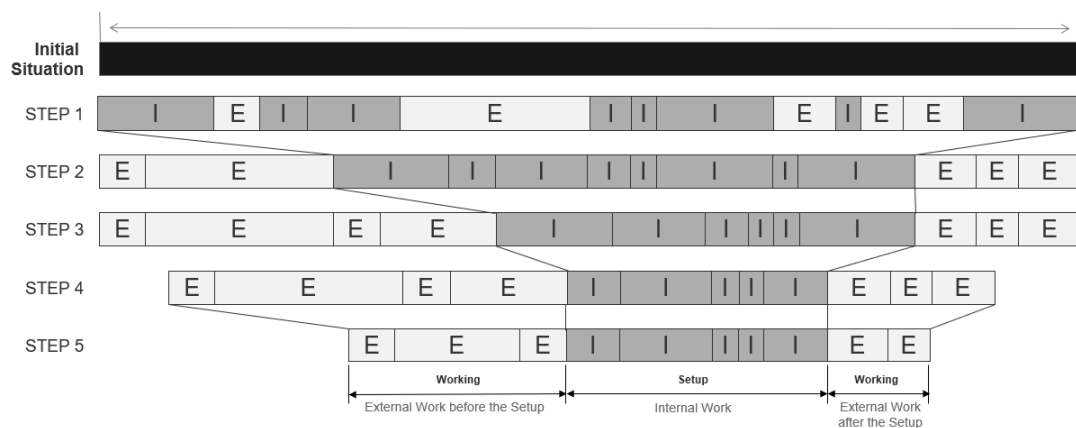


Figure 2.2: Evolution throughout the 5 SMED steps

tasks, trying to reduce or eliminate the ones left that were not transformed in the previous step. The last step is to reduce external work.

The final goal, and at each step, is to standardize the improved work sequence that should contain the tasks to realize, in which equipment or area, its duration, who does it and what are the tools needed to do it.

The application of SMED at the Limatambo clinic helped to reduce the patient waiting times by 30% during the first medical examination and the triage care times by 40% (Calero et al. (2020)).

Chapter 3

Problem Description

3.1 Introduction

This chapter applies the Value Stream Mapping methodology for a better understanding of the two services in study: the medical appointments service and the OR. For each one of them, information about the current processes is analyzed. The patient (material flow) and information flows are presented and the main improvement opportunities are identified for each flow.

The following data was made available by the hospital for the realization of this project. The data refers to the period between the beginning of 2019 and September 2020, since the latter marks the date KI started working at the hospital. COVID-19 postponed the project, that restarted in February 2021.

All the phases of this project are realized in collaboration with a multidisciplinary team of members of Hospital de Guimarães. Change must occur at all levels, with everybody's help, so everyone can contribute to and feel enthusiastic about their work. Involving people and empowering them to help is a fundamental principle of Kaizen and crucial to get sustainable results.

The symbols used while mapping the current situation are the following:

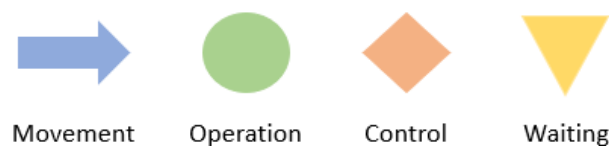


Figure 3.1: Value Stream Mapping: Symbols

3.2 Medical Appointments Service

A multidisciplinary team with different functions was selected. The team counted with one hospital manager; one person from the billing service; one from ULGA, the unit that manages access to healthcare services and is responsible for the compliance of the maximum response times in the

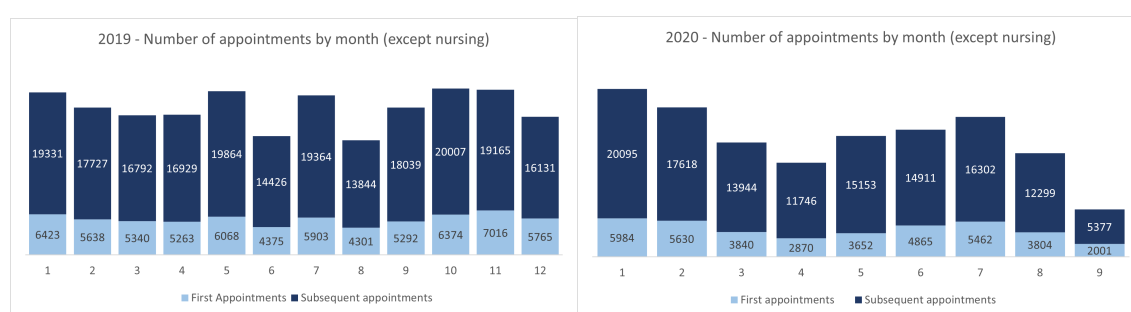
hospital; one from the secretariat; and the doctor responsible for the appointments' service. When selecting a team at this stage, it is important to be able to count on proactive people that are eager to contribute to change.

The hospital works with multiple information systems. The two main systems used by the Appointments' Service that manage all the patients are the following:

- *Sc nico* provides all the information about the patients' health, visible only for the health personnel. Appointments that are scheduled in this system are transferred to *Sonho* in batches at night.
- *Sonho* manages all the patients in terms of appointments, hospitalizations and payment of user charges. This system is used by administrative staff. To guarantee data privacy, the system does not provide access to private health information of patients.

3.2.1 Data Analysis

HSOL performed 279377 appointments in 2019. Until September 2020, 165553 appointments were realized in that year. Although data corresponds to a smaller number of months, in September 2019 this number reached 204919. COVID-19 explains this gap, with a large number of appointments being cancelled by the fear of going to the hospital or the hospital's lack of capacity. Considering data from 2019, to interpret data before COVID-19, the hospital receives approximately 23281 patients per month. First appointments represent 24% of the total. The number of appointments except nursing from January 2019 until September 2020, distinguished by first and subsequent appointments, can be seen below.



(a) Number of appointments except nursing in 2019 (b) Number of appointments except nursing in 2020

Figure 3.2: Number of appointments except nursing from January 2019 until September 2020

Despite the differences in number between 2019 and 2020, the distribution of appointments per hour is similar in both years, as can be seen in the graphics below. Moreover, there is an unevenness between the number of appointments in the morning and in the afternoon. Data from 2020 shows 63% of the appointments were realized until 1pm.

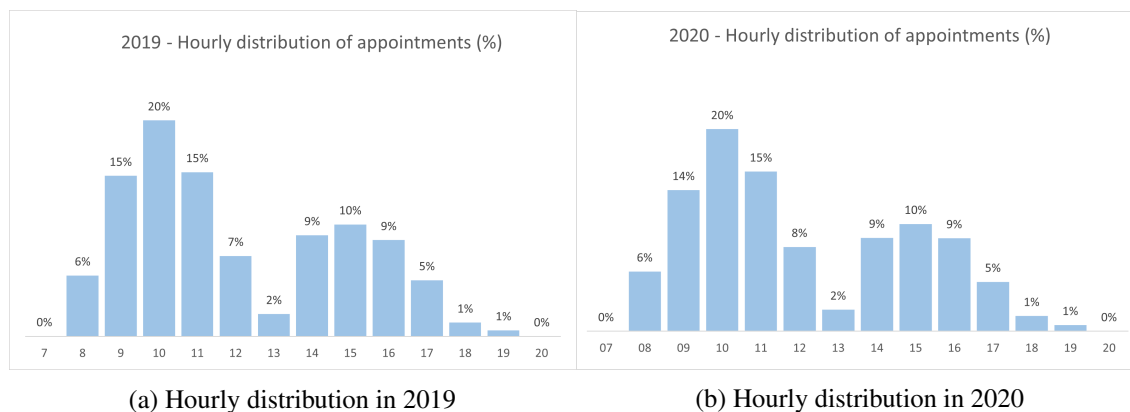


Figure 3.3: Distribution of appointments per hour in 2019 and 2020

Appointments that are not carried out can be described differently depending on the moment they are cancelled. An effectuated appointment means the patient has already checked in at the hospital.

- Annulled appointments are the ones that occur if the patient has already arrived at the hospital and effectuated the appointment at the reception desk or at the kiosk.
- Cancelled appointments, on the other hand, occur when the patient has not yet effectuated the appointment.

The first case is not so common, whilst the second represents a larger number of cases. The number of carried out, annulled and cancelled appointments in 2019 can be observed below.

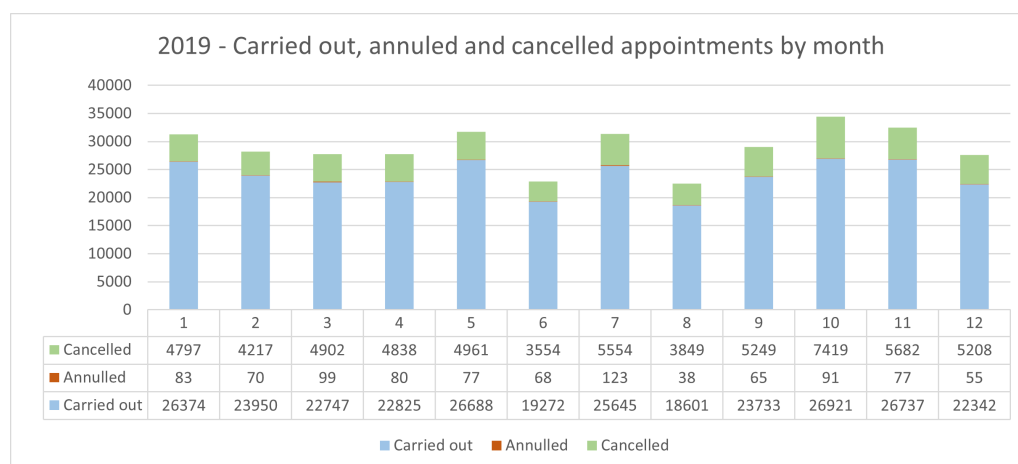


Figure 3.4: Number of carried out, annulled and cancelled appointments in 2019

Although representing a smaller number of cases, annulled appointments are more serious than cancelled ones, causing more discomfort to the patient. The reasons for annulment are presented below, with mistakes at the top of the causes, followed by doctor's absence and patient's absence. Mistakes refer to wrong scheduling. Patient's absence is when the patient does not appear to the

appointment, whereas abandonment designates cases where the patient effectuates its appointment but leaves the hospital before the appointment.

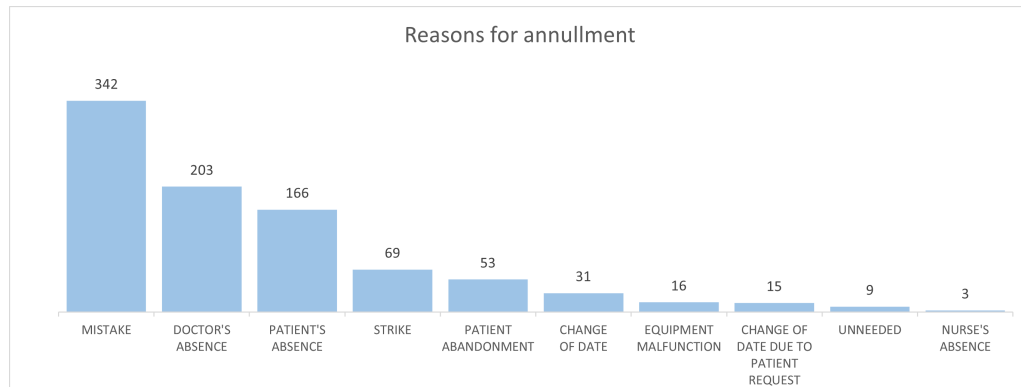


Figure 3.5: Reasons for annulments in 2019

Appointments can be cancelled in advance, but it is important to understand how early or late it happens. The graphics below show that in 2019, 24% of appointments were cancelled one, two or three days before. In 2020, that number declined to 9%, with appointments being cancelled more than three days before appointments' day. This decrease, together with the increase in the number of cancelled appointments, can be explained by COVID-19. A enquiry realized between 6 and 9 April 2020 by CESOP (Center of Studies and Polls of the Portuguese Catholic University) to 1700 people revealed that 74% of them admitted to having fear of going to healthcare services. 26% of them even assumed they stopped seeking medical care. The fear of acquiring a COVID-19 infection pushed people away from hospitals.

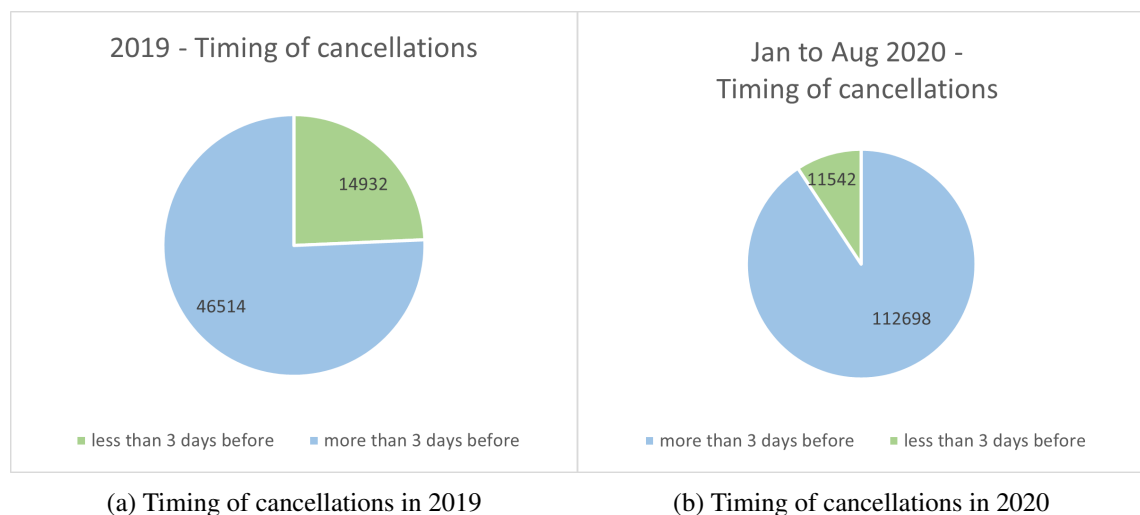


Figure 3.6: Timing of cancellations in 2019 and 2020

Due to their different nature, the reasons for cancellations differ from the reasons for annulments. While the motives are the same, the number of times they happen diverge. Change of date

is the main reason for cancellations, representing 67% of them. When adding change of date due to patient's request, the percentage increases to 81% of the grand total.

