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LEAN TOOLS AND STRATEGIC COST MANAGEMENT IN A HOSPITAL UNIT

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Abstract: The objective of this work is to analyze how the use of Lean tools can be applied in the services of a hospital unit, in order to increase its efficiency and reduce its costs, while ensuring the improvement of the quality of the services provided. In addition to the number of users, their journey within the hospital unit's services is a cost generator, so the user's flow through the system must be analyzed to identify, remove or optimize activities that do not add value to the process. The case study took place in two services of the Hospitals of the University of Coimbra (HUC), where the tools used showed results such as: increased quality and safety, improved waiting times, greater efficiency, We concluded that Lean tools can be used in order to optimize resources, improve quality, thus leading to cost reduction in health services.
Keywords: *Lean* in the hospital sector, Value Stream Mapping, Spaghetti Diagram, 5S Methodology, Strategic Cost Management.

INTRODUCTION

The generalization of the right to health to all citizens led to an increase in public expenditure on health. Inherent to this increase is the aging of the population and technological innovation, which, given the current economic and financial situation, causes strong budgetary restrictions in the Portuguese National Health Service (SNS). In this context, the current scenario of cost containment requires a scarcity of resources, which causes a huge impact on the management of health institutions, namely those in the public network.

In addition, citizens are also increasingly demanding, causing increasing pressure on the system, which requires greater cost containment and greater responsibility, in order to maintain high standards of care performance.

To achieve the desired goals and gain competitive advantage, organizations face the challenge of producing more, with less resources, faster and more efficiently. Currently, there is a wide range of tools and methodologies that allow organizations to improve their performance, among which we can highlight the Lean Methodology. Lean thinking is characterized by identifying and reducing all tasks that do not add value, considered waste, while simultaneously adding value to the client and motivating employee participation.

Lean has shown good results both in terms of quality and efficiency; however, in health services this is a sensitive and challenging issue, including achieving efficiency gains without affecting quality.

In short, Lean, through its specialized analysis tools, seeks to redesign organizational processes in order to reduce waste and increase productivity.

LITERATURE REVIEW

The recent past refers to the application of tools *that are* essential for the industry sector, and more specifically for the automotive sector, preferred for its application. However, nowadays there has been a continuous growth in the demand for Lean in the services sector, which are part of the health sector. The application of the methodology in health is taking its first steps and there are still few specialists in this matter, but Lean Healthcare will certainly be a strong and safe strategy, which we must bet on.

Lean is considered an innovative approach to management practices, leading its actions towards the continuous elimination of activities that do not add value, that is, eliminating waste using simple tools. Based on dissatisfaction and continuous improvement, the aim is to achieve process perfection, making time the main competitive weapon. This methodology focuses on the client and

seeks to systematically identify and eliminate all problems that arise. Cumulatively, it guarantees clients the required quality and price standards, thus also gaining competitive advantage and shareholder value.

THE CONCEPT AND EVOLUTION OF LEAN

The expression "Lean" was mentioned for the first time in 1987 by John Krafcik, one of the researchers of the International Motor Vehicle Program - Massachusetts Institute of Technology (MIT), after, together with his team, having analyzed the successful system implemented by Toyota. Krafcik (1998) observed the model developed by Ohno and showed that, compared to large American companies, it required fewer resources and maximized efficiency, productivity and flexibility, through agility and innovation, being able to better face conjunctural changes and market.

The main objective of Lean is to maximize value for end consumers by minimizing waste, that is, creating value for end clients using the fewest possible resources. Since the ultimate goal is perfection, it implies developing the perfect product with 0% waste. This way, a company that implements this system is in a constant search for perfection, in a cycle of continuous improvement.

The Lean Manufacturing concept was developed between 1948 and 1975 and had as its main pioneers Taiichi Ohno, Shigeo Shingo and Eiji Toyoda, who belonged to the Japanese Toyota automotive industry. This concept, then called Lean Thinking, had artisanal production and mass production as antecedents.

With its origins in the principles of Fordism and Taylorism (Oliveira and Holland, 2007) and in the evolution of Quality Management in the USA, which after the 2nd World War emerged as Total Quality Management (TQM), the Japanese adopted it in industry in the post-war reconstruction phase (Janakiraman and Gopal, 2006).

Referring to a post-war period marked by the scarcity of resources, to which the people had to adapt and do a lot with few resources, the theory of "doing a lot with little" was already well established at Toyota, a place where added value of the Lean philosophy was revealed and proven and where the flexibility and speed that were absent until then were acquired. In addition, Toyota still had other competitive advantages, namely the identification and consequent elimination of waste, directing its attention to client satisfaction.

THE PRINCIPLES OF LEAN

Lean Thinking comprises a set of principles that seek to simplify the way a company produces and delivers value to its clients, while seeking to eliminate all waste. It is aimed at the continuous improvement of processes and the focus of means and promotional methods on these improvements.

There are five principles defined in the book "Lean Thinking" and that guide companies when they intend to implement Lean: Definition of Value: Definition of the Value Chain, Optimization of Flows; Implementation of the Pull System (pull); Perfection (or Continuous Improvement).

VALUES AND WASTE IN THE LEAN METHODOLOGY

To understand what waste means, it is first necessary to understand what value means from the client's point of view.

According to Hines et al. (2004), the issue of 'understanding what value means' is appreciated as a strategic issue. Radnor (2011) and Womack and Jones (1996) also recall that specifying value is one of the five principles of Lean. At the operational level, the main doubts are based on the tools indicated to

eliminate waste.

We can define waste as everything that consumes resources but does not add value to the client (Ohno, 1988), so we must eliminate it or reduce it as much as possible. In any type of organization there is waste and, according to Carreira (2005), in addition to not adding value to the product, they can make the client pay more for the product. To identify waste, it is necessary to know all the processes very well.

MAIN TOOLS OF LEAN

There are many Lean tools that can be applied, however their application only makes sense when aligned with a correct implementation strategy. In a first phase, it is important to know how to identify and quantify the problems of organizations, that is, to know how to identify where the losses and opportunities for improvement are, as well as to find the root causes. After this diagnosis, one must choose which improvement tools are likely to be applied to the recognized problems and opportunities; however, it is not always easy to select the best tools to solve the problems in question (Langstrand and Drotz, 2015). According to the authors Machado and Leitner (2010), the choice of problems for Lean implementation must have as beginnings the most inefficient processes or those that entail more costs, examining the system as a whole and paying attention to dependent systems. Also, the inherent characteristics of certain services can hinder the application of Lean tools (Daultani, et al., 2015).

