

Design and Implementation of a New Commercial Network to Improve Operations in a Clinical Diagnostics Company

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Abstract

Private healthcare services operate in an extremely challenging context. In recent years, this market has suffered a big growth in supply and a concentration of demand due to subsystems linked to public and private insurance. This scenario imposes strong restrictions on the profitability of private healthcare operators, as well as in their viability. Operational efficiency and productivity gains become the most critical factors in the strategy of companies operating in this sector.

Since the Company under analysis is operating in this market and has grown through mergers and acquisitions, it aims to increase the volume of business and decrease operating costs. Therefore, the aim of this dissertation arose from the possibility of opening an innovative diagnostic center, relying on a customer journey transformation with support of digital tools.

The main focuses of the study were the mapping and restructuring of some existing processes, eliminating errors and waste, the implementation of management tools and solutions to improve the customer's flow in units and the design of the layout of the new diagnostic center and the improved customer journey.

The digital improvements were tested and validated in other operating diagnostics centers. All of the improvements developed will ensure a pleasant customer experience.

In order to design all these solutions, as well as to implement a culture of continuous improvement in the team, the main constraints and opportunities for improvement found were registered and analyzed, to guarantee their success. Lean concepts were presented in the design of the layout and in the restructuring of processes. At the end of these implementations, it was necessary to ensure the adaptation of all employees through tracking their activities.

An increase in productivity is expected, a more effective definition of flow and decrease in activities that do not add value. Furthermore it is expected the inclusion of new digital medical care features in the company's app, as well as the expansion of the idealized concept of diagnostic center to other regions of the country.

Resumo

Desenho e implementação de uma nova estrutura comercial para melhorar as operações numa empresa de diagnóstico clínico

Os prestadores de serviços de saúde privados operam num contexto extremamente desafiante. Os últimos anos registaram, por um lado, um forte aumento da oferta neste mercado, e, por outro, revelaram uma concentração da procura, principalmente devido à existência de subsistemas ligados aos seguros públicos e privados. Este cenário impõe fortes restrições à rentabilidade dos operadores privados de saúde, quando não coloca em causa a sua viabilidade. A eficiência operacional e consequentes ganhos de produtividade tornam-se, assim, num dos fatores críticos na estratégia das empresas que operam neste setor.

Estando a Empresa em análise a operar neste mercado e tendo crescido através de fusões e aquisições de outras empresas, tem como objetivo aumentar o volume de negócio e diminuir os custos operacionais. Surge assim a oportunidade de abrir um centro de diagnóstico inovador, assentando numa nova jornada do cliente, cuja transformação foi feita com base em melhorias e ferramentas digitais.

Os principais focos do estudo desta concentração foram o mapeamento e reestruturação de alguns processos existentes, eliminando erros e desperdícios, bem como a implementação de ferramentas de gestão e soluções que melhoram o fluxo dos consumidores nas unidades e o desenho do layout do novo centro de diagnóstico, bem como a jornada do cliente otimizada.

As melhorias digitais implementadas foram testadas e validadas para servirem de base nestas modificações. Todas estas medidas serão desenvolvidas com o propósito de garantirem uma experiência que agrade ao cliente e o atraia.

Para desenhar todas estas soluções, bem como implementar uma cultura de melhoria contínua na equipa, foram levantados e analisados os principais constrangimentos e as oportunidades de melhoria encontradas, de forma a garantir o sucesso dos mesmos. Foram apresentados conceitos lean no desenho do layout e na reestruturação de processos. No final destas implementações mostra-se necessário assegurar a adaptação de todos os colaboradores através do seguimento das suas atividades.

Estimam-se resultados que potencializem a produtividade, um desenho mais eficaz dos fluxos e uma diminuição de atividades que não acrescentam valor. Espera-se também a inclusão de novas funções digitais de acompanhamento clínico na app da empresa, tal como a expansão do centro de diagnóstico conceptualizado a outras regiões do país.

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"Visualization gives you answers to questions you didn't know you had."

Ben Schneiderman

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Acronyms and Symbols

M&A	Merger and Acquisition
MMM	Mission, Motto and Mantra
BU	Business Units
B2C	Business-to-consumer
PLT	Process Lead Time
KPI	Key Performance Indicator
CEM	Customer Experience Management
CJM	Customer Journey Mapping
TPS	Toyota Production System
VOC	Voice of Customer
CVA	Customer Value Added
BVA	Business Value Added
VSM	Value Stream Map
JIT	Just in Time
PLT	Process Lead Time
WiP	Work in Progress
SLA	Service Level Agreement
NPS	Net Promoter Score
FTE	Full-Time Equivalent
PDCA	Plan Do Check Act
CAPEX	Capital Expenditure

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Chapter 1

Introduction

This dissertation is part of a project carried out in a business environment at Unilabs Portugal. The objective comprises the restructuring and mapping of the customer journey, along with the processes associated to it, with the aim of creating a project that may be suitable for the opening of a new concept of a diagnostic center in Porto.