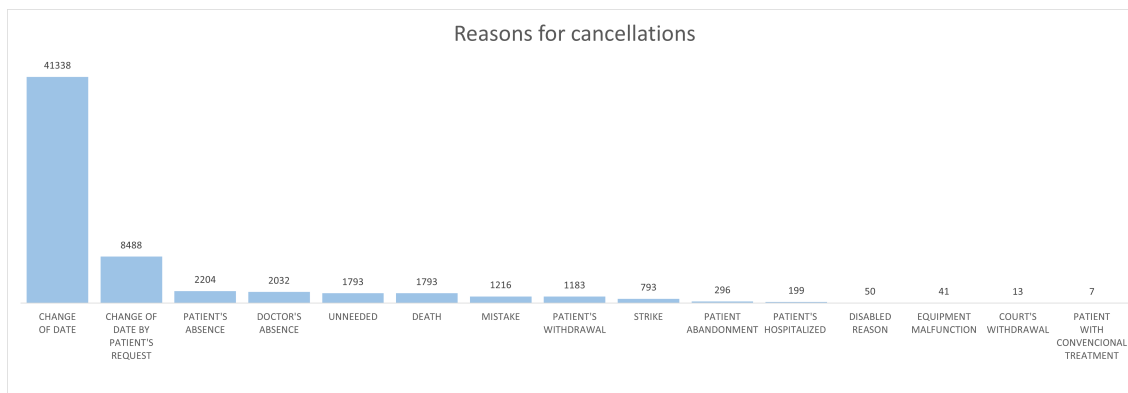


Figure 3.7: Reasons for cancellations in 2020 (January to August)

This section started by analysing the number of appointments per month to understand the hospital's dimension. The data that followed allowed to draw some conclusions. First, the distribution of appointments, per hour, demonstrates that the majority of appointments is realized in the morning. When studying appointments that were not realized, it is possible to conclude there are not sufficiently detailed motives to justify cancelled or annulled appointments. Change of date, for example, can mean the doctor is ill, in vacations or even that the patient does not have the necessary exams requested for the appointment. The importance of distinguishing annulled and cancelled appointments is reinforced by the different reasons that represent them.

3.2.2 Mapping the Current Situation

The flow begins with the general practitioner's decision to send the patient to an appointment of a specific medical specialty. ULGA receives this request and sends it to the respective service, where the triage personnel assigns it a priority, only if the patient's clinical information is complete. If not, the request is sent back. According to its priority, the triage staff defines the doctor, the sub-specialty and the date. The request returns to ULGA, and the appointment is now scheduled. If the appointment is more than three weeks away, a letter is sent to the patient. Otherwise, the patient is contacted by phone. When the appointment day arrives, the patient travels to the hospital and goes to the appointments' building. When called for, enters the building and is presented with two options: effectuate the appointment at the kiosk or take a ticket to effectuate it at the reception desk. Information that the patient is in the building is now available at Sonho and visible at Sclínico and the patient goes to the waiting room to await its appointment.

During the appointment, the doctor registers all the information and if necessary schedules blood tests and/or requests medical exams. The next appointment is also scheduled. Once the appointment is over, the patient can leave the hospital immediately or after returning to the reception desk to pay, obtain a declaration of presence or schedule exams. The patient can proceed to the payment of the appointment when arriving or when leaving, always at the reception desk.

3.2.2.1 Material Flow

The material flow describes the path the patient follows since his arrival to the hospital for a appointment until his exit, and can be seen in the figure below:

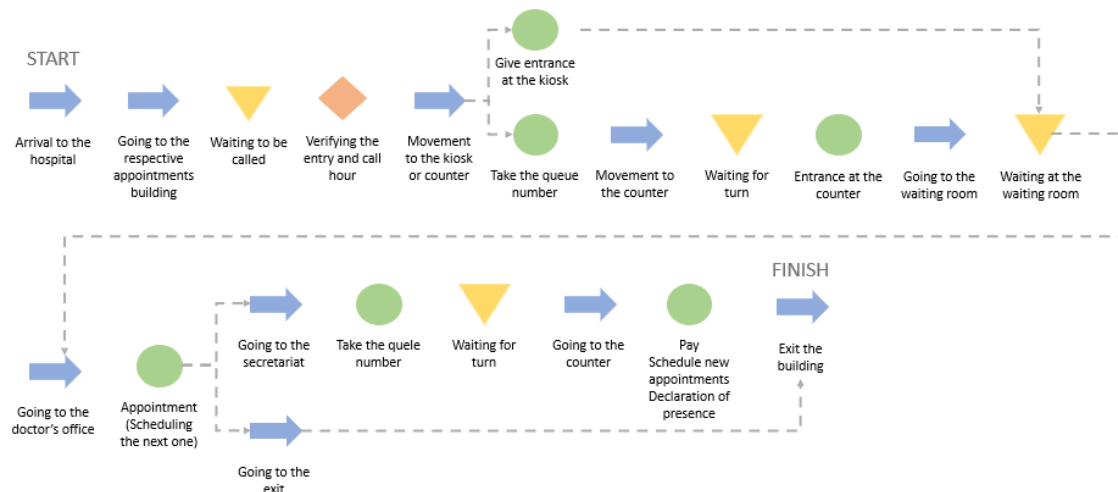


Figure 3.8: Medical Appointments: Material Flow

When mapping the current situation, multiple improvement opportunities were found:

- Lack of visual signs at the hospital's entrance.
- Accumulation of patients at the entrance (they end up waiting on the outside).
- Most patients enter the building at the same time.
- The control of escorts is not always respected (security guard).
- COVID procedures delay patient's admission.
- Calls from the intercom overlap with the automatic calls by Sclínico.
- Doctor's delays arriving at appointments (due to visits to inpatients, etc.)
- Not all doctors have the same tolerance to delays from patients.
- Patient leaves the appointment without all his exams scheduled, only clinical analysis.
- No data crossing between doctor's vacations and schedules.
- Patients can arrive at the appointment without the required exams and it is necessary to repeat the medical act.
- The ticket to pay is taken in the same kiosk where the patient gives entrance.
- Not all employees from the secretariat charge the appointment. The charging process of previous episodes in Sonho is very complicated.

- Charging is not always done in a continuous flow at the end of the appointment.

3.2.2.2 Information Flow

The information flows through time according to the figure below:

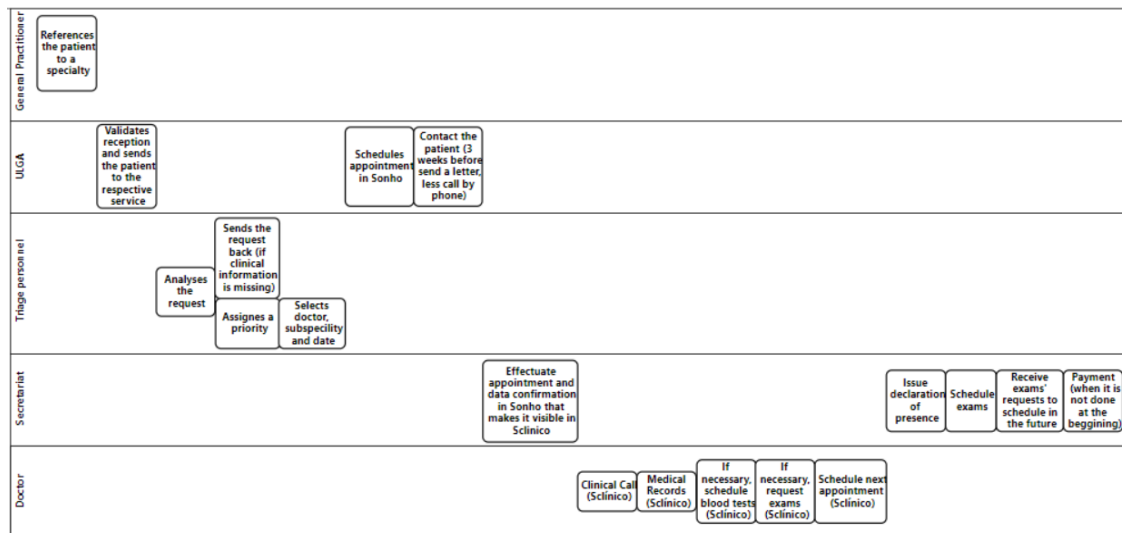


Figure 3.9: Medical Appointments: Information Flow

The information flow allowed to find the following improvement opportunities:

- When a patient cancels the appointment, it is not possible to automatically swap with another patient without consulting the service.
- It is not possible to convert vacancies of subsequent appointments into vacancies for first appointments.
- The envelope machine malfunctions several times.
- RNU (National registry of users) has a different number of characters for the patient's address from Sonho.
- Not every patient receives SMS (Short Message Service).
- It is not possible to actualize patients' data in RNU.
- When a doctor cancels an appointment, the patient is not always informed.
- Giving entrance for a phone appointment does not match the appointment itself.
- For online appointments: only one observation field from Sonho appears (not possible to see if the scheduling is on-site or by phone)
- All calls are realized "manually".

- Online appointments are not realized or re-scheduled to another hour/day.
- Doctors schedule tests without a date to show they are urgent.
- Not always doctors schedule first the appointment and only then exams. Consequently, the next appointment date does not always appear at the exam requisition.

3.3 Operating Rooms

A different team was chosen to map the flow in the OR. It is important to involve people that work at and know the Gemba. The team is constituted by the director of the OR, the director of anesthesia, both the chief nurses and a hospital manager.

There are four types of nurses in the OR: circulating, instrumentalist, anesthetist and the responsible for the recovery. The circulating nurse plays a fundamental role in assuring patients' safety, guaranteeing the correct positioning of the patient on the operating table, monitoring the sterile field and verifying all materials and equipment are safe to use. The instrumentalist nurse focuses on the needs of the surgical team, possessing the scientific knowledge to understand all procedures and surgical techniques so the surgeon needs can be anticipated. The anesthetist nurse is responsible for receiving the patient in the OR and prepares everything to assure that the anesthesia takes place without any problem. This nurse also collaborates in the awakening of the patient and their transport to the recovery room, where the nurse responsible for the recovery provides medical care to the patient.

3.3.1 Data Analysis

The OR usually counts with five operating rooms for programmed surgeries, but its capacity took a toll with COVID-19.

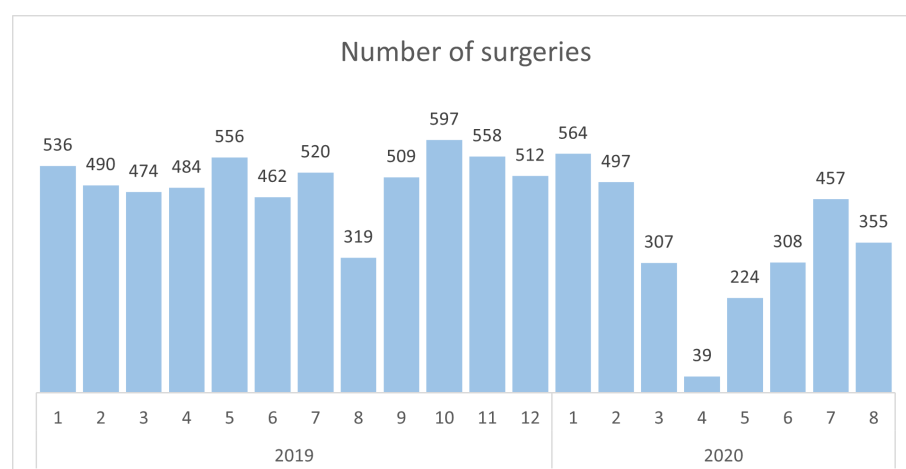


Figure 3.10: Number of surgeries in 2019 and 2020 until August

The previous chart, that presents the number of programmed surgeries realized in the OR between January 2019 and August 2020, demonstrates the impact of the arrival of COVID-19 to Portugal in March 2nd 2020, with only 39 surgeries happening in April 2020. In 2019, in regular conditions, the OR realized 6017 programmed surgeries, with 3841 surgeries happening between January and August. In 2020, in the same period, only 2751 surgeries were realized.

One way to increase the number of surgeries in the OR is to diminish the time between the end of the previous surgery and the arrival of the patient to the room for the next surgery, which is defined as the turnover time. A big portion of this time is the time it takes to clean the operating room, but other factors can add to it, like the time it takes to transport a patient from his floor to the OR.