There are numerous diagnostic tools, of which the following can be highlighted:

1. VSM – Value Stream Mapping;
2. Kaizen;
3. 5S methodology;
4. 6 Sigma;
5. Root Cause Analysis (5 Whys; A3 Report; Spine Diagram);
6. Spaghetti Diagram;
7. PDCA cycle;
8. Visual management;
9. Poka-Yoke;
10. Heijunka.

LEAN IN THE HEALTHCARE INDUSTRY

Besides, for healthcare organizations, waste and the need to offer quality care are a real challenge. In recent years, Portugal has experienced a consecutive growth in interest in activities covered by this philosophy (Bendavid et al., 2011). The emergence of the Lean Healthcare concept is due to the numerous authors/researchers who have proposed the implementation of Lean Manufacturing philosophy practices to respond positively to these challenges (Daultani et al., 2013; D'Andreamatteo et al., 2013; Machado e Leitner, 2010; Mazzocato et al., 2010; Poksinska, 2010, Young, 2014)

METHODOLOGY

The case study is the methodology adopted in this work. This methodology is indicated for works where one intends to explain, describe and understand events and contexts involving several factors. For Yin (1994) this is the most used research strategy when we want to know the "how?" and the "why?". As a data collection method, the participatory observational method will be used, as the intention is to generally observe the processes underlying the user's journey, to which Lean tools will be applied.

The application of these tools took place in two services of the Hospitals of the University of Coimbra (HUC), called Service A and Service B. Both services are outpatient and

are intended to carry out diagnostic tests, being located in different physical spaces and integrating different human and technical means. Because it is a reserved matter, the data referring to both services have been adjusted; however, the sequence of activities presented will follow the actual coherence.

In a first phase, and in both services, a framework was made of the initial state, where an attempt was made to identify what the real needs were by observing the various flows and working with the professionals.

The tools used in the two services were different, as they are services with different needs. In service A, Value Stream Mapping (VSM) was used both for the diagnosis phase and for the improvement proposal phase. In service B, the Spaghetti Diagram was used for the diagnosis phase and the 5S Methodology tool for the improvement proposal phase.

CASE STUDY

Based on the theoretical foundation, it was intended to demonstrate how Lean tools were used to explore issues related to the continuous improvement of processes.

The application of these tools took place in two services called Service A and Service B. The data collected during the practical activities are confidential, so that, in accordance with these limitations and because it is a reserved matter, all data referring to both the services were worked as scenarios not corresponding to the true scenario.

In a first phase, and in both services, a framework was made of the initial state, where an attempt was made to identify what the real needs were by observing the various flows and working with the professionals.

Using and analyzing some diagnostic tools, namely Value Stream Mapping (VSM), the stages of the various processes were identified and described, as well as the waste inherent to them. The tools used in the two services were different, as they are services with different needs. As already mentioned, the Lean methodology aims at continuous improvement; in this sense, improvement proposals were also suggested at different times, depending on the identified constraints.

The work is structured, for each service, as follows:

- Brief characterization of the service;
- Observation and analysis of processes with a view to identifying underlying waste based on Lean tools;
- Presentation of proposals for improvements.

SERVICE A

SERVICE CHARACTERIZATION

Service A is an outpatient service, which is intended to carry out complementary diagnostic tests, and aims to ensure a quality service to its users in terms of waiting time on the day of the test.

In terms of physical spaces, this service consists of several sections, the most significant for the case study being: the examination rooms (composed of 12 boxes), the two administrative areas and a waiting room.

This service receives users only on weekdays, between 8 am and 3.30 pm from external consultations, as well as from health centers in the region, and has an integrated laboratory management information system, allowing the entire examination process, from your prescription until the results, is in computer support.

APPLICATION OF THE LEAN METHODOLOGY IN SERVICE A

It was identified by both the UGPD and Service A teams that there were areas where there was room for service improvement.

Thus, the following main problems were identified:

A) Long waiting times for blood collection;

B) Non-compliance with the scheduling of harvests;

C) Communication and signage deficit.

It was pointed out that in the morning, between 8 am and 11 am, there is a large concentration of patients. All the analysis that follows will assume between 400 and 500 patients per day.

With the aim of continuous improvement in the face of existing problems and to identify the main wastes, various activities were carried out, both observation and generation of ideas to solve the identified inefficiencies. It was decided that, given the identified concerns, it would be necessary to make direct observations regarding the process of admitting the user to the counter, the cadence of the tickets and the performance of the exam.

DESCRIPTION OF THE INITIAL STATE OF THE PROCESS

Wherever there is a service provided to a client, there is a value stream. This flow refers to all subsequent tasks that must follow a certain order in order to create value for the user. Thus, the first step will be to understand what has value from the user's point of view. This is the only way to identify which activities add value and which do not, and subsequently eliminate or minimize these "non-value" steps.

The technique used to truly understand user value was direct observation. It was necessary to analyze the user's complete flow to understand the obstacles and intrinsic barriers. The user's complete circuit comprises all stages from the moment of arrival until the moment the examination is completed.

The patient's journey begins when he/she arrives at the Service and has to withdraw a password according to the type of appointment. The possibilities existing in the machine are: password for those who have an appointment, password for those who have priority, password for those who do not have an appointment and password for those who only have to deliver a product. To carry out the collection, the user is obliged to be accompanied by the medical request.

We are thus faced with the following four situations:

- **User with tag:**

In the medical prescription that accompanies the user, there is a field called "Date and Time of Examination" that indicates the scheduling of the examination. In this case, the user can only withdraw the password 15 minutes before the scheduled time. Then go to the upper floor where the waiting room is located and wait for your password number to be called on the screen; at that moment, he goes to the counter and makes his admission with the administrator. Once the admission process is over, the user waits again until his number is called again on the screen, authorizing entry to the box where the exam will be carried out. The process ends when the user leaves the box.

- **Unmarked User:**

This password must be withdrawn by users whose designation in the field "Date and Time of Examination" says "To be Scheduled". There is no limitation of 15 minutes since there is no scheduled time. The rest of the procedure is the same as for the user with an appointment.