The search for solutions for a better diagnosis has been developing over the years. As medical science lengthens average life expectancy it also leads to an increase in the ageing population, which implies a greater number of clinical evaluations. These lead to an increase in the number of diagnostic tests.

One of the main focuses of health systems is to balance the objectives, namely by combining the reduction of costs with the improvement of the efficiency and speed of the processes and, in addition, with the elimination of errors and waste. These measures promote a better quality of service, which is the ultimate goal of the company, to add value to the customer.

1.1 Unilabs Group International

1.1.1 Mission and Vision

Unilabs was born in 1987, founded through takeover of three Swiss labs and has grown rapidly ever since, following a strategy of acquiring high-quality partner laboratories across Europe, allowing an organic growth. In 2007, Unilabs merged with major imaging diagnostics company Capio, whose reach encompassed Sweden, Norway, Finland, Denmark and the UK, positioning Unilabs as the undisputed European leader in diagnostics. The company continued to grow their business, and their portfolio of cutting-edge diagnostic services, moving from a European business to a worldwide operator.

Recognised by a strong performance in controlling costs and organic growth, Unilabs formulated a corporate culture and ambitious Merger and Acquisition's (M&A) strategy in 2017. This led to what is known by the company's Mission, Motto and Mantra (MMM), described below in Figure 1.

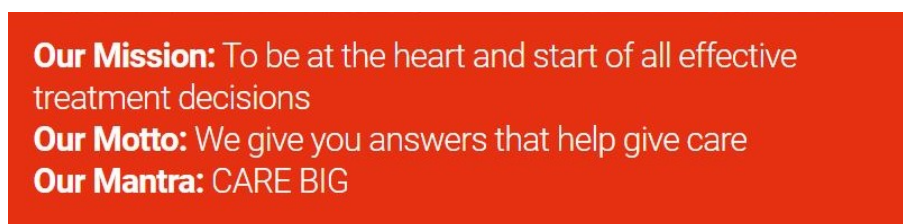


Figure 1: Unilabs Mission, Motto and Mantra

CARE BIG and the culture building behaviours encourages the company to focus on the needs of the customers and reminds them that their ultimate goal is not simply processing samples, but finding answers that help improve people's lives. By combining their broad range of locations and services with this philosophy, Unilabs advances diagnostic expertise and services around the world.

Currently, Unilabs is present in 17 countries, counting with more than 12000 employees worldwide. The annual sales exceed €1 billion, supported by 150 imaging centres and over 250 laboratories.

1.1.2 Unilabs Group Portugal

Unilabs journey in Portugal started in 2006 with the acquisition of 85% of *Medicina Laboratorial Dr. Carlos Torres*. Unilabs Portugal grew rapidly by constantly acquiring laboratories and partners spread all over the country, aligned with their strategy of M&A, which led them to consolidate a well-defined position in the national healthcare diagnostic market.

In 2017, Unilabs acquired *Base Holding*, which was a leader in integrated clinical diagnostic, thus extending their diagnostic portfolio to Radiology and reinforcing the presence in Portugal, becoming a leader in the provision of complementary means of diagnostic.

Currently, Unilabs operates in 7 different areas, which are cardiology, clinical analyses, radiology, pathological anatomy, nuclear medicine, gastroenterology and medical genetics. These *Business Units* (BU) involve more than 3500 contributors and the annual medical acts registered exceed 24 millions.

1.1.3 Network Management at Unilabs

With a variety of *Business Units* included in Unilabs operations, in order to reach all the people in need of medical services, Unilabs has fortified its presence all over the country with a wide number of care units, composing a strong network, fitted into a Business-To-Consumer (B2C) model that plays an important and significant role in the company's mission.

Any business that relies on B2C revenue streams must maintain a good relationship with their customers and elicit an emotional response to them. The Department of Customer Experience is the responsible of the Unilabs Network Management, to ensure that the relation customer/unit develops the best way possible, being among its priorities, the customer's trust and the care unit processes efficiency.

The present Network counts with more than 1000 care units around the country integrated in 7 different areas of business: cardiology, clinical analysis, radiology, pathological anatomy, nuclear medicine, gastroenterology and medical genetics. In order to maintain a healthy information flow and a communicable structure, the network is organized in clusters as presented in Fig. 2.