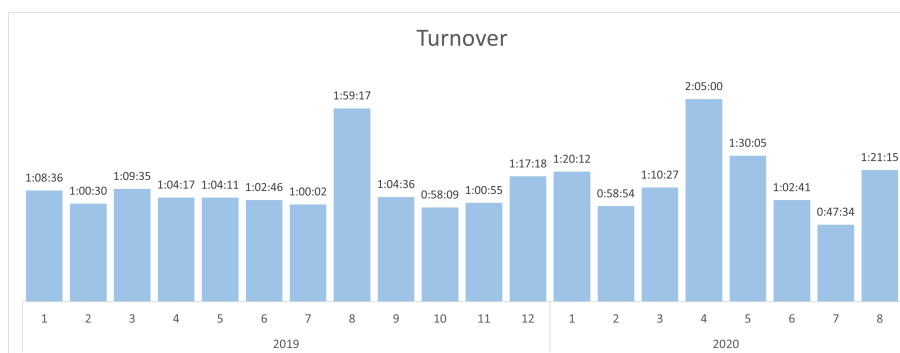


Figure 3.11: Turnover time between surgeries

The times of unoccupied rooms were divided into two categories: normal changes of patients when the turnover time does not surpass one hour and thirty minutes, and atypical times when it does. Atypical turnovers represent approximately 50% of the time the OR is unoccupied. Analyzing a specific room (the chosen room was room 1), these two categories were evaluated for each of the months of 2020.

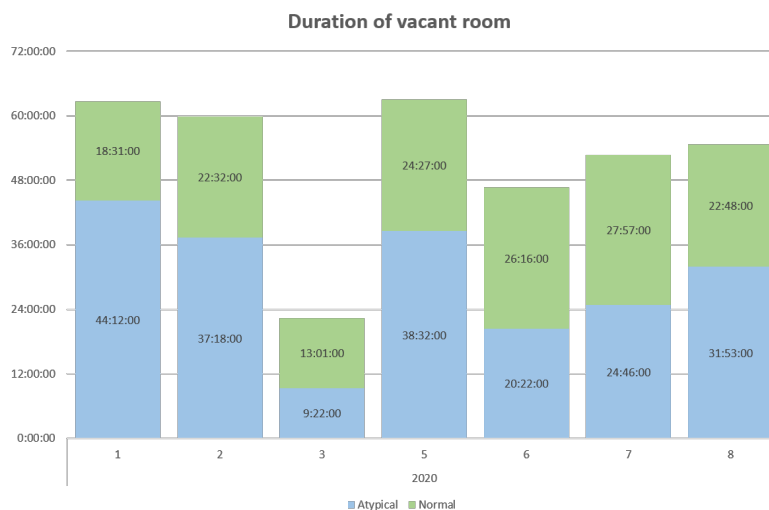


Figure 3.12: Duration of vacant room

As the previous chart demonstrates, there is a significant number of atypical turnovers, surpassing the time of normal turnovers in several months. The number of atypical turnovers that generate unoccupied rooms was studied throughout the hours of the day, to identify critical hours for the OR. The time of the day when more unoccupied times happen is at 12h.

Surgeries can be canceled in two different moments, by the specific specialty service or in the OR. Starting with the first one, surgeries canceled in the Services were analyzed according to the specialty and to the reason. Orthopedy is the specialty that cancels more surgeries (36%), followed by General Surgery, with 23%.

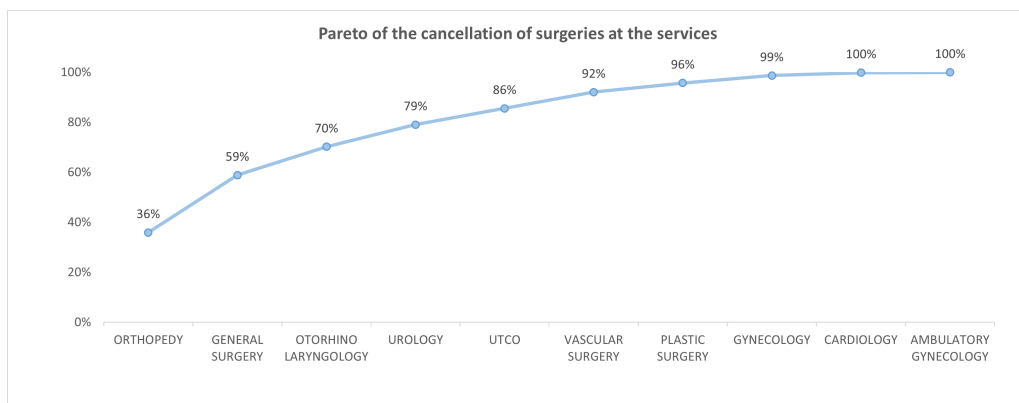


Figure 3.13: Cancellation of surgeries at the Service

A defined criteria to classify cancellations and understand which ones vacate the OR does not exist in the services. At the top of the reasons list is rescheduling due to urgent clinical needs, followed by a deficit of material, room or support. Alterations in the patient's clinical state and strike come in third and fourth.

Surgeries that are canceled in the OR causing unoccupied rooms were also examined. January and February 2020 had a significant number of cancellations, as the following chart demonstrates. 2019 allows to study data from before the arrival of COVID-19, representing a common year in the OR.

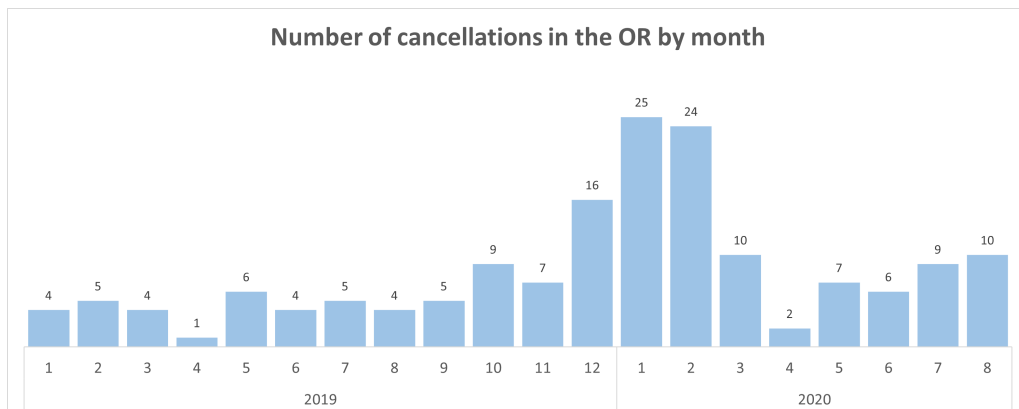


Figure 3.14: Number of cancellations in the OR in 2019 and 2020 until August

The main reasons behind this cancellations are duplicate records, lack of surgical time and anesthetic risk, as can be seen in the Pareto chart below. Duplicate record is an administrative mistake that creates two bookings for the same person. Cancelling one does not result in a person not having surgery, just in the correction of that mistake. On the other hand, lack of surgical time and anesthetic risk represent a surgery that was cancelled and did not happen on the previous scheduled time.

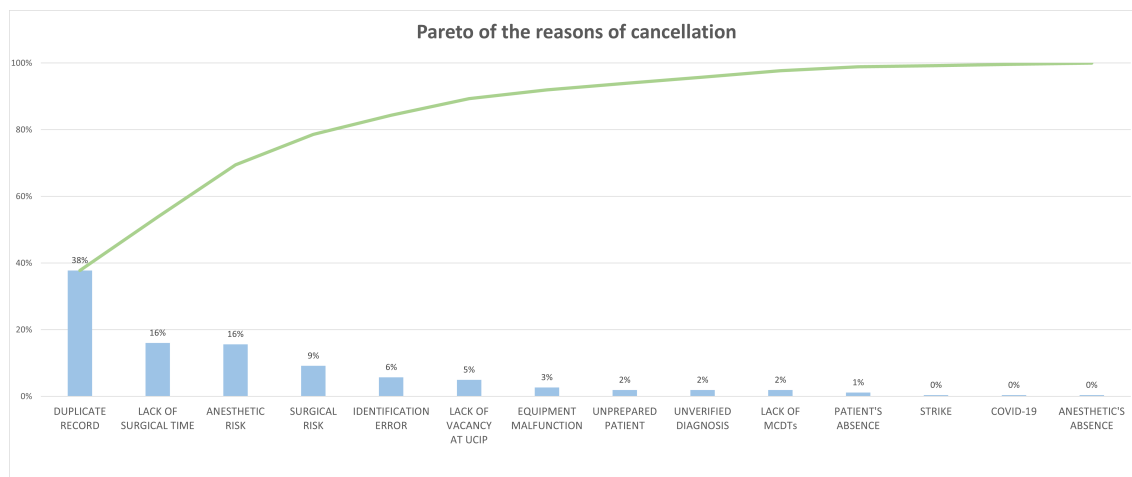


Figure 3.15: Pareto of the reasons of cancellations in the OR in 2019 and 2020 until August

A brief explanation of the capacity of the OR was given for a better context of the number of surgeries before and during COVID-19. The turnover time, time between surgeries, is studied to understand its impact on the productivity of the OR. A further analysis distinguishes normal from atypical turnovers in one room, where the latter represents approximately 50% of the unoccupied time. Cancellations were also explored, differentiating between surgeries cancelled in the service or in the OR. Cancellations in the service need to be defined and tackled, as well as the ones that happen in the OR.

3.3.2 Mapping the Current Situation

The flow initiates with the inscription of the patient for surgery. The director of the respective specialty service has to validate the enrollment. The surgeon distributes all scheduled patients by pathology groups and pre-schedules their surgeries. In accordance with that date, the secretariat of the service schedules an appointment before the operation, that happens between the patient and the surgeon. After that appointment, the surgery date is fixed and scheduled at Sclínico by the secretariat, that also has to request materials from the outside if needed. The patient then arrives at the hospital and is admitted by the secretariat. A nurse receives the patient and helps with his hospitalization.

Before the surgery, the patient is prepared in their respective floor, which depends on the specialty of the surgery. Then, the patient transporter receives a call from the OR to transfer the patient and tags the patient's bed with the entry time on the OR.

Once inside the OR, the patient has to wait to be transferred to the induction room. Once all equipment is verified and a patient's checklist is complete, the patient enters the operating room, receives anesthesia and is positioned for surgery. The circulating and the anesthetist nurses are responsible for registering what happens during the surgery and at what time. The surgery ends with the awakening of the patient. The surgeon completes a report about the surgery. The patient is then transported to the recovery room, where discharge criteria is evaluated. There is a waiting compass for the patient transporter and for the nurses of the patient's floor, and the patient returns to his floor. The recovery nurse has to register what happens at the recovery room and the discharge time.

3.3.2.1 Material Flow

The following figure demonstrates the flow of the patient since his preparation while still in the respective floor until his return to the floor after the surgery.

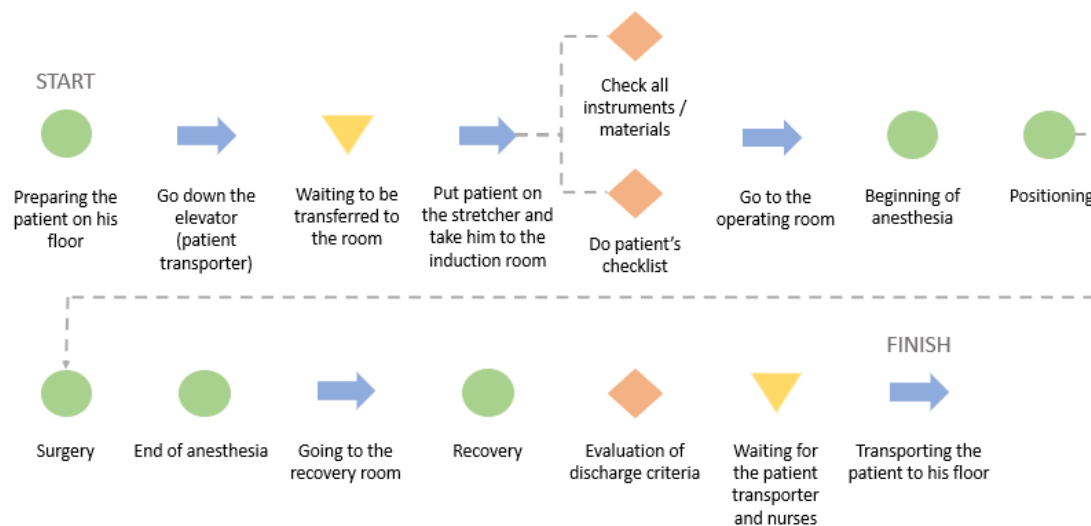


Figure 3.16: Operating Room: Material Flow

The following opportunities were found to help improve the material flow:

- Low availability from the cleaning assistant.
- Patient transporter has a considerable waiting time for the elevator.
- Resources are not leveled.
- No computer records of the induction room.
- High number of cancellations due to lack of vacancies at the Multipurpose Intensive Care Unit.
- Mismatch of resources assigned to each room.

- Cleaning rooms at the same time (unavailability of the cleaning assistants).
- Delay on the transportation of the patient from the recovery room to his floor (availability of the floor nurse).

3.3.2.2 Information Flow

For the information flow, it was important to observe a broader scope than the one in the material flow. The flow starts with the patient's enrollment for surgery and ends when the patient leaves the OR.