- **Priority User - With or Without Appointment:**

Patients considered priority[1] must

1. Priority is given to users with certain pathologies in which they have a defined time to carry out the analysis or are in a certain physical condition.

withdraw this password. The treatment process is the same as that of a user with or without an appointment, this password only serves to signal that the user, for some reason, has priority over the others.

• **Product Delivery:**

When the user arrives, he removes this password and goes to the upper floor. He waits for his turn and goes to the counter to confirm his presence. Then he waits again until his password is mentioned on the screen again, heading to the TSDT to deliver the products for analysis.

After withdrawing the password, the user must wait in the waiting room waiting for his/her call. Two different colors appear on the screen: orange for the call to the counter and blue for the call to the exam room.

From the visual observations made in the initial phase, to understand the flows and procedures, it appears that there will be waiting times between activities, which means that we will be facing a waste. In the Lean methodology all waiting times must be analyzed to verify whether or not they can be eliminated. In health, as in other branches of activity, there are waiting times that services have to deal with because they are absolutely necessary.

Figure 1 shows the set of main activities that integrate the process of Service A, in which the following were defined as actors in the process: The Technical Assistant (TA), the User and the Senior Diagnostic and Therapeutic Technician (TSDT).

DESCRIPTION OF WASTE AND THE INITIAL STATE VALUE STREAM

In this phase, all the steps that make up the process from the arrival of the user to the service until the examination were carried out were identified. To complete this analysis, the time consumption for each step (Processing Time) and between each step were recorded.

Thus, the macro activities of the process were grouped as follows:

1. Call to the counter for user admission
2. Call for the box to carry out the harvest

CALL TO THE COUNTER FOR USER ADMISSION

The first data collection corresponds to the admission of the user, whose task is performed by technical assistants (TA).

The results of the observations of the tasks that make up this process, defined by the team, are compiled in Table 1. The implicit mode in the table does not correspond to reality.

In addition to the tasks described in Table 1, it was also verified that other tasks were carried out that disturbed the workflow, which did not allow fluidity in the admission of patients. These disturbances come from the fact that there is no standardization of work processes, such as, for example, there are other criteria for assigning passwords after the technical assistant attends, who can change the password based on the information available in the information system or on the information made available by the user. Requests for declarations of presence are made, requests for the provision of wheelchairs, scheduling and rescheduling of collections and clarification of doubts.

It was concluded, with regard to the patient admission process, that some of the administrative tasks carried out at the service counter can be replaced by an automated system, since for the patient, going to the counter when service arrives does not add value. That is, although they do not add value to the client, they are necessary to perform the service.

There are, however, some tasks that have to be carried out at the counter so as not to compromise the final result. As an example, we have tasks such as requesting information

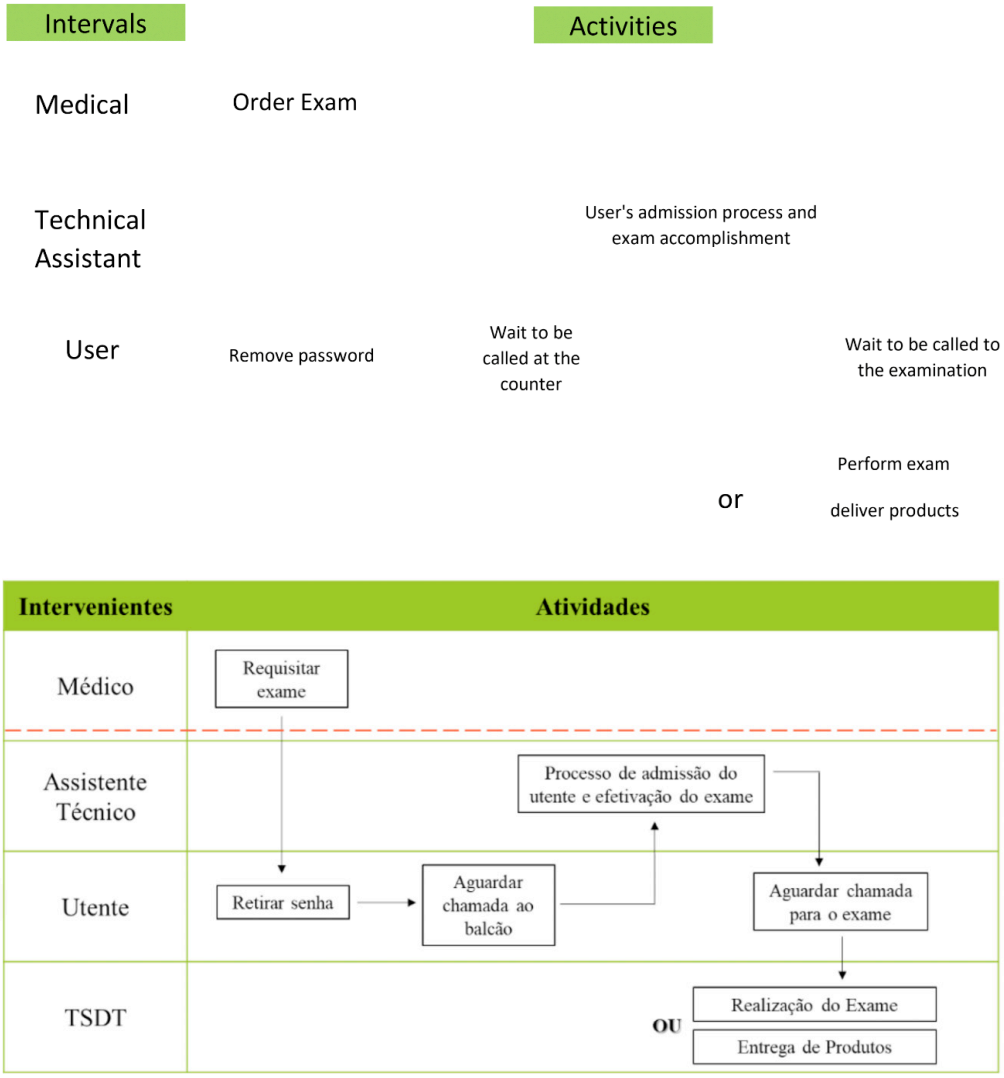

Figure 1-Service Process A

Source: Own Elaboration

Tasks	Order Delivery	Confirmation of the name and registration of the order on the computer	Selection of analyzes (integration) Double confirmation to integrate	Printing labels	
Fashion	0.08	0.13	0.13	0.25	**0.59**
Value and Waste	SVA	SVA	SVA	SVA	**100%**
	pure waste	Waste	pure waste	Waste	
Result	To eliminate	To maintain	To eliminate	To maintain	
Intervening	Technical Assistant (AT)				