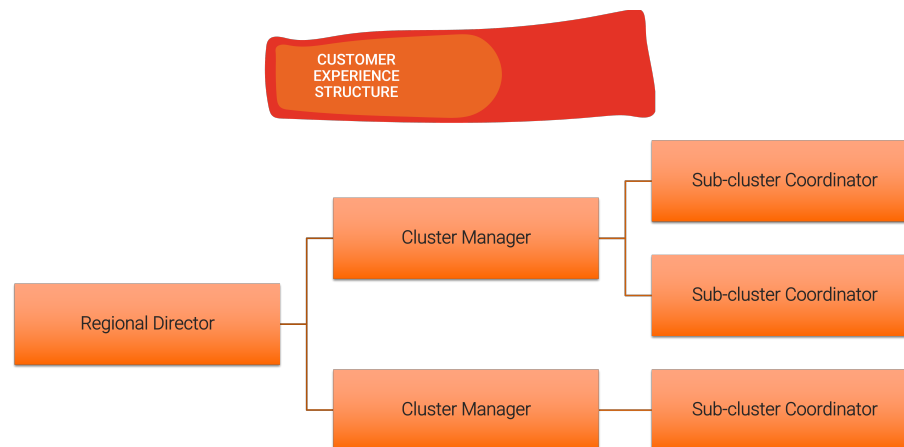


Figure 2: Customer experience department hierarchical structure

As in every business, in the management of Unilabs Network, there is always margin for development to maintain a culture of continuous improvement. Providing a quick and efficient diagnostic in healthcare is key to prevent health complications by acting rapidly in treatment needed and to improve general health conditions. If the network focuses on customers and processes associated to each Unit, different gaps and inefficiencies in the medical service provided can be identified. To understand better how these problems can be mitigated, it is important to identify and define the entire Customer Journey, the information flow associated to it and subsequently measure and plan the standard unit ideal process flow.

1.2 Project Context

The present project takes part in defining the Customer Journey in healthcare diagnostic, the customer's data processing and the flow generated by them in a care unit. This initial determination is essential to have a better visualization of the improvements that can be made and exactly where in the processes they can be implemented.

It is expected to optimize the Customer Journey and the customer's data processing by identifying and reducing waste and activities that do not add value to the customer. While living in an era where the resort to digital support is growing, there is a transition to digital tools and processes that is implied with this remodeling. The use of digital alternatives in providing medical services has a lot of advantages such as eliminating unnecessary paper, which is one of the most used materials of support and information record, allows a bigger autonomy in processes and it works as

an exceptional connecting bridge of information between different stakeholders in order to turn the value chain as organic as possible.

Therefore, the transition to digital processes in the value chain need to be considered and is fundamental in the optimization of the matters referred above.

Finally, implementing a solution to the gaps and inefficiencies identified, while balancing all of these factors, will generate a new and improved flow for a standard care unit. The result and final goal of the project is to design and present an optimized layout, able to provide a more efficient and reliable experience to the customer, which is also the main and final objective of the company.

In sum, the project objectives are to find gaps and activities that to not add value to the customer nor to the company and implementing digital improvements, in order to turn the customer experience more autonomous, while improving operational efficiency in a care unit. At last, the project aims to include and apply these improvements on the design of a new diagnostic center, that provides an optimized and more digital customer experience.

1.3 Methodology

The present project follows a structure divided into four stages:

1. Study and overview of different Care Units with high demand of service and considerable flow of customers, in order to choose the adequate object of study for the next steps;
2. Detailed analysis of the entire Customer Journey and the customer's data processing, with support in the elaboration of a visual representation of the value chain, measurement of each *Process Lead Time (PLT)* in it and attribution of responsibilities to each activity;
3. Identification of gaps and inefficiencies in the value chain that can be eliminated or dematerialized and substituted by digital support, to subsequently achieve a paperless and optimized Customer Journey;
4. Design and implementation of a Care Unit layout, having into account the development of an ideal Customer Journey and the flow generated by it.

In figure 3 it is possible to visualize a timeline of the tasks performed in the project:

#	Description	Weeks																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Process contextualization and range definition																		
2	Definition and analysis of the AS-IS customer journey																		
3	Analysis and evaluation of care units flows																		
4	Digital improvement opportunities and layout design																		
5	Discussion of improvements and next steps																		

Figure 3: Timeline of tasks to execute

1.4 Dissertation Structure

The topics covered in the thesis are structured as follows:

- **Chapter 1** - Provides a brief introduction to the company's context where the thesis is inserted and a general overview of the project context and structure;
- **Chapter 2** - Reviews the theoretical framework of the most relevant themes and tools to be developed and implemented throughout the thesis;
- **Chapter 3** - Presents the As Is situation of the project developed in the Company, in great detail, reporting the first practical analysis made, outlining the most relevant problems and summarizing the improvements to be made;
- **Chapter 4** - The implementation of the improvements and solutions defined take place in this chapter. It is also where the design of a layout, to implement an optimized Customer Journey ensued by these results, is presented, with a further explanation of its development;
- **Chapter 5** - Shows and discusses the results of the solutions implemented for the considered analysis. A final reference to prospects of future work and improvements in the entire department is made.