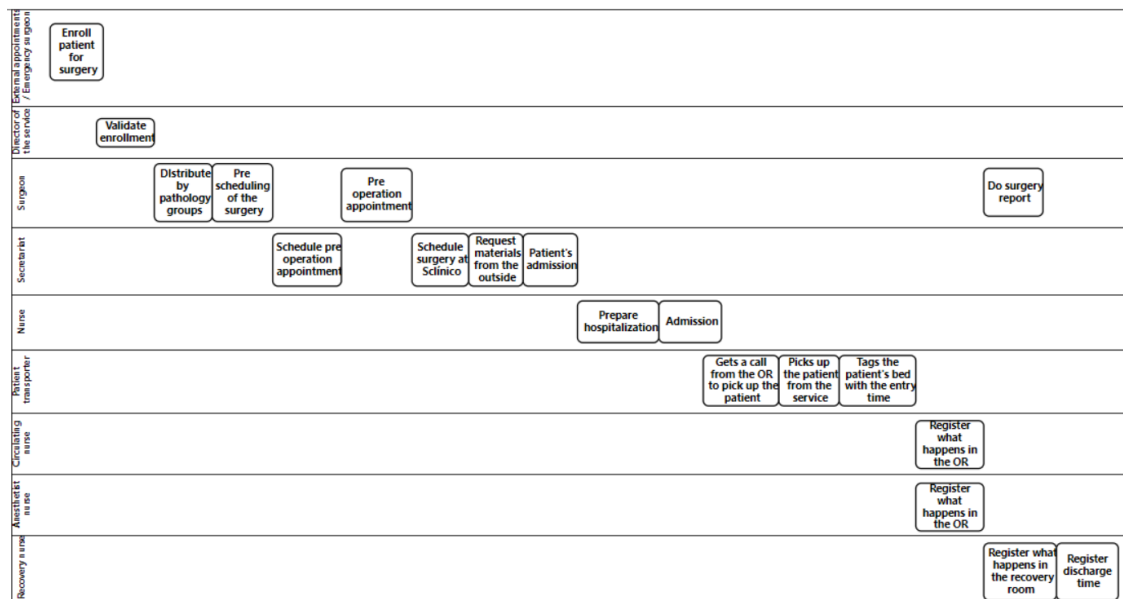


Figure 3.17: Operating Room: Information Flow

Multiple opportunities were found throughout the process:

- Surgeries are scheduled too late (a big part of the process is handled in paper).
- There is no anesthesia's appointment.
- The inscription at Sclínico is only visible at a late stage, which hampers programming in the OR.
- Material from the outside is requested with little advance, which generates a lot of waste.
- The decision to increase production (number of surgeries) is not always synchronized with all support areas (sterilization, recovery size).
- Sterilization planning is not synchronized with the OR.
- Deficit in managing clinical discharges, which causes delays in the OR for lack of vacancies to hospitalize the patient.

- Low synchronization and communication between doctors and nurses.
- Patient transporter receives simultaneous requests to pick up patients.
- Urgent patients or patients transported by collaborators that do not belong to the OR are delivered with low supervision.
- Anesthesia's sheet is not computerized.
- Records from the anesthesia nurse are not integrated with the ones from the anesthesia doctor.

3.4 Conclusions

As previously explained and referenced in chapter 2, Gemba is the best source of information. The mapping stage reinforced the importance of visiting Gemba for a better understanding of the patient flow. Choosing a multidisciplinary and motivated team also proved to be crucial to support all the process.

Analyzing the available data while mapping the process allowed for a broader view and comprehension of both services.

Mapping the value stream is an outstanding tool to identify problems. These problems will be analyzed in the next chapter, serving as a basis for the design of solutions.

Chapter 4

Design of Solutions

4.1 Introduction

After mapping the current situation and understanding the main problems, the main intervention areas were defined. This chapter brings the improvement opportunities found in chapter 3 together creating and developing multiple initiatives that go into more detail, as the project moves from a broader view to observing each intervention area in specific. Every initiative presents the problems found and the solutions developed to tackle those specific problems.

The desired (To Be) state should enable a continuous flow and the elimination of Muda. All non-value adding tasks should be eliminated, while maximizing the value adding ones.

At this stage, the team understands the concepts in use and recognizes the importance of tackling the problems found in the previous stage. Their constant involvement and participation is key for their motivation and acceptance of the proposed solutions without restrictions.

4.2 Medical Appointments Service

In the medical appointments service, a continuous patient flow refers to one where the patient communicates his arrival to the building, has his appointment and goes to the reception desk to pay, schedule new appointments and/or get a declaration of presence. All other tasks presented in the initial situation do not add value and therefore should be eliminated. The following initiatives were born by grouping existing problems and understanding the best way to address them.

4.2.1 Daily Kaizen at the Secretariats

When observing the secretariat, the following problems were found:

- There are no defined criteria to when answer the phone instead of proceeding with administrative tasks.
- The reception desk is not organized in a clear way.

- No clear distribution of tasks between co-workers in the reception desk, everyone does a little bit of everything.
- Phone is always ringing and no one answers.
- Charging is not always done in a continuous flow, which increases the difficulty of charging due to accumulated values.
- Charging takes longer in Pathology due to the larger number of patients.
- Not everyone charges the patient. The process in Sonho is complicated.

Some of these problems were already identified when mapping the as is, and its importance was reinforced when observing the secretariat in specific. The solution to these problems lied in multiple initiatives:

- **Daily Kaizen Meetings**

Traditionally, institutions work in a firefighter model. Problems repeat themselves and have to be solved several times and improvements are difficult, if not impossible, to maintain. The Healthcare sector is one with very rooted habits, and healthcare staff doubts change and its advantages: "It was always done like this, why change it now?". In this context, Daily Kaizen gains a even bigger importance. A cultural change is crucial to sustain and support change that endures and helps the organization improve. Dedicating more time to Kaizen is dedicating more time to work on improving, as well as increasing the number of people who contribute to it. Teams get together in a daily basis to discuss opportunities, solve problems and follow KPIs that are defined and calculated specifically to properly represent the work a team performs.



Figure 4.1: Daily Kaizen board in External Appointments III

The first step is to define the team board. Working with all Secretariats (External Appointments I, II, III, Imaging, Pathology and Immunohemotherapy) from External Appointments, team boards were defined differently for each one. The previous figure demonstrates the External Appointments III board.

Working with each team, the main elements included in every board were defined to be an attendance list, a meeting's schedule, a PDCA improvement plan, a work plan and KPIs determined for each team. External Appointments I, II and III boards also included a competency matrix that describes employees' skills and respective evaluation for each competence. It helps manage and plan existing and desired skills within a team. The correct definition of KPIs is crucial. It is important to know what to measure and how to measure it, to assure teams are being evaluated according to their work and with metrics that fit the team. A workshop with each team was realized to understand and collaboratively define proper indicators.

External Appointments I, II and III are secretariats that serve as the first response to patients that arrive at the hospital for appointments. One of their main tasks is to charge user fees. Two performance indicators were born to evaluate that work. First, the collective value charged by each team by day. A value was defined as the goal and a visual indicator was created so it was simple to see and evaluate the performance on a daily basis - if the value was under the defined goal it would be in the red area, whereas if it were above it would be in a green area. Moreover, an individual indicator was also defined. Two indicators were observed each day for each worker. First, the total number of patients served. Then, the percentage of patients charged within the number of patients served that were not exempted. Not all patients pay user charges, with a big part of the population exempted, and it would not be a proper indicator if it did not have that into account. These indicators were possible to obtain with the help of Sonho for these services.

Pathology and Immunohemotherapy, on the other hand, only had the first indicator of the total value charged as a team by day because the system did not allow to retrieve the other indicators. Due to their proximity and the small number of people in Immunohemotherapy, both teams had their daily meetings together.

Imaging also had that indicator, but others were defined to understand the number of exams canceled in the day and its reasons, to measure the number of exams to schedule, the reasons that justified that number and the number of scheduled exams.

With the design part concluded, it was now time to start the meetings. Implementing Daily Kaizen requires method as the intention is to create a new habit. Habits are difficult to break but they are also difficult to create. The implementation of the board and teams' first meetings were accompanied to guarantee a steady start. After that period, the team had now created a habit and was fully capable of discussing and learning from their KPIs and suggest improvements.

- **Focus on user charges**

The charging process presented multiple problems. The process in Sonho is complicated, patients are not always approached about the value they have to pay and debt starts accumulating. Resorting to the tool Standard Work, the charging process was analyzed and a charging standard was created to define how to act in the different possible situations, the questions that should be asked to the patient and good practices. A good example is asking how instead of if the patient wants to pay. The standard was given and introduced to all administrative staff working in all secretariats. Simple, concrete changes can have a great impact in the end goal of increasing the payment of user charges.

- **5Ss in all Secretariats**

5S is a simple methodology, easy to apply, that increases productivity by, for example, reducing the time wasted searching for necessary materials or tools. It is interlinked with Visual Management, as the two combine to create a culture based in thinking and acting by observing. 5S demonstrates how a work station should be organized, making deviations from the desired state visible.

5S was applied in all services with the help of the teams, after providing training on the methodology. An example of the differences between the before and after of its application can be seen below:



(a) Before



(b) After

Figure 4.2: 5S in External Appointments I: Cardiology

These three initiatives had a direct impact in one particular indicator: the value of user fees charged. Before these changes, the hospital charged approximately 57000 € per month (average of January, February and September 2020 to consider months when COVID-19 did not have such an impact) in the medical appointments service as a whole (External Appointments I, II, III, Imaging, Pathology and Immunohemotherapy). The ambition of the project was to increase that value.

4.2.2 Improvement of the Patient's Flow

The challenge lied in improving the flow and visual management of all Appointments' spaces, so patients can have a better experience, ensuring them greater comfort and satisfaction.

The main problems found in the patient's flow are described below, together with the solutions implemented:

- Kiosk is not intuitive (the patient does not know which option to choose).
Believing in the potential of the kiosks, the hospital hired workers to teach patients how to use them. Visual signs were placed both next to the kiosks and directing people to them, to increase their utilization.
- Lack of visual signs at the hospital's entrance and at External Appointments I and II. It is not clear to the patient if it is necessary to go to the reception desk when leaving.

A study was made to understand the necessities of the hospital in terms of visual signs. Furthermore, the entrance and exit flows were separated to enable a better flow.



(a) Visual signs



(b) Separating flows

Figure 4.3: Improvement of the patient's flow at External Appointments III

- Doorman does not have a standard to let people in and patients enter the building at the same time.

A standard was created for the doorman to let people in only thirty minutes before the appointments' time. This way, it was now possible to control the waiting rooms' occupation.

- Doctors call patients through Sclinico and through an intercom.

The solution lied in placing a new standard of how to call patients through Sclinico in each one of the doctor's room. This way, it was possible to normalize this action.

There were two main difficulties found in this initiative. The delay obtaining new, standard and uniform visual signs due to lack of communication and lag from suppliers. Talks with a company were initiated to obtain a dashboard to manage the waiting rooms' capacity, but at the end of this dissertation project it was not yet implemented.

4.2.3 Improvement of the Scheduling and Planning of Medical Appointments

The main problem found in this initiative was that the allocation of rooms to specialties was fixed and not reviewed often. The solution principle lied in reviewing this allocation of rooms according to the scheduling of appointments. An excel, that can be seen below, was created to simulate the distribution of rooms per specialties.

Distribution of rooms per specialty																
Indicator	III - 2		III - 2		III - 2		III - 2		III - 2		III - 3		III - 3		III - 3	
	Surgery	Vascular Surgery	Plastic Surgery	Urology	Internal Medicine	Gynecology / Obstetrics	Dermatology	Otolaryngology	Nutrition	Neurology	Immunology	Pulmonology	Pediatrics / Neonatology	Orthopedy	Podiatry	Cardiology
Number of periods per week	30	10	1	12	155	59	19	40	16	21	26	23	65	24	3	31
Number of hours per period	4	2	4	4	2	4	4	4	4	4	4	4	4	4	4	4
Number of working days	4	5	5	5	4.6	5	5	5	5	5	5	5	5	5	3	5
Number of hours the room is being used	8	8	8	8	10	8	8	8	8	8	8	8	8	8	8	8
Availability (hours per week) per room	32	40	40	40	46	40	40	40	40	40	40	40	40	40	24	40
Number of rooms	3.8	0.5	0.1	1.2	6.7	5.9	1.9	4.0	1.6	2.1	2.6	2.3	6.5	2.4	0.5	3.1
Number of rooms (rounded)	4	1	1	1	7	6	2	4	2	2	3	2	7	2	1	3
Suggestion of number of rooms	4	1	1	1	7	6	2	4	1	2	2	2	7	3	1	3

Number of rooms External Appointments III - 2nd fl	21	21	0
Number of rooms External Appointments III - 3rd fl	11	13	2
Number of rooms External Appointments II - 2nd fl	3	5	2
Number of rooms External Appointments I	14	15	1

Duration of first appointments	00:30	00:20	00:20	00:20	01:00	00:45	00:25	00:20	00:45	00:45	00:40	00:30	00:45	00:20	00:45	00:40	00:40	01:00
Duration of subsequent appointments	00:20	00:20	00:15	00:15	00:20	00:30	00:20	00:20	00:30	00:30	00:30	00:20	00:30	00:15	00:30	00:20	00:20	00:30
Number of periods per day	2	4	2	2	5	2	2	2	2	2	2	2	2	2	2	2	2	2
Number of first appointments	2	4	2	2	5	2	2	2	2	2	2	2	2	2	2	2	2	2
Number of subsequent appointments	21	20	29	29	15	13	22	22	13	13	13	21	13	29	13	20	20	12
Number of appointments per day per room	23	24	31	31	20	15	24	24	15	15	15	23	15	31	15	22	22	14
Number of appointments per week	368	120	0	157	644	450	235	480	75	150	153	230	525	470	45	330	110	112
Number of appointments per hour	2.9	3.0	0	3.9	2.0	1.9	2.9	3.0	1.9	1.9	1.9	2.9	1.9	3.9	1.9	2.8	2.8	1.8
Average number of appointments per week (Jan to Dec)	406	82	17	149	352	336	137	203	89	131	76	87	298	314	N/A	300	187	67
Number of rooms need for appointments	4.4	0.7	0.1	1.0	3.8	4.5	1.2	1.7	1.2	1.7	1.0	0.8	4.0	2.0	N/A	2.7	1.7	1.2
Number of current rooms	5	1	1	1	6	7	2	5	1	3	3	1	7	5	1	2	2	2
Number of appointments per hour	2.5	2.0	0.4	3.7	1.3	1.2	1.7	1.0	2.2	1.1	0.6	2.2	1.1	1.6	0.8	3.8	2.3	1.1
	-1.3	-0.5	-0.9	0.2	0.7	-1.1	-0.1	-1.0	0.6	-0.9	-3.0	1.3	-0.5	-2.6	1.1	-0.9	-0.6	

Figure 4.4: Distribution of rooms per specialty

Using Internal Medicine as example, the number of periods all doctors from that specialty have available per week are 155, with the minimum hours per room per doctor being 2, representing a total of 310 hours per week. The number of working days per week is 4.6 and the room is used 10 hours per day, which results in a availability of 46 hours per week per room. Dividing the total number of hours per week (310) by the availability per room, the result indicates the number of rooms needed, 7.