VA - Added Value / SVA - No Added Value

Table 1 - Interpretation of the main tasks intrinsic to the admission process

Source: Own Elaboration

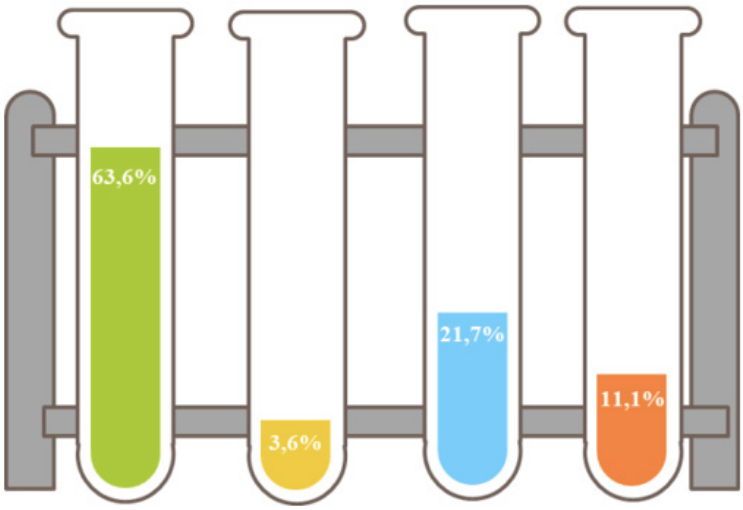

Figure 2 – Total volume of analyzed prescriptions

Source: Own Elaboration

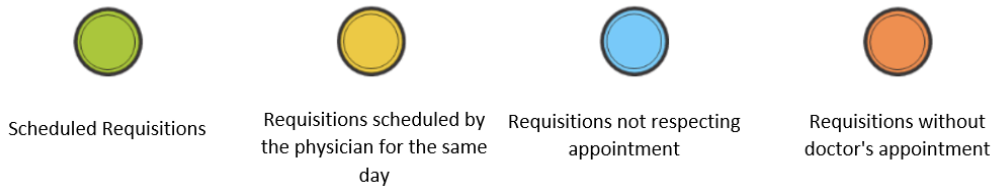

Figure 3 – Caption corresponds to the previous graph

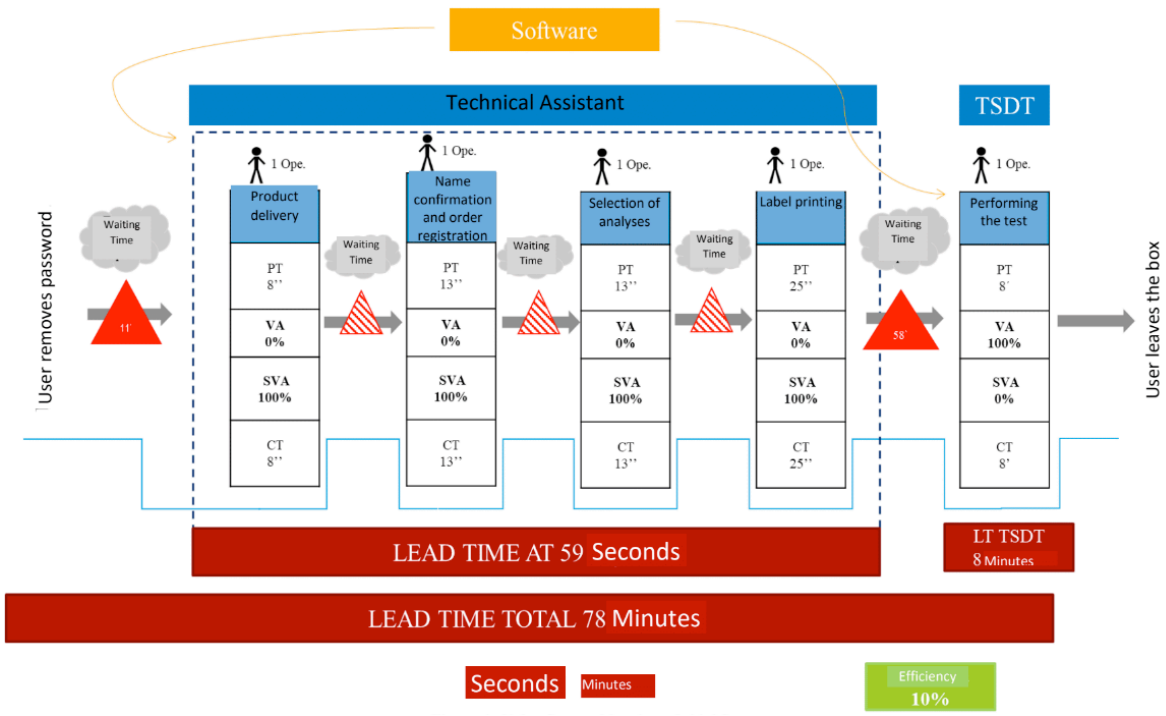

Figure 4 -*Value Stream Mapping - Initial State*

Source: Own Elaboration

or declarations of presence.

CALL TO THE BOX TO PERFORM THE EXAM

The next stage, being a clinical area, had to be carried out by a health professional and with the patient's authorization, for reasons of professional ethics and respect for the citizen. The observation consisted of accounting for the duration of the examination, from the time the user enters until he leaves the box.

This activity is essential to the process, no waste is observed, and thus represents 100% added value. In statistical terms, it is only possible to present what could be the average that each patient takes to be seen in the box, which is equal to 8 minutes.

Besides, as a complement to this study, prescriptions for three different days were analyzed in order to understand the percentage of unscheduled patients who use the service.

- **Prescription Analysis**

Examination requests must be scheduled by the prescribing physician at the time of their prescription, but sometimes this does not happen, which is why the credential referring to the date of the examination contains the designation "To be Scheduled". On the contrary, when the request is made correctly, the credential mentions the day and time at which the exam will take place.