Chapter 2

Bibliographic Review

In order to proceed with an accurate description of the project, it was developed a theoretical framework about the key concepts and the essential steps inherent to the main topics covered in the dissertation.

The study begins by describing the customer experience, evidencing the different phases of it and highlighting the best practices in studying and defining the pathway in order to deliver positive customer experiences. In addition, it is carried out an analysis to the *Lean* methodology, detailing its application in the healthcare industry, evidencing relevant information concerning the topics covered along the dissertation, followed by a theoretical support base of the digital transformation in healthcare. Finally, the most relevant key performance indicators (KPIs) to sustain future procedures are addressed and described.

2.1 Customer Experience

Customer experience focuses on the relationship between a business and its customers. It includes every interaction, no matter how brief and even if it does not result in a purchase.

Whether it is a call to a contact center, exposure to an ad, or even something as mundane as the payment of a bill, every exchange between customers and businesses builds (or damages) the relationship. Customer experience involves every way a customer interacts with a company, at all stages of the customer journey.

According to Lemon and Verhoef (2016), understanding customer experience and the customer journey over time is critical for firms, as customers now interact with firms through countless touch points in multiple channels and media, and customer experiences are more social in nature. These changes require firms to integrate multiple business functions, and even external partners, in creating and delivering positive customer experiences.

2.1.1 Customer Experience Management

Customer experience management is the process of strategically managing a customers' entire experience with a product or company. It consists of five steps (Lemon and Verhoef (2016)):

1. Analyzing the experiential world of the customers;
2. Building the experiential platform;
3. Designing the brand experience;
4. Structuring the customer experience;
5. Engaging in continuous innovation.

According to Grewal et al. (2009), it is fundamental to understand the customer in order to succeed in retail. First it is important to review and analyze past customers' experiences to recognize the possibilities for the future experience, while considering an holistic perspective that includes the different responses to the retailer - cognitive, affective, emotional, social and physical. The experience a customer has when interacting with a firm is created by a variety of factors, such as the price, service interface and environment, which are controllable by the retailer but also by some other factors outside the retailer's management and control, such as the influence of others or the motive of consumption. Therefore, the Customer Experience Management (CEM) must be aligned with a strategy that benefits both the customer and the company, that goes beyond the service interactions and customer-provider duo.

CEM can be studied under three disciplinary perspectives (Kandampully et al. (2018)):

- **Marketing:** Scholars in this area focus on studying the beneficial actions of creating an improved customer experience. In many cases, studies are oriented to connect the customer experience to the management of customer relationships in multichannel environments;
- **Operations:** This perspective focus on providing more efficient and smoother processes, when experiencing the entire service;
- **Human Resources:** Highlights the importance of the employees mindset and providing appropriate training, focusing on high service-level interaction, being a critical factor for managing the customer experience.

On that account, a conceptual framework is necessary to include every fundamental elements of the customer experience in CEM strategies (see Figure 4). In fact there are many factors that influence the customer's experience. Since the moment a customer gets in touch with a brand until the last instant of contacting with it, everything is unintentionally evaluated and essential in creating the best/worst customer experience. By that, companies can not only focus on the elements that directly affect customer's perception of the business such as the price and the service interface, but also on the ones that involve them during all their journey such as the social environment. Finally, the previous customer experience is crucial when repeating (or not) the service. Actually, the past experience is critical in shaping customer's idea about the service level agreement (SLA) and the quality of products.