Furthermore, the distribution of rooms per specialty has a direct impact in the number of appointments realized. The duration of first and subsequent appointments is standardized and know for each specialty. Dividing the number of hours the room is used by the number of hours per period, it is possible to obtain the number of periods per day. The number of first appointments is defined as equal to that number, while the number of subsequent appointments is calculated taking into account the number of hours left from the number of available hours per day and the duration of each appointment. The total number of appointments per day per room is the sum of first with subsequent appointments. The total number of appointments per week is the multiplication of the number of appointments per day per room by the number of days and the number of rooms. For Internal Medicine, this number is equal to 644 appointments. The average number of appointments per week in 2020 for this specialty was of only 352, which means only 4(3.8) rooms were needed from the 6 existing ones, causing low rates of occupation. Although the data from 2020 shows that

Internal Medicine only needed 4 rooms, the high number of periods per week suggests otherwise. The final suggestion was 7 rooms.

These calculations were realized for every specialty represented (Podiatry has no historical data of appointments), resulting in the following alterations:

- External Appointments I: gains an extra room that can absorb multiple specialties according to the necessities, as Orthopedy loses two rooms and one goes to Cardiology.
- External Appointments II: gains one room from Gastroenterology and another one was already free for eventual necessities.
- External Appointments III: all rooms are occupied in the second floor, with Plastic and Vascular Surgery sharing a room. On the third floor, there's a gain of two rooms.

A better distribution of rooms per specialty will hopefully increase the occupation of rooms, indicator chosen to evaluate the performance of this initiative. Data from 2020 shows an average occupation rate of 88% in the final weeks of the year.

4.2.4 Improvement of the Scheduling of Medical Exams

This initiative was born due to the existence of the following problems:

- Lack of synchronization of schedules between doctors and technicians to schedule exams.
- Doctor only schedules clinical analysis but not other exams.
- The process of scheduling emergent clinical analysis is very bureaucratic.
- Doctors do not always follow the standard of scheduling first the appointment and only then the exams.

The patient leaves the appointment with the date of the next one, together with a requisition of exams. When leaving, the patient delivers this requisition in the secretariat and leaves the hospital with zero visibility of when these exams will be. Medical exams are then scheduled at Imaging, and a letter is sent to the patient with all the details about the exams. Furthermore, the process at Imaging happens according with the date of the request, instead of having into account the date of the patient's next appointment. Consequently, appointments can be realized without the result from the exams.

The objective was to create an uniform process of scheduling exams, for the patients to leave the appointment with all MCDTs scheduled. The following solutions were defined:

- Start synchronizing schedules between doctors and technicians.
- Warnings for appointments that still do not have the exams realized.

- Create a restriction so it is not possible to schedule exams without scheduling the appointment first.
- New process of scheduling exams at the Appointments, with the exception of clinical analysis(scheduled by the doctor) and exams done outside of the hospital:
 1. Doctor schedules next appointment.
 2. Doctor requests exams.
 3. Secretariat schedules the exams.
 4. Patient has his exams scheduled and receives that information at the exit.

The vision is that exams are scheduled at the patient's check-out in the appointments' secretariat. This way, the patient participates in the decision, assuring their availability. Moreover, it is no longer needed to send a letter to the patient, also avoiding loss of correspondence. The scheduling is realized taking into account the patient's next appointment date instead of the date of the request. As different exams require different times to be ready, dates were defined so the exams would be scheduled until X (specific number of days depending on the exam) days before the appointment. X-rays, for example, can be scheduled at the same date as the appointment. The number of visits of a patient to the hospital would decrease and appointments would not happen without the result from the exams.

The new process of scheduling exams at the appointments' secretariat required workers from Imaging to leave their secretariat to teach their coworkers how to schedule exams, since there is a specific computer program to do it. During the implementation of this dissertation project, the computer system used to schedule exams was updated, delaying this initiative. It is only when mastering the new system that makes sense to send people from Imaging to the appointments to start the transition. Although a standard explaining how to schedule exams has already been created (and can be seen in the Appendix B), at the delivery date of this dissertation project workers from Imaging are yet to move to the appointments' service to implement this vision.

4.3 Operating Rooms

The tasks related to the OR that add value to the patient are their preparation, anesthesia, positioning, surgery and recovery. All non-value adding activities should be eliminated or at least minimized to optimize the patient's flow. Four different initiatives were born to improve the OR.

4.3.1 Daily Kaizen in the Operating Rooms

Without a formal moment of communication to evaluate the current performance, it is harder to understand what goes wrong, why and how to improve it. Daily Kaizen was implemented in the

OR to create a culture of talking with data. Through defined KPIs, it is possible to measure the current status and think about improvement measures.

Although the importance of Daily Kaizen has been previously explained, it increases exponentially when talking about the OR. Every second counts and a meeting can be seen as a time thief. On the contrary, meetings are intended to be short and precise. By making sure everything is prepared for surgeries, time that would be spent solving problems is minimized. This initiative started with only one room, the only one working for programmed surgeries due to COVID-19. As the number of cases of COVID-19 started decreasing, the number of rooms increased and this initiative spread to every room, except the emergency room. The goal of the meeting was to discuss the surgeries planned for the shift, which was impossible in the emergency room for its unpredictable nature.

The design of the team board was made in collaboration with a team of multidisciplinary workers from the OR. As the OR works in shifts, meetings were scheduled twice a day, one for the beginning of the morning shift and another for the beginning of the afternoon shift, for every room. As the meeting intended to include the team specified for surgery: surgeon, anesthetist, anesthetist nurse, circulating nurse and instrumentalist nurse, a board was placed in every room. These boards were all equal and included a meeting's schedule that included questions to go through and help guide the meeting, an attendance list, the surgeries planned for each shift and four indicators: starting time, causes for a late starting time, turnover time and causes for high turnover times. The figure below demonstrates the board of room 6:

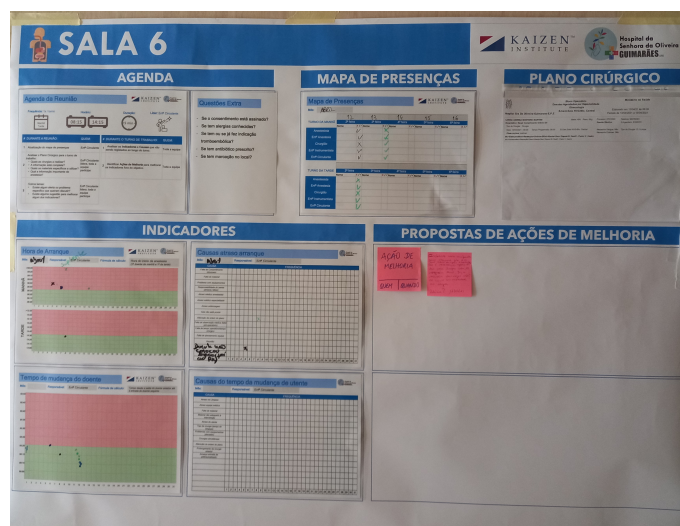


Figure 4.5: Daily Kaizen board in the OR: room 6

A surgery is unpredictable, so the focus has to be on what it possible to predict and, therefore, improve. It was important to understand both the starting time of the OR and the turnover time between surgeries. Moreover, the causes for delays in both these times. Only when understanding the causes, it is possible to address them. The starting time of the first surgery was measured in both shifts by the beginning of anesthesia. Turnover time is the difference between the beginning

of the next surgery and the end of the previous one. Initially, this value was calculated as the difference between the beginning of anesthesia and the end of the previous surgery. The end of surgery represented the end of the surgeon's job. This was not the best representation of the time between surgeries, since the patient was still in the room after that moment. It is only after waking up from anesthesia that the patient leaves the room to go to the recovery room. The turnover time was corrected to be the difference between the beginning of anesthesia of the next patient and the end of anesthesia of the previous one.

All the data collected during the week in these meetings is then analyzed by the OR's directors in a weekly management meeting that happens every Thursday. An excel file was developed, along with a dashboard, that can be observed below, with instructions to facilitate the data analysis. The secretary of the OR receives, every Monday, data related with the past week and pastes it in the main excel file, where only has to refresh data, select the week and print all charts to put them in the management meeting's board.

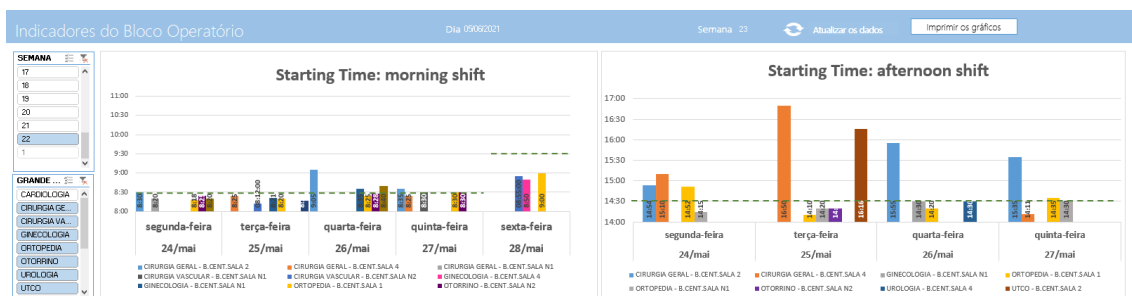


Figure 4.6: Dashboard: indicators for the Daily Kaizen Management Meeting

In addition, and in order for everybody to be able to prepare for the meeting, these indicators are sent by email. Appendix C demonstrates the indicators sent in this email, using week 23 as example. Besides the starting and turnover times, these meeting also addresses the cancellations in the OR and its reasons. All these indicators are calculated with the help of the same Excel file. In addition, the board also contains a meeting's schedule, an attendance list and a PDCA improvement cycle as can be seen below.

As time went by, the team felt it was important to add other measures of the productivity of the OR: the end time of the last surgery per room per day, to understand if the scheduling is done properly and the cancellations that happen in the Service with the same intervention date as the cancellation date. This means the patient does not enter the OR, but was already at the hospital at the specific specialty service to be prepared for the surgery.

A board, available on attachment D, was also defined for the cleaning assistants, including a meeting's schedule, an attendance list, a work plan, the daily tasks, the cleaning standard, a PDCA improvement cycle, the surgeries planned for each shift and two indicators: the cleaning time and reasons for a soared cleaning time. The cleaning standard was developed through the implementation of SMED, as a part of the initiative of reduction of the turnover time, that will be addressed later on this chapter.



Figure 4.7: Daily Kaizen: Management Meeting Board in the OR

The cleaning assistants were now able to monitor the cleaning time and study deviations from the target. Talking with data facilitates the analysis of the causes of deviations. This moment also contributed to the communication between cleaning assistants, increasing team spirit and elevating the importance of working as a team towards a common goal.

4.3.2 Visual Management of the Patient and Organization of the Work Spaces

When observing the OR, several organizational problems were identified:

- Induction rooms had equipment that was not used in the induction room.
- Imaging equipment unorganized and without a fixed position.
- Lack of visual management, mainly in the entrance/admission area.

The main goal of this initiative was to assure everything in the OR has a defined place. With the previous problems in mind, the following solutions were defined:

- Implement 5S in the OR common areas.
- Improve visual management in areas used by people external to the OR.
- Tool to manage and visualize the patient's flow.
- OR spaces with normalized stocks (kanbans).