To complement this analysis, it was necessary to understand the volume of daily prescriptions. Figures 2 and 3 illustrate the scenario regarding the analysis of prescriptions:

It is understood as essential to disseminate and raise awareness of the importance of complying with the scheduling rules among the professionals involved, namely with the test prescribers, thus achieving standardization of procedures, better organization of the service and minimization of the percentage of unscheduled exams.

From the study of prescriptions, it is possible to conclude in the first instance that the total number of patients treated per day is clearly lower than the data thought in the initial phase (400 to 500 patients/day). This leads us to question whether the problem is: Lack of resources or lack of planning?

This question will be answered later based on the calculations made.

VALUE STREAM MAPPING (VSM) – INITIAL STATUS

The VSM allows you to document the time of each step, and quantify the activities that generate and do not generate value. Objectively, it consists of identifying the critical processes along the user's journey, from the user's arrival at the service to their departure. The ultimate goal is to design a new map that minimizes or eliminates the identified waste. The analysis of the process is carried out from the perspective of the value chain. This value is identified by client requirements.

The various observations made, carried out from the point of view of the client (user) were recorded and standardized. In Appendix A there is a record of what could have been the observations made and the calculation of the various waiting times between steps, which makes it possible to build the VSM.

Based on the macro activities listed above and in the fashion of the collected times, the map of the current state of the process was drawn, as shown in Figure 4.

- **User admission:** With the observation of the admission process, the Processing Time (PT) was recorded – the time that a stage takes – for each stage inherent to the process. These values are reflected in Table 1 (previously presented), through the mode of each stage, and these values are displayed in the VSM. From the set of steps that make up the

admission process, we conclude that the Lead Time (LT) – total process time is 59 seconds.

- **Conducting the exam:** this process consists of a single step, so the Lead Time will be equal to the Processing Time (PT) being equal to 8 minutes.

When analyzing the current state map (Figure 4) it is possible to observe:

- The total Lead Time is very high (78 minutes = 1h 05minutes);
- 0% added value in administrative admission processes;
- Long waiting times between steps.

After building the VSM, it was possible to identify the problems and possibilities for process improvements, namely eliminating or optimizing the steps that do not add value to the process and thus reducing waiting times. From the user's perspective, the biggest existing problem is the waiting time between the admission process and the collection, which is the main bottleneck on which most suggestions for improvement will fall.

The improvement actions suggested and implemented with a view to eliminating bad processes and waste foresee the creation of standard working methods, always bearing in mind the aspects that are intended with patient safety.

IMPROVEMENT PROPOSALS

Services are usually "pull" systems, because the process is initiated by the client. And from his perspective, the big difference whether a service is well or poorly designed is reflected in the waiting times until its completion. The biggest waste usually found in these processes is the waiting time, so the proposals for improvement are aimed at trying to reduce, in the various stages, the patient's waiting time. In particular, in this service, the most worrying waiting time is between the call to the counter and the call to the box.

This point focuses on suggestions for improving the patient's journey (in lead time), making them spend less time in the service, which translates into shorter waiting times and greater satisfaction, of which the following stand out:

- Elimination of activities that do not generate value;
- Development and application of procedures;
- Automating process steps whenever possible.

In addition to the proposals for improvement that presuppose the elimination of two of the tasks without added value related to the admission process, another proposal for improvement is presented below, this one referring to scheduling.

WEEKLY PLANNING BASED ON THE NUMBER OF APPOINTMENTS

It was identified that it was possible to improve the planning of work based on the data already presented, so it is proposed that there be prior planning on how many boxes must be in operation throughout the day, during the various days of the week. Planning must be organized according to the number of bookings per hour.

For this purpose, it is essential to remove the number of patients scheduled from the information system and plan the opening of the number of boxes according to the number of appointments.

Despite not having the exact number of appointments, in the proposed scenario, 400 patients will be considered.

Scenario option: During the 7:30 am operation, have 5 boxes in operation, and during the peak period (for example: between 8am and 12pm) have 5 more boxes open, that

is, a total of 10 boxes. Then, the calculations and conclusions will be presented in view of the scenario.

Total available minutes= (7.5h x 60min x 5 box) + (4h x 60min x 5 box)

= 3450 min/day

If, on average, the care of each patient takes 8 minutes, it is possible to collect samples from approximately 8 patients per hour.

Capacity = 5 box ×7,5h × 8 sick people + 5 box × 4h × 8 sick people

= 460 sick people per day

After the above calculations, we can conclude that there is no response problem, that is, the laboratory has sufficient resources. Concluding that there is no dilution of patients throughout the day, due to the absence of rules in scheduling, which is why there are complaints.

Solution: Elaboration of a weekly planning procedure including a personnel management table, thus allowing an efficient management of the number of TSDT to be operated, and guaranteeing an adequate response to the patient in terms of waiting time. If bookings are made for the same day, this must only be done based on existing vacancies.

Expected results: Greater dilution of patients scheduled throughout the day, with the objective of reducing approximately 50% of the waiting time (currently it is around 50 minutes to 1 hour, and the intention is to reduce it to 20-30 minutes of waiting), thus increasing satisfaction of professionals and patients.

VALUE STREAM MAPPING (VSM) – FUTURE STATE

It is expected, with the suggested improvements, an increase in the efficiency of the process, as well as a decrease of Lead Time due to the reorganization of the process.

The VSM of the future state is drawn in Figure 5. Then, changes are visible because some of the non-value activities have been eliminated and others minimized, resulting in the reduction of admission time (due to the acquisition of the automated system).

Promising results are expected: Total Lead Time of 28 minutes, that is, a reduction of 36% equal to 50 minutes.[2]As shown in Figure 5, the greatest time savings are obtained by eliminating activities that did not add value, thus improving the efficiency of the process.

MEASURES AND PERFORMANCE INDICATORS USED

The answer to the problem "Is it the lack of resources or the lack of planning?" was based on the data presented initially. One of the basic measures of Lean, the Takt-Time, whose objective is to align production with demand, was calculated, considering the following data:

- Hours of Operation (8am to 3:30pm) = 7.5 hours = 450 minutes
- Demand = 400 patients/day
- Number of boxes available = 10 boxes

$$\text{Takt-Time= "Available time/Search for clients"= } \frac{450 \text{ minutes}}{400 \text{ sick people}} = \textbf{1,125 minutes}$$

Admitting only 1 box in operation with 1 professional, each patient must be attended to in 1.125 minutes, as shown by the calculations made above. That is, every 1.125 minutes a patient must be seen (assistance flow).

$$\text{Takt-Timetotal= } \frac{450 \text{ minutos} \times 10 \text{ boxes}}{400 \text{ doentes}} = \textbf{11,25 minutos}$$

With 10 boxes in operation, that is, with 10 professionals performing collections, each patient can be seen in 11 minutes.