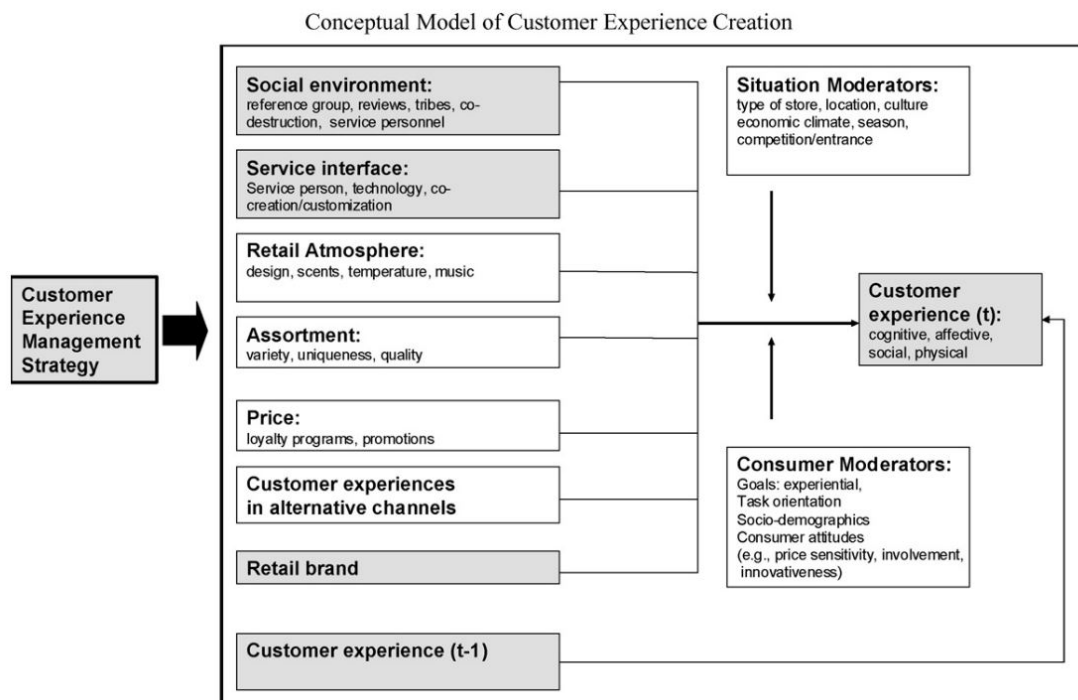


Figure 4: Conceptual model of customer experience creation. Source: Verhoef et al. (2009)

2.1.2 Customer Journey Mapping

The understanding of the customer's journey is fundamental when studying the customer experience. In a customer journey analysis, firms usually focus on the interaction of customers with multiple touch points, in order to understand the customer behaviour towards the options and choices available in multiple purchase phases.

The first step toward creating a customer journey map, and making sure customers are satisfied every step of the way, is identifying the touch points, which are represented by any interactions a customer has with a brand - before, during and after a purchase. It is important to identify critical touch points throughout the customer journey that have the most significant influence on customer outcomes (Lemon and Verhoef (2016)). In order to understand the customer journey proposition and the possible service *TO-BE*, it is first necessary to map the *AS-IS* customer journey, addressing implemented service processes and data collection with customers, to map the journey from a customer perspective, as a customer-oriented management philosophy is the key for competitive advantage of organizations (Tseng et al. (1999) Følstad and Kvale (2018)). In Figure 5 follows a general idea of how service operations can be improved through customer journey mapping (CJM).

Customer journey mapping (CJM) (Rosenbaum et al. (2017)) is a well-known technique that focuses on assessing how customers interact with a company or organization. This allows the gain of a deeper knowledge about the customers' perceptions, and becomes an essential tool to improve the overall customer experience. This knowledge can be used to generate competitive advantage

and satisfied customers (McColl-Kennedy et al. (2019)). Understanding each step required to complete a process (customer paths), and how customers interact with a company's services throughout that journey are key aspects to assess customer needs, the ability to improve them, and the delivery of great products and services. During a journey, customers can interact with a company through different methods or channels (e.g., on-line, phone call, etc.), go through different stages, and face specific business context factors. A widely known engineering technique used as supporting tools are the process mapping techniques based on combining graphics and text that are then presented in an organized way, consisting of a set of processes flow diagrams (Tseng et al. (1999)) Recently, companies in several industries embarked in a transformation to take advantage of the benefits of new digital technologies. This digital transformation may impact key business factors, customer relationships, as well as products, services and processes (Matt et al. (2015)). In healthcare, there is a particular interest in a correct and efficient execution of both clinical and business processes. However, it is widely known that healthcare processes are often challenging due to their complexity, dynamics, and sometimes owing to their ad-hoc nature and multiplicity of disciplines involved (Homayounfar (2012)). Hospitals usually embrace standards to ensure the quality of healthcare processes. As a consequence, the identification of typical and non-typical patient journeys, and the monitoring compliance (process deviations) with hospital policies and standards become a focus of interest.