The first step was to implement 5S in the chief nurses' office. This measure was not only about productivity. The focus was cultural change. Starting by the chiefs nurses' office, the example was given about the importance of organization in the work space. If the nurses in charge dedicate their time and effort into it, the message is sent about the significance of this change. Besides, the result and impact can be seen by everybody, raising not only awareness but developing interest and



Figure 4.8: 5S in the chief nurses' office: Before

dedication to achieve the same results in their own work space. The following image demonstrates the chief nurses' office before implementing 5S.

Working together with the chief nurses, it was possible to achieve a more inviting space, as can be seen below. Following the 5S methodology, the work process was now simplified by making it easier to find necessary tools.



Figure 4.9: 5S in the chief nurses' office: After

5S were also applied to all other OR areas, as the locker room, the halls and the stock rooms. Besides the main storage room, each operating room has its one smaller adjacent stock room, so materials that are essential for the surgery are not too far away. The process of moving materials from the main storage to the smaller rooms was not clearly defined. To implement a kanban system that could help manage stocks, it was important to start by understanding all type of materials that exist in the OR. This explanation is available on the table below.

Table 4.1: Type of stocks in the OR

Type	Description
A	Exists in the main storage room and in the adjacent room
B	Exists only in the adjacent room
C	Exists only in the main storage room
D	Exists in both like type A but refers to very specific rarely used materials, with a different process to request more

A kanban system is one that triggers the need to restock. It can be a card or a empty box. When visualizing it, it becomes clear there is a need to restock. This card/empty box contains all the information about the product, the ordering point and the quantity to order. The ordering point refers to the number of units that exist when it is possible to visualize the kanban. After restocking the quantity referred to as quantity to order, the kanban has to be positioned at the ordering point. To account for the expiration date of the products, the new products must be placed under or behind the existing products, so the latter are used first. This concept is known by FIFO (first in, first out): the first product arriving is the one that is there the longest and is used first.

The pilot room for the implementation of kanbans was the adjacent room to the operating rooms 2 and 3, since it contained mainly type A products.

An example of a kanban can be seen below:

Figure 4.10: Kanban

At the delivery date of this dissertation project, the implementation of the kanban system had just started. The implementation will move on to the rest of the adjacent rooms.

4.3.3 Improvement of the Process of Managing Materials

The number of cancellations by lack of materials or equipment reflected 11 cancellations per month at the service and 0.4 cancellations per month with the patient already in the OR, represent-

ing a total of 11.4 cancellations per month due to problems in the process of managing materials. The cancellations by lack of material that happen at the services are included in the reason "Deficit of a support structure (room/material/human resources)".

The situation found at the OR for the preparation of materials can be characterized by:

- Surgery codification in Sclínico was not perceptible, forcing nurses to open the patient's file or call the surgeon.
- Protocols are outdated.
- It was necessary to request material of clinical consumption.
- The scanner was not working.
- Scheduling did not have the necessary detail for the instrumentalist nurse to prepare the material.

Solutions were defined and implemented to tackle the problems presented above:

- Improve surgeries' codification in the system to facilitate the preparation.
- Update protocols.
- Improve productivity of the preparation tasks (use scanners).
- Update minimum and maximum stock in the system to avoid requesting consumables.
- Define service level/deadline to replace material.

There are materials and equipment in the OR that have to be requested from the outside due to its higher price and specificity. This also hampers the relationship with sterilization, as materials get lost or forgotten because there is not a defined process or defined responsibilities. For these types of materials, the following problems were discovered:

- No formal follow-up of the requests.
- No one is defined to control suppliers.
- No structured process to plan next day surgeries.

Some solutions were defined to address these problems:

- Define responsibilities in the process.
- Define the process to assure previous preparation of all materials.
- Assign a OR's nurse to receive and check materials from the outside in the sterilization.

The challenge here was to guarantee all materials were prepared in advance. To achieve that, SCLínico needed to have the correct codification for surgeries, with the specific materials for the surgery indicated in a field called "Observations". This was made possible by talking with the secretary of each service that, as the person responsible for scheduling surgeries, would now include the necessary material to realize them according to the surgeon. The goal of this initiative was to reduce the number of cancellations related with the process of managing materials to 5,2 patients per month, which translates in a 50% reduction.

4.3.4 Reduction of the Turnover Time and Improvement of the Starting Time

Both the turnover time and starting time were previously addressed as integral part of the team's board in Daily Kaizen, which allowed to measure and accompany the evaluation of both these metrics. A earlier starting time and a minimized turnover time mean higher productivity, since it is possible to realize more surgeries in the programmed time.

Relatively to the starting time, some problems were identified when observing the current situation.

- No defined hours for every team member to be in the room.
- Anesthetic interns in the first time can delay the starting time.
- The official starting time is not clear in the afternoon (14h or 14h30).

Daily Kaizen meetings at the beginning of each shift had an impact on the starting time, because it defined an hour for everyone to be inside the OR. Every team member now knew when to be in the OR and the official starting time in the afternoon was now clear to be at 14h.

The key performance indicator of this initiative is clear. The current situation is characterized by a starting time of 8:53 in the morning shift for rooms 1, 2 and 4. In the afternoon shift, the starting time for these rooms is 14:48. Data was collected and selected to study the OR before COVID-19 so the current situation refers to one without the impact of COVID-19. The goal of the project is to achieve average starting times of 8:30 and 14:30, for the morning and afternoon shifts, respectively.

Regarding the turnover time, it was crucial to understand its elements. This time can be referred to as the setup time, because it represents the time it takes to change from one patient to another. Although the turnover time is not exclusively composed by the cleaning time, it is its biggest component, so the focus had to be in reducing the time it takes to clean the room for the next patient. The tool used to reduce the setup time was SMED (Single Minute Exchange of Die). SMED distinguishes work in internal and external work. In this case, internal work is the work that can only be done with the patient outside the room, whereas external work can be done while the patient is still inside the room.

First, it was important to go to the Gemba for a better comprehension of the work process. Several observations were made, filming some of them, to be able to list all tasks and measure the time of each one. The Gemba walk has another valuable advantage: the engagement with

employees and understanding the improvement opportunities they see in their jobs. The following problems were identified:

- Some materials don't have a defined and specific position inside the operating room.
- Waste bins are small, which complicates the cleaning process.
- Waste bins' bags are replaced, instead of replacing the bins.
- A lot of time is wasted moving just to pick up more cleaning wipes or throw the garbage out.
- A lot of cables have to be clean instead of replaced.
- The room can stay empty just waiting to be cleaned.

A workshop was realized with part of the workers responsible for cleaning the rooms, following the steps from SMED:

1. Work Study

With the help of the previous observations at the Gemba and the videos recorded, all tasks were listed, classified as internal or external and the time each took registered (Attachment E), with the result presented in the table below:

Table 4.2: Workshop SMED: Work Study

Task	Internal/External	Duration
Remove used equipment	Internal	1min
Remove bed linen	Internal	15sec
Remove garbage bags	Internal	2min
Place the bags in the container	External	20sec
Grab cleaning towels	External	20 sec
Place the bed linen in a bag	External	30 sec
Change gloves	Internal	45 sec
Clean	Internal	12 min
Change cleaning towel	Internal	1min 15sec
Place the cleaning towels in the garbage	External	15 sec
Remove gown and gloves	Internal	15 sec
Get bed linen and garbage bags	External	25 sec
New garbage bags	Internal	45 sec
New bed linen	Internal	30 sec
New equipment	Internal	30 sec
New gloves	Internal	30 sec
Clean the floor	Internal	4 min

The previous times are representative and can vary depending on the type of surgery. Some rooms are harder to clean than others, depending mainly on the specialty of the surgery. Furthermore, "Clean" is a global step that was not fully described at this moment, but will

then be separated in its multiple components when defining a work sequence. Change of gloves is considered internal as it is a required part of the process, in order to ensure all the safety protocols are fulfilled. Now that tasks are listed and classified, it is possible to move on to the next step.

2. Separate Internal and External Work

With the help of the team, the best work sequence was defined for one person and for two, creating a standard for both occasions. Regarding external tasks, the ones that refer to preparation were placed at the beginning and the other ones at the end, since they can be done with the patient still in the room.

Before entering the room, it was defined a kit would be prepared with all the necessary material for cleaning the room. This kit would then be positioned close to the room, to reduce the Muda motion.

Once inside the room, the sequence for one person was defined to be:

Table 4.3: Cleaning Standard: 1 person

Order	Task
1	Remove used equipment
2	Remove bed linen
3	Remove garbage bags
4	Change gloves
5	Clean handles
6	Clean anesthesia support cart
7	Clean support and electrical scalpel
8	Clean circulating nurse support cart
9	Clean keyboards
10	Clean lighting fixture
11	Clean ventilator and wires
12	Clean gurney
13	New garbage bags
14	New bed linen
15	New equipment
16	New gloves
17	Clean the floor

Table 4.4: Cleaning Standard: 2 people

Person A	Person B
Remove used equipment and bed linen	Clean handles and anesthesia support cart
Remove garbage bags	Clean support and electrical scalpel
Clean lighting fixture	Clean circulating nurse support cart and keyboards
Clean gurney	Clean ventilator and wires
New garbage bags, equipment and bed linen	Clean the floor

When two people were available to clean the room, the tasks would be divided between the two according to the table above. This division of tasks was also realized with the help of the team, to understand what tasks could be done at the same time and to try to equally divide the working time between the two.

After leaving the room, the material used during the surgery is counted. This is a verification step to confirm all material is accounted for and to register what goes to sterilization.

3. Transform internal work into external work

4. Reduce internal work

In this specific case, both step 3 and 4 of transforming and reducing the number of internal tasks are not possible, since every task is required to be done to assure a proper clean space for every patient. Defining the best work sequence allowed to reduce internal work in terms of time spent doing it, not in the number of tasks.

5. Reduce external work

Preparation tasks were defined in an attempt to reduce transportation and motion. The implementation of 5S in the OR also helped and contributed to that goal.

With the workshop concluded, cleaning tasks were now normalized, motion and transportation were reduced and, with the help of 5S, materials now have a defined position. Cleaning time was now measured and improvement opportunities were discussed everyday on Daily Kaizen meetings, with the ultimate goal of achieving a 20 minute cleaning time. Other solutions were thought of to improve the cleaning time:

- A portable cleaning kit.
- Create clean duplicates whenever possible (example: cables and waste bins).
- Increase the size of the waste bins.
- Create a warning for the end of surgery to avoid waiting times for the assistants.

Regarding these ideas, a request for the implementation of pagers was made. Every room of the OR will have a button that nurses can press at the end of the surgeries, and every cleaning assistant will have a pager that will receive a message with the indication of the room where the button was pressed. With rooms far away from each other, there were multiple times when the assistants did not hear nurses calling about the end of the surgery. This way, they will know rapidly what room ended and can respond to requests faster, avoiding waiting times for the room to be cleaned.

It was now time to tackle the other components of the turnover time. The cleaning time has been approached, so it is important to understand what other elements increase the turnover time. To help with that mission, a timeline for the patient was developed. This way, it is possible to understand, for each day and in each room, how long each step took.

Chapter 5

Results

Although this project is still being implemented, some results are already visible and can be shown below. These results are described for each service in study.

5.1 Medical Appointments Service

The first initiative developed in this service, described in 4.2.1, was Daily Kaizen at the Secretariats. The main goal was to develop a culture of continuous improvement, while working on daily problems. This global initiative divided itself in three: Daily Kaizen meetings, 5S and focus on the charging process. The impact of all three would be measured by the value of user fees charged by all external appointments' secretariats. Below, the evolution of these value can be observed.

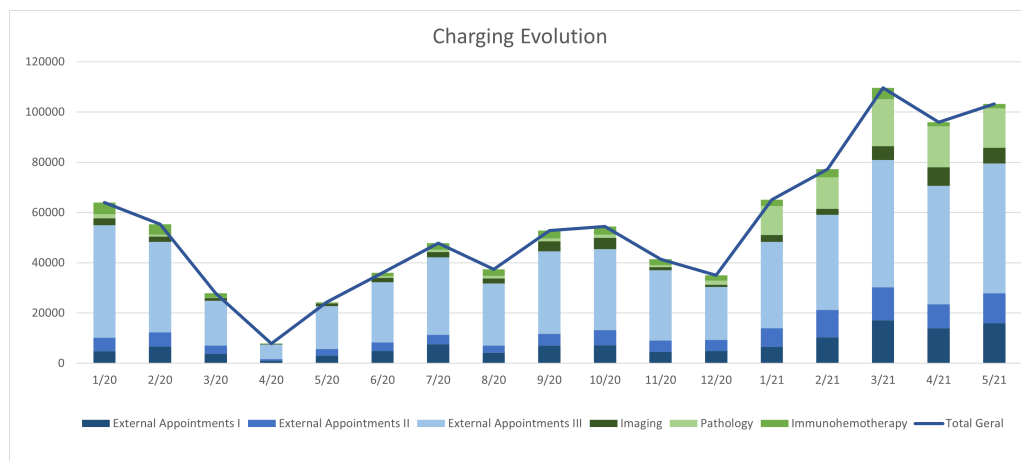


Figure 5.1: Evolution of the charging process 2020 and 2021

The impact of COVID-19 and the consequent fear of going to the hospital explains the decrease in the value charged starting in March 2020 and going forward. Despite that, the increase in 2021 is clear. January, February and September 2020 (to account for months least affected by COVID-19) represent an average value of approximately 57000€, while 2021's average is approximately

90000€. This represents a 57% increase in the value of user fees charges until the end of this project.