As previously mentioned, the path taken by the patient from entering the collection area to leaving [3]consumes a maximum of 8

2. The duration time of the stages of the VSM –Initial State was maintained, as it is impossible to calculate and estimate the new duration times of the stages, with the new proposals implemente

3. Observation made inside the box by a health professional.

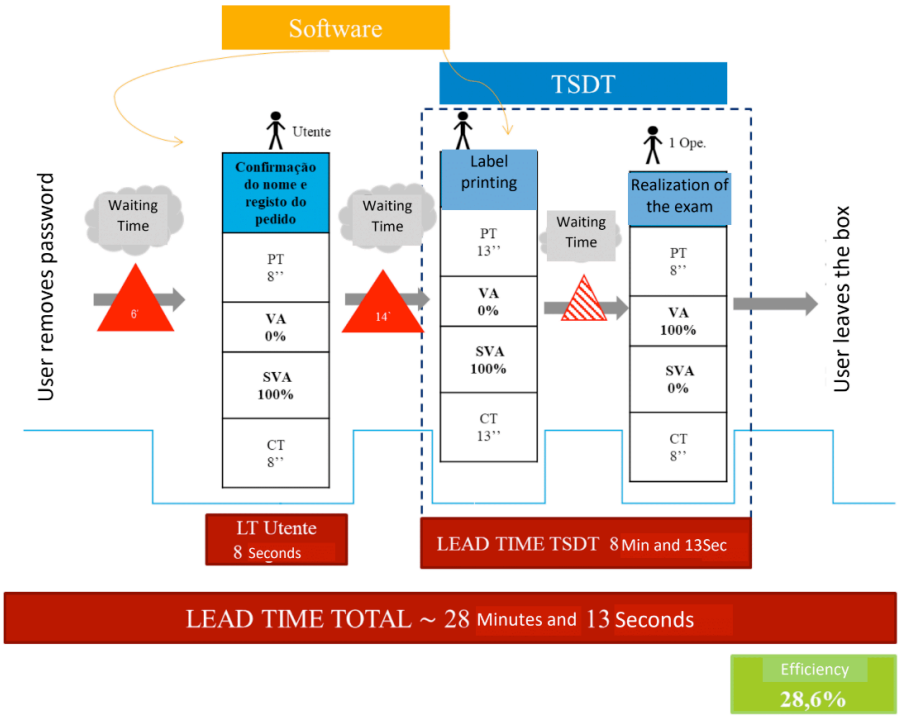

Figure 5 -*Value Stream Mapping -Future State*

Source: Own Elaboration

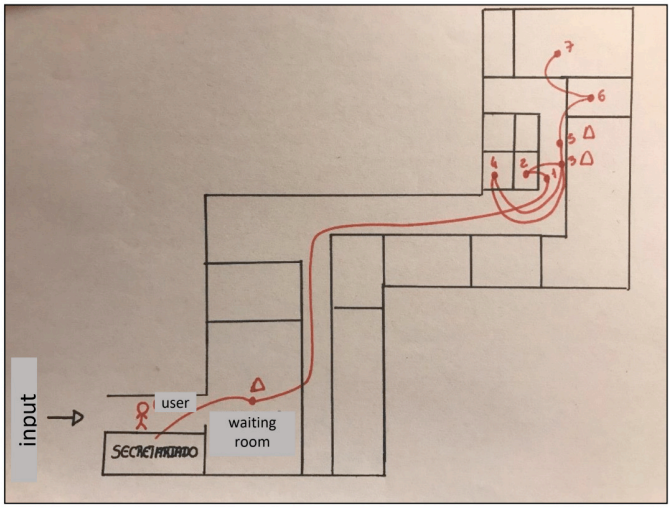

Figure 6 -Application of the Diagram of *Spaghetti in Service B*

Source: Own Elaboration

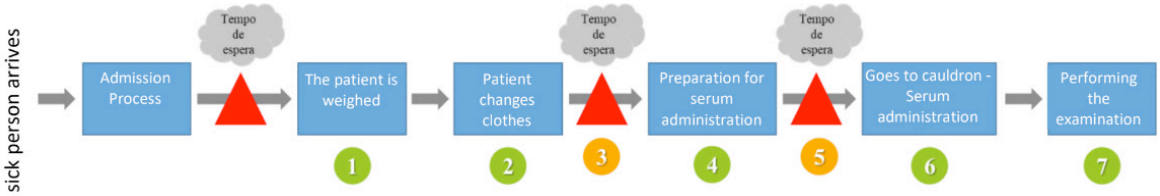

Figure 7 -Path of the patient

Source: Own Elaboration

minutes per patient.

With a daily demand of 400 patients, the laboratory has the installed capacity to attend to all patients and there are still 3 minutes left.

IMPROVEMENT PROPOSALS

IMPROVE PATIENT INFORMATION

It was also found that the information addressed to the patient must be improved, both in terms of the information itself and in terms of appealing design suitable for the elderly population, so that they have all the necessary information until the moment of the examination.

This information must include, in addition to the date, time and place of the exam, also the time before which the password can be withdrawn, the need for fasting or not, the importance of complying with the times defined for the exam and also an adequate explanation regarding how to use the password withdrawal machine.

This information can be prepared in different formats, such as leaflets, videos in the waiting room, information on the prescription, posters, among others.

TICKET DISPENSER MACHINE

It was also understood that the type of passwords must be rethought and reformulated, reducing the number to simplify the process. For example, the ticket machine could be reduced to three options (With Appointment; Without Appointment and Product Delivery). The Priority Ticket must not be deleted, but can be assigned at the counter, upon admission, if the patient falls into one of the situations mentioned above and upon presentation of medical evidence.

RELOCATION OF THE SERVICE DESK

The service counter located in the service waiting room is located next to its entrance. It is considered, from the observations made, that its location is not the most favorable because it causes a large concentration of people at the entrance, with no fluidity. This happens because the first stage of the process is carried out at the counter (admission process).