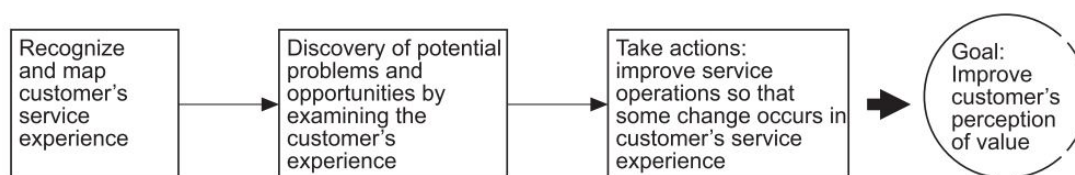


Figure 5: Process mapping technique to improve service operations. Source: Tseng et al. (1999)

2.1.3 Digital Transformation

Customers seek to engage with service brands and interact with service organizations that enable superior experiences (Lemon and Verhoef (2016)). Technological developments are changing the capabilities of service organizations and systems and transforming the customer experience. This is leading to the incorporation of routine knowledge and behaviours that are simplifying tasks and freeing up resources for deliberate action (Sharma et al. (2018)).

Online purchases and transactions have become widely accepted alternatives to the physical act of shopping. The effort to integrate healthcare, utilizing applications, strengthens value and enhances the customer engagement (Thuemmler and Bai (2017)). A customer's experience with a brand involves various touch points across the prepurchase, purchase and postpurchase phases of the customer journey and mobile device channels offer new location-based, time-sensitive opportunities to create firm-initiated touch points (Lemon and Verhoef (2016)).

Launching a branded mobile app allows it to be involved in direct and indirect interactions between the customer and the brand and when designing it, there must be considered attributes having into account the main challenge of the customer experience transition that is undergoing in healthcare - bringing together the digital, physical and social domains (Bolton et al. (2018)). When designing an app, there are features that are necessary to include for involvement of various customer behaviours such as awareness, evaluation, payment, usage and loyalty. *Personal-oriented features* are based on interactions between the customer and the brand, enabling users to search for information related to their interests and *transaction-oriented features* that focus entirely on the purchase phase of the customer journey, providing a more autonomous process to the customer and firm, creating value for both and offering important touch points (Boyd et al. (2019)).

Despite the myriad of challenges, there are several potential solutions counting with digital health technologies that can accelerate the incorporation of these in healthcare delivery and clinical trials, requiring a complex and collaborative work between stakeholders (Sharma et al. (2018)). In Figure 6 it is shown a framework for stakeholder relationship for the use of digital technology in healthcare:

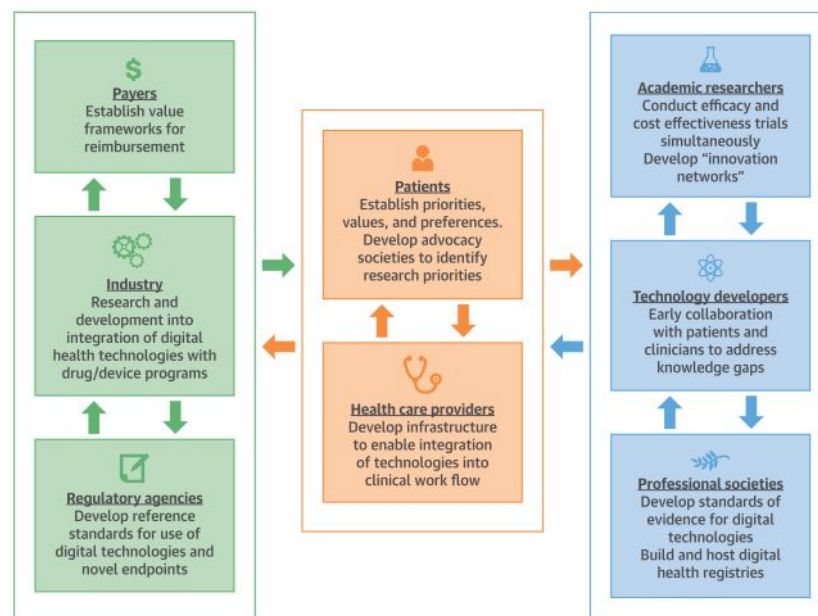


Figure 6: Framework for Stakeholder Relationship for the Use of Digital Technology in Healthcare. Source: Sharma et al. (2018)

2.2 Lean Methodology

The origin of Lean comes from what was later called the *Toyota Production System (TPS)*. It was developed by Taiichi Ohno, with the objective of increasing production efficiency by eliminating every form of waste. Lean recognizes seven types of waste which are transportation, inventory, motion, waiting, overproduction, over-processing and defects (Tempelman and Schildmeijer (2018)).