Regarding the improvement of the planning and scheduling of medical appointments discussed in section 4.2.3, the following chart demonstrates the positive evolution of the occupation rate in 2021. In the final weeks of 2020, the average occupation rate was 88%. 2021 has an average of 96% and good growth prospects.

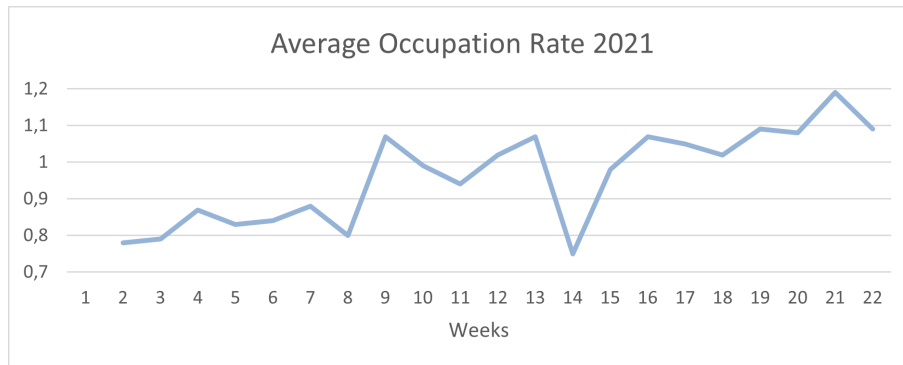


Figure 5.2: Evolution of the occupation rate 2021

5.2 Operating Rooms

In the OR, one of the main focuses was the turnover time and the starting time, as seen in 4.3.4. Although there was a specific initiative for it, Daily Kaizen also played a major role in obtaining results. The evolution of each one of these indicators in 2021 can be seen below, comparing the before and after of the implementation of Daily Kaizen in the OR. Daily Kaizen guarantees the stabilisation of the target condition, decreasing the variability, as can be seen in the graphic below for the starting time, which was calculated as the minimum time of the beginning of anesthesia per room in the morning shift of each day. These data refers only to programmed surgeries.

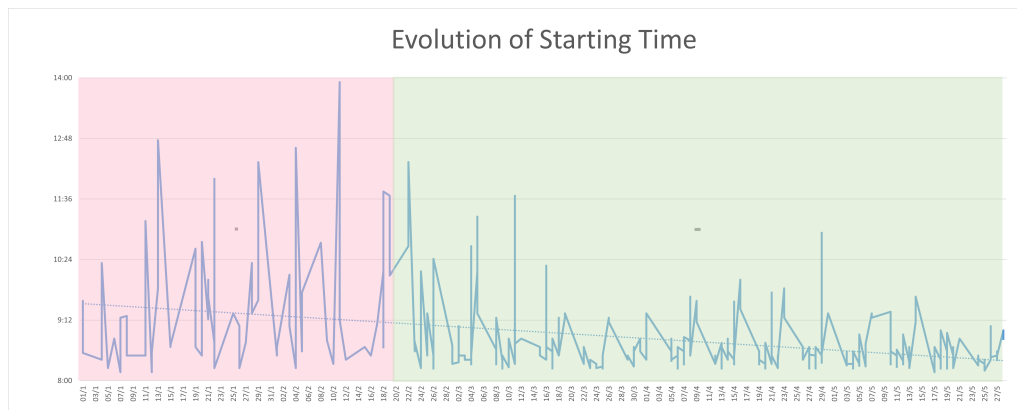


Figure 5.3: Starting Time in the OR

The difference between the maximum starting time and the minimum decreased from 5h45min to 4h10min with the implementation of the Daily Kaizen meetings in the OR. Furthermore, the average diminished from 9:30 to 8:41. When the project first started, data was collected for before COVID-19 and the average starting time was 8:53 for rooms 1, 2 and 4. To be able to compare with this value, the current average starting time was calculated just for rooms 1, 2 and 4. Nowadays, these rooms have an average starting time of 8:29, which represents a decrease of 24 minutes. The afternoon shift, that was previously characterized by a starting time of 14:48 in these rooms, has now a average starting time of 14:21 since the implementation of Daily Kaizen in the OR. Goals were defined with the team based on historical data and what felt a reasonable target to achieve. The following table sums up these information:

Table 5.1: Evolution of Starting Time in rooms 1,2 and 4

Shift	Before	Goal	After
Morning	8:53	8:30	8:29
Afternoon	14:48	14:30	14:21

The turnover time is calculated as the daily average of all turnover times for programmed surgeries, including both the morning and the afternoon shifts. Before Daily Kaizen was implemented, the average turnover time was 1h43min. Nowadays, the current average is 34 minutes. The gaps in the data can be explained by mistakes in the records with, for example, different patients having surgery at the same time in the same room.

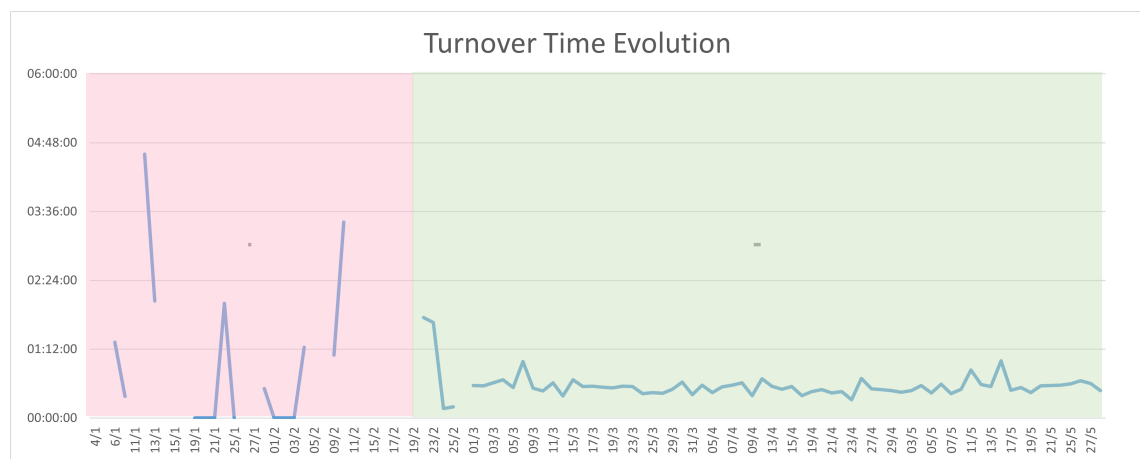


Figure 5.4: Turnover Time in the OR

The reduction of the turnover time was also possible due to the implementation of SMED on the cleaning time. The following chart demonstrates the evolution of the cleaning time during 2021, calculating the average cleaning time per week, while also comparing the before and after of the application of SMED.

The average decreased from 29min to 21 in week 22, achieving a minimum average cleaning time of almost 19min in week 21.

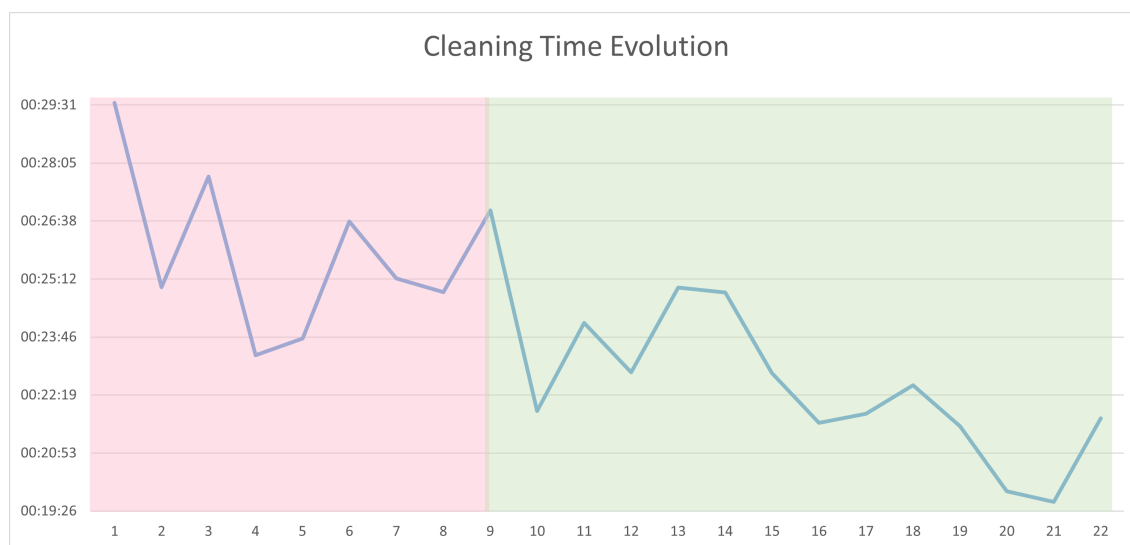


Figure 5.5: Cleaning Time in the OR

It was also possible to achieve results in the initiative of improvement of the process of managing materials described in 4.3.3. There were 11.4 cancellations per month due to problems in the process of managing materials. In 2021, until May, 18 surgeries were cancelled by "Deficit of a support structure (room/material/human resources)" at the services, representing 3.6 cancellations per month. With the patient already in the OR, 2 surgeries were cancelled in 2021 until May, reflecting 0.4 cancellations per month. Brought together, there were a total of 4 cancellations per month related with the process of managing materials, which represents a decrease of approximately 65%.

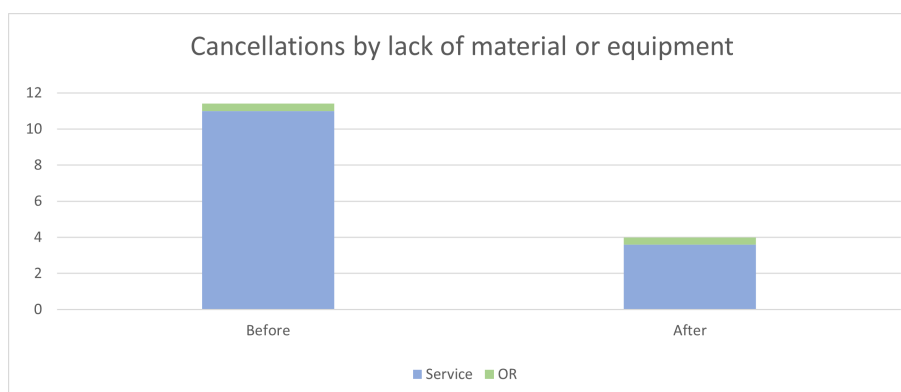


Figure 5.6: Evolution of cancellations per month due to problems with materials

5.3 Conclusion

A global view of the results of every initiative is not possible yet, since the project is still in its implementation phase. Nevertheless, the results presented in this chapter are a good indicator of the success of this project, demonstrating:

- For the Medical Appointments Service, a increase of the user fees charged of 57%, which represents an increase of 33000€ per month; and a positive evolution of the occupation rate, with an average of 96% in 2021.
- For the OR, a decrease of the variability of the starting time, with a gain of 24 minutes in the morning and 27 minutes in the afternoon; a decrease of 67% of the turnover time, from 1h43min to 34 minutes; a reduction of the cleaning time from 29 to 21 minutes, representing a improvement of 27%; a decrease of cancellations due to problems with materials from 11.4 to 4 per month, representing a decrease of 65%.

Moreover, these results fulfill the objectives previously defined at Chapter 1, Section 1.3.

Chapter 6

Conclusions

Result of the agreement between Hospital de Guimarães and Kaizen Institute, a project was born to increase the productivity of the Operating Room and External Appointments, as well as the service level provided in both services.

Value Stream Mapping proved its usefulness in understanding the patient's flow, identifying waste and capturing problems throughout the course of the patient. The level of detail it creates facilitates the design of solutions. The solutions created were based on Kaizen principles and methodology, which enabled to tackle the root causes of the problems encountered. The creation of a continuous flow for the patient, through the elimination of Muda, was the guiding principle of this project.

The implementation of the project was only possible due to the hospital's personnel. It is crucial that people believe in change to be a part of it. That requires time and follow-up to guarantee people are motivated and understand the concept of continuous improvement. Daily Kaizen is a fundamental tool to help achieve a much needed cultural change in organizations: it brings people together to work on daily problems, increasing communication and motivation.

Although all solutions were defined, the project is still in its implementation phase. Regarding the Medical Appointments service, the improvement of the scheduling of exams is pending the transition of workers from Imaging to the Appointments' service, that is planned for the month of July. Visual signs were placed in all Medical Appointments' service for the improvement of the patient's flow. Nevertheless, a dashboard to manage the waiting rooms' capacity is still part of the goals and will continue to be worked on. In the OR, the implementation of a kanban system to help manage stocks is still in progress, as well as the observation of the turnover time as it was still not possible to identify the culprit of high turnover times.

Moreover, future work has to focus in reducing the number of cancelled appointments as data shows a large number of cases. As there are not sufficiently detailed motives to justify cancelled or annulled appointments, the alteration of motives would be a starting point. Regarding the OR, the focal point has to be the improvement of the scheduling process of surgeries. When studying the reasons of cancellation, lack of surgical time has a preponderant weight.