In order to make the patient's journey more fluid, the possibility of changing the location of the counter was evaluated, possibly to the opposite side, to the back of the waiting room.

It is believed that the suggested changes are sustainable, not increasing costs and adding value to the user's experience in the service. The use of Lean concepts and tools allowed a better understanding of the service's capabilities, the activities carried out and the regular demand. Activities that add and those that do not add value to the value chain were identified. Improvements were suggested, through the application of Lean fundamentals, with the identified waste being mitigated; that is, waiting times were reduced and consequently it was also possible to improve the response to clients' needs, therefore, increasing their satisfaction.

SERVICE B

SERVICE CHARACTERIZATION

Service B is located in the main building and is intended for carrying out complete diagnostic tests, and is divided into the following areas: reception/secretariat; waiting room in which there is a space dedicated to patients of pediatric age and the various examination rooms.

Professionals from the following categories actively participate in this service: physicians, nurses, TSDT, senior health technicians, operational assistants (AO), technical assistants (AT).

APPLICATION OF THE LEAN METHODOLOGY IN SERVICE B

The continuous improvement work in this service will have a different approach, as it was the professionals who felt the desire to improve. The general objective will be to improve the patient's circuit in the service. In this service, scenarios will be created assuming displacements as the greatest waste, so two other tools will be explained, the spaghetti diagram and the 5'S methodology.

SPAGHETTI DIAGRAM

The term "spaghetti" is applied because, when we use a plan of the studied place and draw the trajectories, we will see a series of confusing lines that constantly intersect. The greater the number of lines our drawing has, the more ineffective the layout of that area. This tool allows you to visually identify how movements and displacements are wasteful.

Thus, given its wide use in flow analysis, the spaghetti diagram was used as a tool for analyzing a patient's circuit in the performance of a random examination.

To apply this tool, follow these steps:

1 – Choose the process to be monitored;

2 – Get the detailed plan of the space already updated;

3 – With the blueprint in hand, we begin to follow the process under study. We draw the movements on paper so that there are no "gaps" in the movements. That is, we must not take the pen off the map, so that the lines are continuous and there are no breaks.

4 – Study with the team the possible improvements to be achieved.

You can see the waste in Figure 6[4] when the patient moves to perform the exam:

From the observation it was confirmed that there is a set of physical movements of the patient that originate waste. The survey and analysis carried out made it possible to identify seven steps in the process, shown in the following figure.

This exercise is part of the continuous improvement policy, which suggests optimizing and improving the quality of services provided to users. The patient's circuit is not effective due to the waiting times and the too many trips that the patient is subject to. At this level, we can see that there is a need to adapt the patient's movements, concluding that there would be room, even if small, for improvement.

METHODOLOGY

Based on the observations made and the professionals' enthusiasm in wanting to improve the quality of the service provided, it is suggested that one of the service's workrooms be reorganized, where two different functions are carried out in the same place. In the room in question, interruptions were observed, as another professional was constantly entering, as he had to fetch some papers, which were inside the room.

It is therefore proposed to implement the 5S methodology in this room, in order to generate better use, organization of space and storage of materials. For professionals, it will be reflected in better performance, promoting teamwork and improving the work environment.

In this exercise, you must start by understanding the most functional layout for the room, and the best location for the different work tools. After identifying which work tools are indispensable, those that are expendable and can be eliminated must be selected. Among the essential materials, it is necessary to understand with the professionals who perform this task, which must be the perfect location for them. Another suggestion, which

4. The use of hospital plans was not authorized, so the figure is merely illustrative, not corresponding to the true layout.

would allow for better visual management, would be, for example, to delimit the work areas, with ribbons of different colors, or to draw instruments/materials on the workbench, thus keeping the tools in their proper place, among others.

According to what was studied, it is possible to assume that the implementation of 5S, with the collaboration of visual management tools, would cause profound changes in the service, both in terms of the reorganization of the work environment, and in terms of changing attitudes and ways of thinking of professionals, alerting them to the importance of teamwork. The great impact of applying this methodology would be portrayed through before and after photographs.

IMPROVEMENT PROPOSALS

In this service, the creation of a staff management framework was suggested as a proposal for improvement, explained below.

PERSONNEL MANAGEMENT BOARD

The exams carried out in this service are long-term exams, and one of the needs mentioned by the companions of the users was the lack of information transmitted to them during the exam.

In environments as dynamic as the hospital, where there is rotation between the various professionals and the various examination rooms (24 hours a day, 7 days a week), the technicians also found it difficult to help the companions when asked. Thus, given the need to find a formalized method to better manage and organize the service and communication, a personal management chart was developed, which shows the allocation of different professionals to the various exam rooms, throughout the week. In order to maintain rigor in updating this table, a professional from the service was appointed with this responsibility.

Sheets were cumulatively created, to be filled in by the technicians when calling the patient, with the purpose of being handed over to the patient's companion, indicating the name of the responsible technician and the expected duration of the examination.

The service's concern for the needs of users is evident. According to Lean principles, organizations must let clients "pull" value, depending on their needs. Thus, after analyzing the process and dealing with the existing problems, the service needed to apply management tools that allow for better organization of the service, without at the same time assuming greater satisfaction on the part of patients and their companions.

CONCLUSIONS AND CONTRIBUTIONS

In the implementation of the processes studied, there was some resistance to change on the part of some professionals, although there were others who joined with enthusiasm and a desire to improve, despite the fact that the concept of Lean management was practically unknown in both services.

The tools used showed results in the services where they were applied, such as: increased quality and safety, improved waiting times, clear processes that allow continuous improvements, greater efficiency which corresponds to less waste and a reduction in costs. We therefore conclude that Lean tools can be used in order to optimize existing resources and improve the quality of care provided to users in hospital services.

REFERENCES

Aherne, J., & Whelton, J. (2010). *Applying Lean in Healthcare - A Collection of International Case Studies*. Nova Iorque: CRC Press.

Aslani, A. & Zolfagharzadeh, M. & Naaranoja, M. (2015). Key items of innovation management in the primary healthcare centers case study: finland. *Cent Eur J Public Health,* 23(3):183-187.

Bendavid, Y., Boeck, H., & Philippe, R. (2011). RFID-Enabled Traceability System for Consignment and High Value Products: A Case Study in the Healthcare Sector. *Journal of Medical Systems*, 36(6), 3473–3489.