The lean methodology is based on five principles (Tempelman and Schildmeijer (2018)):

1. **Specify value:** The first step for an organization to improve its processes is determining the Voice of the Customer (VOC), which is made by determining who the customer is and what this customer expects from the process. Besides that, it is necessary to define the various activities in a process, which can be assigned to one of three categories: Customer Value Added (CVA) which deliver added value, Business Value Added (BVA), that do not add customer value but are necessary to the company and Waste, which serves no useful purpose and should be eliminated;
2. **Identify the value stream:** Provides a better insight into the entire production process, by making a Value Stream Map (VSM), which is a process modelling technique that is aimed at making improvements by mapping elements of waste in the production process;
3. **Create flow:** Guarantee that every step adds value - in a production process there is *Flow* when all the steps follow one another without waiting periods, defects or having to redo things;
4. **Let the customer pull value:** Focuses on minimizing the inventory and directly connecting to the customer demand, driven by actual customer consumption;
5. **Pursuit of perfection:** Applying all the principles mentioned above in order to create a cycle of continuous improvement, by finding more ways to eliminate waste.

2.2.1 Lean Toolbox

Currently, production industries use a variety of resources to improve productivity, stabilize the resources allocation and the work environment, using tools to optimize the processes and obtain good results to be able to provide for the actual demand. Companies need to connect the tools to lean techniques.

The basis of the Toyota Production System is the absolute elimination of waste. To support this system Just-In-Time (JIT) is an important pillar, representing the ideal state from the standpoint of production management (Taiichi (1990)). JIT indicates that production only takes place when there is an actual order, to prevent overproduction and inventory and therefore delivering exactly the right amount at exactly the right time, avoiding unnecessary inventory (Tempelman and Schildmeijer (2018)). Balancing processes is essential for flow to be realised, and for that there are two important variables:

- **Process Lead Time (PLT):** Depends on the *Work in Progress (WiP)* divided by the exit rate, indicating the latency between the initiation and completion of a process;
- **Takt Time:** Indicates the pace of production needed in order to meet customer demand. It can be calculated by dividing the available time for the customer demand, being independent of the number of people working in the process.

The ideal situation is when the *process time* of the various work cells are equal to the *Takt Time*, allowing for a continuous production flow. In Figure 7 the line balancing is outlined and explained with further detail below.

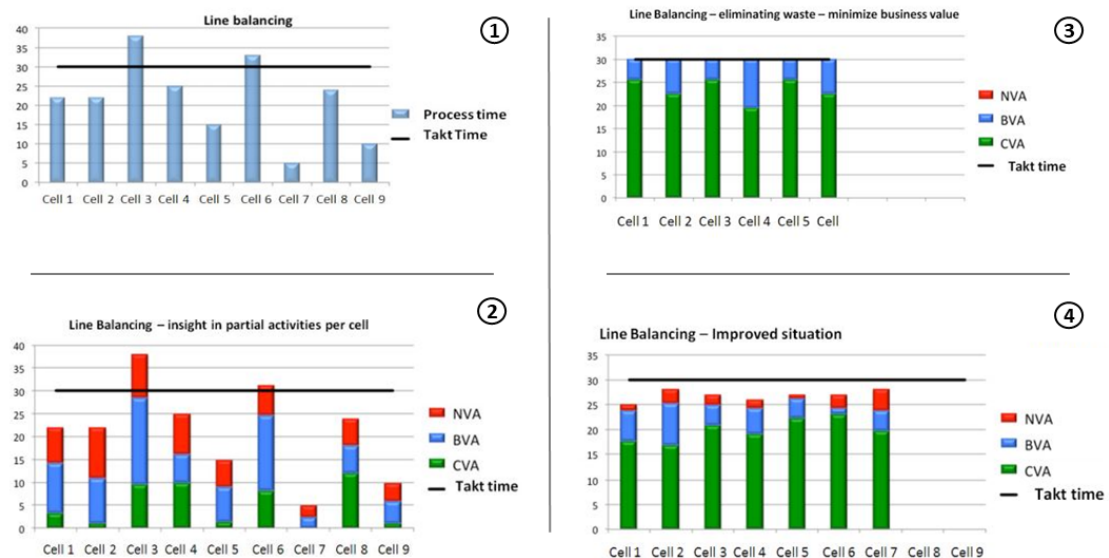


Figure 7: Line Balancing of Processes. Source: (Tempelman and Schildmeijer (2018))

After identifying the *bottleneck* of the process, which is the task that defines the duration time of it, the focus must be on eliminating waste, reducing the business value and balancing the lines in order to create flow (Tempelman and Schildmeijer (2018)).

However, research shows that when reaching an ideal state where every work cell *process time* is equal to the *takt time*, the process becomes very vulnerable as there are as many *bottlenecks* as the number of work cells. If anything happens there will be an immediate queue, that will lead to considerable waiting time and the process becomes unpredictable. In addition, in practice, it is not possible to remove all the waste from the process.