The solutions implemented have benefited the Hospital, allowing for a growth of 57% in the

value of user fees charged in the Medical Appointments Service, together with a higher occupation rate of 96%. In the OR, the implementation of Daily Kaizen, aligned with the initiative of reduction of the turnover time and improvement of the starting time, contributed to a decrease of the variability of the starting time, with a gain of 24 minutes in the morning and 27 minutes in the afternoon, a decrease of 67% of the turnover time and a reduction of the cleaning time of 27%. Furthermore, the process of managing materials also improved, with a decrease of 65% in cancellations due to problems with materials.

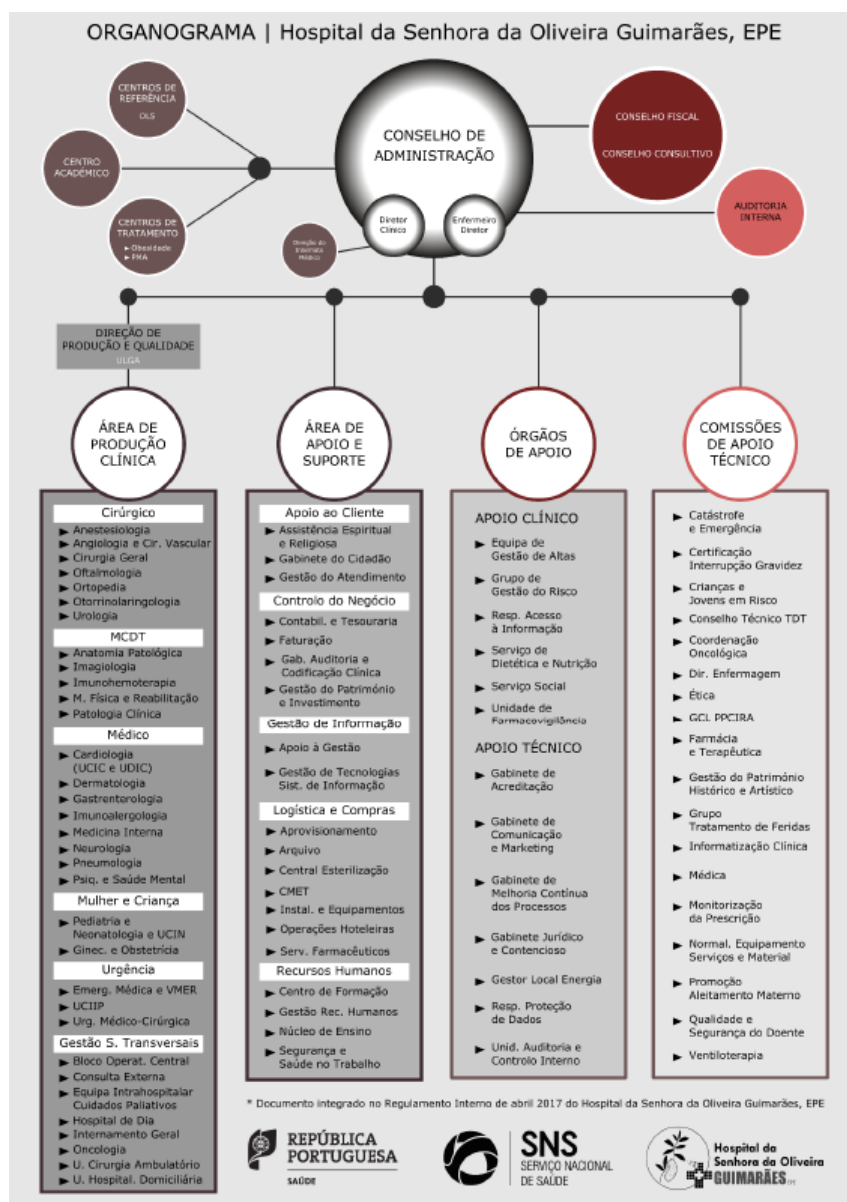
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Appendix A

Organizational Chart



Appendix B

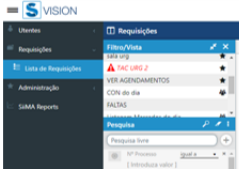
Standard on How to Schedule Exams

Marcação de Exames



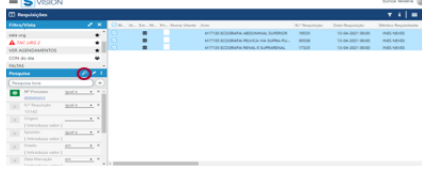

1

Inicie o SiimaVision e selecione "Lista de Requisições" na secção "Requisições" do menu lateral.



2

Na secção "Pesquisa", inserir o número de processo e carregar na lupa. A pesquisa pode ser realizada com qualquer dos campos detalhados abaixo. Os exames a marcar devem ser seleccionados.



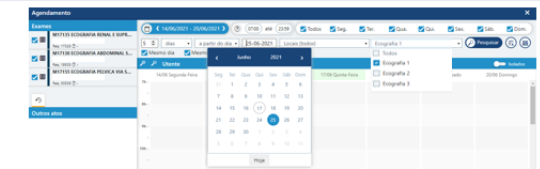
3

Selecione, na barra superior, o calendário e confirme depois a operação. Se for necessário forçar o agendamento, ver passo X.



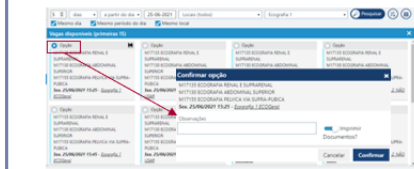
4

Selecione uma data do exame com base na data da próxima consulta* e a sala onde o exame vai ser realizado.



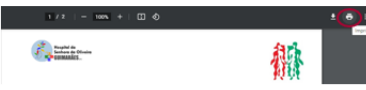
5

Ao carregar "Pesquisar", surgem as vagas disponíveis. Seleccionar uma e confirmar.



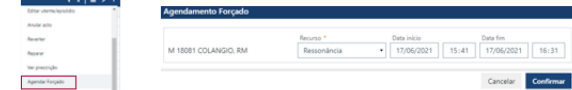
6

A marcação obtida deve então ser impressa e colocada num envelope para envio ao utente.



X

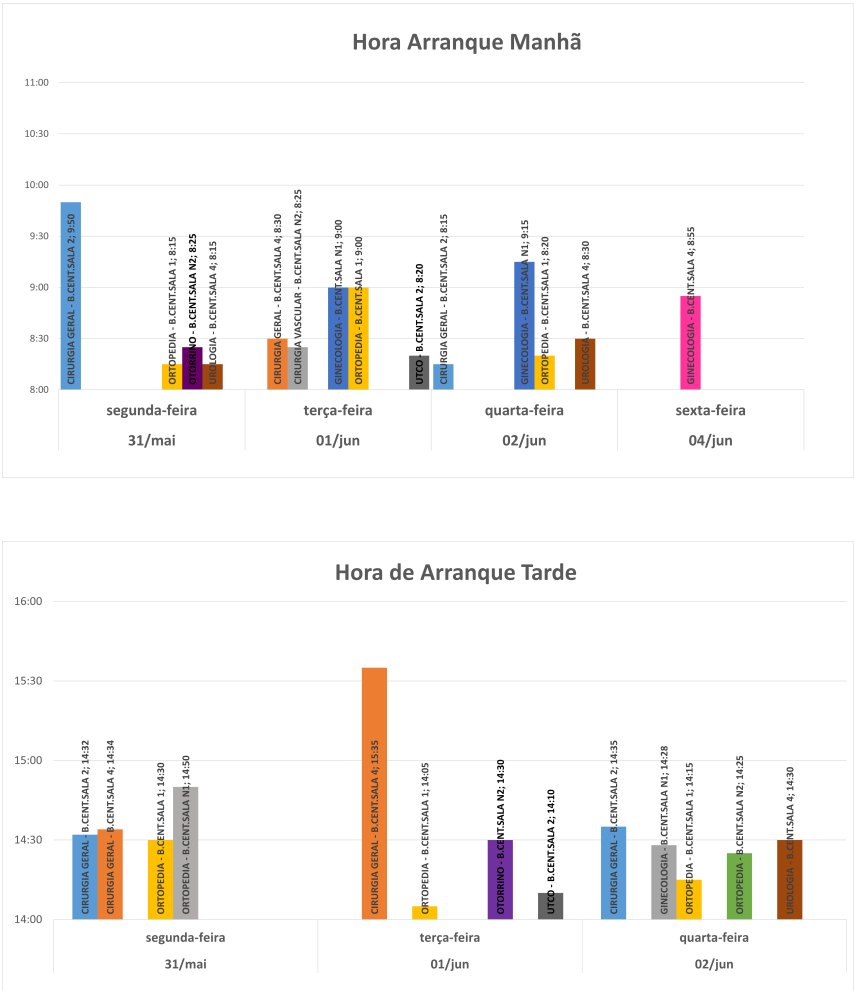
Selecione, na barra superior, o três pontos verticais e escolha "Agendar Forçado", que permite seleccionar a data e a hora. A confirmação leva à marcação do exame (passo 6).

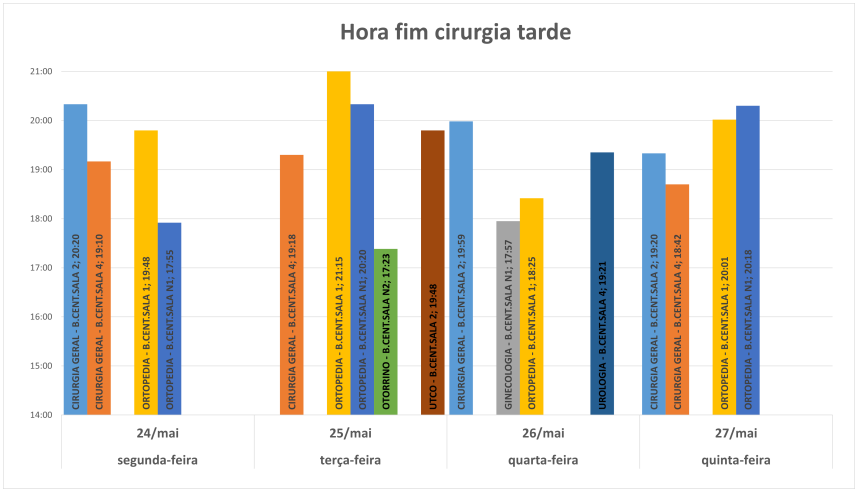
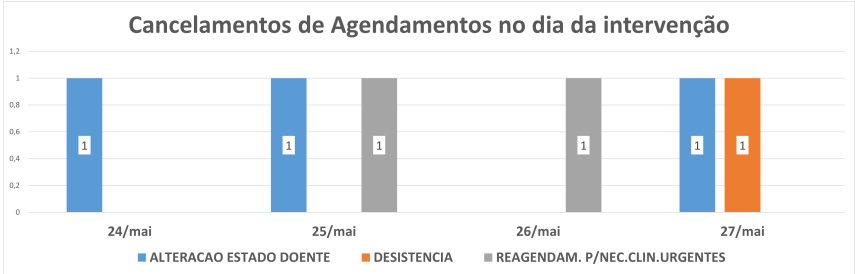
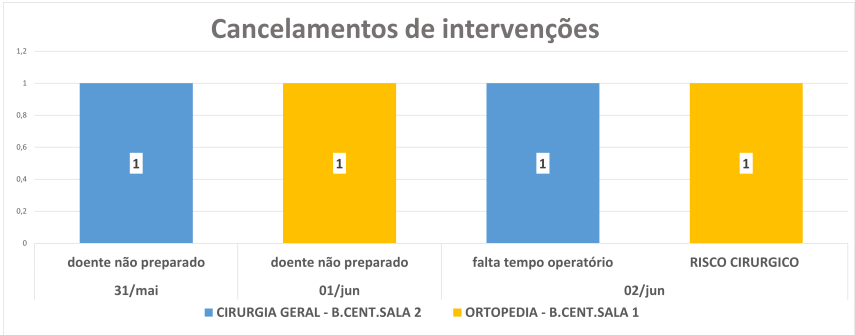
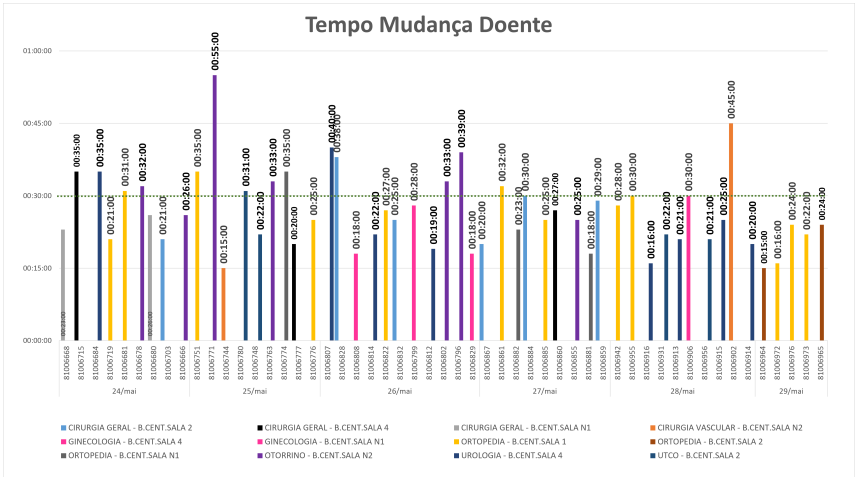


Appendix C

Weekly Indicators for the OR's Management Meeting

The following indicators refer to week 23.





Cleaning Assistants Daily Kaizen Board



Appendix E

Workshop SMED