Carreira, B. (2005). *Lean Manufacturing That Works: Powerful Tools for Dramatically Reducing Waste and Maximizing Profits*. New York: AMACOM. Fujimoto.

Chiarini, A. (2014). Lean Thinking Implementation in The Public Healthcare: Results from Italy. *Liverpool: 17th Toulon-Verona Conference "Excellence in Services"*.

D'Andreamatteo, A., Ianni, L., & Lega, F. (2015). Lean in Healthcare: A Comprehensive Review. *Health Policy,* 119:1197–1209.

Daultani, Y., Chaudhuri, A., & Kumar, S. (2015). A Decade of Lean in Healthcare: Current State and Future Directions. *Global Business Review*, 16(6):1082–1099.

Edwards, K & Nielsen, AP. (2011). Improving Healthcare through Lean Management: Experiences from the Danish healthcare system. *Paper presented at 5th Nordic Conference on Health Organization and Management,* Frederiksberg, Denmark, 13/01/11 - 14/01/11.

Guimarães, C. (2012). *Lean Thinking In Healthcare Services- Learning From Case Studies*. Tese apresentada para obtenção do grau Doutor em Gestão de Serviços de Saúde. ISCTE.

Hines, P., Holweg, M. & Rich, N., (2004). Learning To Evolve: A Review Of Contemporary Lean Thinking. *International Journal Of Operations & Production Management*, pp. 994-1011.

Janakiraman, B. e Gopal, R.K. (2006), *Total Quality Management: Text and Cases*, PHI Learning Private Limited.

Jasti, N. & Kodali, R. (2015). Lean Production: literature review and trends. *International Journal of Production Research*, 53 (3):867-885.

Krafcik, J.F. (1988). "Triumph of the Lean production system", *Sloan Management Review*, Vol. 30

Lapão, L. V. (2016). Lean na Gestão da Saúde: uma oportunidade para Fomentar a Centralidade do Doente, o Respeito pelos Profissionais e a Qualidade nos Serviços de Saúde. *Revista Cientifica da Ordem dos Médicos*, 237-239.

Langstrand, J. & Drotz, E. (2015). The Rhetoric And Reality Of Lean: A Multiple Case Study. *Total Quality Management & Business Excellence*, 27(3-4):398-412.

Machado, V., & Leitner, U. (2010). Lean tools and Lean transformation process in health. *International Journal of Management Science and Engineering Management*, 5(5): 383–392.

Mazzocato, P., Savagem, C., & Brommels, M. (2010). Lean Thinking In Healthcare: A Realist Review Of The Literature. *Qual Saf Health Care*, 19:376-382.

Nash, M., & Poling, S. (2008). *Mapping The Total Value Stream: A Comprehensive Guide For Production And Transactional Processes.* NY: CRC Press.

Ohno, T. (1988). *Toyota Production System: Beyond Large-Scale Production, Portland*, OR: Productivity Press

Oliveira, T.C. e Holland, S. (2007), "Alternative paradigms of hospital work organization and health provision", *Revista Portuguesa de Saúde Pública*, Vol. 25, Nº 1, pp.19-37

Poksinska, Bozena (2010), The Current State of Lean Implementation in Health Care: Literature Review, *Quality Management in Health Care*, Vol. 19 (4): 319-329.

Radnor, Z. (2011). Implementing Lean In Health Care: Making The Link Between The Approach, Readiness And Sustainability. *International Journal Of Industrial Engineering And Management* (IJIEM), 2(1):1-12.

Simon, R.W. e Canacari, E.G. (2012). A Practical Guide to Applying Lean Tools and Management Principles to Health Care Improvement Projects, *AORN Journal,* Vol.95, (1): 85-103.

Yin, R. (1994). *Case Study Research: Design and Methods* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Young, F. (2014). The Use Of 5s In Healthcare Services: A Literature Review. *International Journal of Business and Social Science*, 5 (10), September.
Waring, J.J. and S. Bishop, (2010). Lean Healthcare: Rhetoric, Ritual And Resistance, *Social Science & Medicine*, 71(7): 1332-1340.

Womack, J. P., & Jones, D. T. (1996). Lean Thinking: Banish Waste and Create Wealth in your Corporation. New York, USA: Simon & Schuster. Womack,

ANNEX A: RECORDS OF OBSERVATIONS MADE

	Number of notes	1	two	3	4	5	6	7	8	
	Time you removed the password	09:43	8:18	9:46	09:19	09:20	10:37	10:45	10:46	
	Time at which the user was called	09:46	8:44	10:13	09:30	09:31	10:48	10:48	10:48	
	Time you were called to the box	10:39	9:10	10:34	10:24	10:27	11:46	11:46	11:46	
	Time it came out of the box	10:48	9:14	10:37	------	------	------	------	------	
										FASHION
waiting times	Withdraw Password - Call at the Counter	00:03	0:26	0:27	0:11	0:11	0:11	0:03	0:02	**0:11**
waiting times	Call from the Counter - Call to the Box	00:53	0:26	0:21	0:54	0:56	0:58	0:58	0:58	**0:58**
waiting times	Box entry - Box exit	00:09	0:04	0:03	------	------	------	------	------	
waiting times	**TOTAL Waiting Time**	**01:05**	**00:56**	**00:51**	**01:05**	**01:07**	**00:59**	**01:01**	**01:00**	

	Number of notes	9	10	11	12	13	14	15	
	Time you removed the password	8:37	8:49	8:26	8:30	8:42	11:40	09:44	
	Time at which the user was called	8:48	8:53	8:41	8:44	8:48	11:56	09:50	
	Time you were called to the box	9:05	9:25	8:52	9:00	9:02	12:09	10:04	
	Time it came out of the box	------	------	------	------	------	12:12	------	
									FASHION
waiting times	Withdraw Password - Call at the Counter	0:11	0:04	0:15	0:14	0:06	0:16	0:06	**0:06**
waiting times	Call from the Counter - Call to the Box	0:17	0:32	0:11	0:16	0:14	0:13	0:14	**0:14**
waiting times	Box entry - Box exit	--------	------	------	------	------	0:03	------	--------
waiting times	**TOTAL Waiting Time**	**00:33**	**00:36**	**00:26**	**00:30**	**00:23**	**00:32**	**00:20**	