The situation most likely to occur is one where all the *process times* of the work cells are below the *Takt Time*. As long as customer demand is constant, there will be no queues and there is flow (Tempelman and Schildmeijer (2018)).

2.2.2 Lean Applied to Healthcare

Nowadays, the healthcare industry has complex delivery systems and in need of further improvement and innovation in management. The problems with healthcare are not only of clinical nature but mainly organisational, which can have a great impact in providing the appropriate medical care along the entire customer journey of the patient, without incurring extra costs and generating savings. Therefore, researches show that hospitals are focusing on organizational improvements and redesigning internal management of processes to become more effective and efficient, enhancing the quality of medical service (Prado-Prado et al., 2020).

Lean applied to healthcare focuses on simplifying processes by identifying value-added activities from the customer's standpoint and applying it by improving clinical and operational efficiency, reducing costs, improving quality and ultimately increasing customer satisfaction (Ker et al. (2014)). According to *Lean*, value is a system property, rather than an individual level concept. If the value chain activities are suboptimal for any stakeholder, the point of leverage is the system and not the individual (Berwick, 1996).

Basically, if there is margin for improvement in value added activities of a system, it is also necessary to improve operational and sociotechnical characteristics of the system (Joosten et al. (2009)). At an operational level, it is fundamental to analyze the patient's journey by identifying non-value adding activities and mapping the value stream in order to improve the system (Joosten et al. (2009)). Concerning the sociotechnical aspects of lean thinking in healthcare, it is based on a cultural shift that is necessary at a managerial level, focusing on creating an environment where the interaction between team members lead to a boost in performance that can not be achieved individually by team members (Berwick (2003)) (Ramori et al. (2021)).

2.2.3 Design and implementation of a *Layout* in Healthcare

Nowadays, lean principles are widely applied to healthcare facilities, determining the allocation of space and the interacting flows including: patients, clinicians, visitors, medication, supplies, equipment, and information. The design characteristics of a *layout* in healthcare have a great impact on patient and staff outcomes and, therefore, in providing an optimized experience for all the stakeholders involved (Ulrich et al. (2008)).

In order to include all the key stakeholders involved, considering all their interactions, there is a lean design process that encourages this collaboration and which is the *Lean 3P Design*. The *3P* (production, preparation and process) is based in lean methodologies that help improve and maximize quality and minimize costs, reducing the amount of production problems a design or process will have, as well as greatly streamlining the production process (Ramori et al. (2021)). This allows to define, develop and integrate processes to create a more patient focused environment (Hicks et al. (2015)).

Therefore, when designing healthcare facilities, it is necessary to involve the analysis of six flows of medicine (Hicks et al. (2015)):

- Patients;
- Staff;
- Family and friends;
- Equipment;
- Medication;
- Patient's information;

- Supplies.

A successful layout design must incorporate a simple yet efficient relationship between these flows. Lean tools such as 5S, visual management, Takt Time, standardisation and value stream mapping are applied in healthcare to engage stakeholders and flows, considering a more holistic view of value to target improvement that benefits patients as well as clinicians and management (Smith et al. (2020)).

2.3 Key Performance Indicators

In order to assess the feasibility and performance of a project, monitor its daily progress and any barriers that may exist or manifest themselves, key performance indicators are required for continuous monitoring. The definition of these indicators is done throughout the design of the project. When developing a business plan, beyond mission, vision and values, it is important to understand what return expectations and what risks this will face in its implementation. This anticipation of scenarios before they are implemented is a crucial parameter for the successful implementation of the plan (Haass and Guzman (2020)).

2.3.1 Importance of Project Evaluation

The systematic evaluation of the project is necessary and should be done in several stages. Depending on their objectives, the evaluation criteria need to be adapted to the context and time frame of it (Haass and Guzman (2020)). This article highlights the different approaches that can be applied to the evaluation of a project. According to the authors, the most important questions at the time of its development are:

- What are the reasons why projects fail?
- The evaluation tools used to analyze projects are suitable for the complexity that involves its evaluation?
- What are the implicit assumptions underlying the project assessment tools at question?
- How do these assumptions influence the results of the evaluation process?

Only after developing more sophisticated concepts and tools to evaluate projects, it is possible to better understand why they fail and take steps to make them proceed (Haass and Guzman (2020)).

2.3.2 Important KPIs in Healthcare

As previously mentioned, in healthcare, project management is a very important instrument. Includes methods, techniques and tools for approval, management and analysis of operational processes (Newell et al. (2008)). KPIs are metrics that provide critical information to control and

predict business performance in accordance with established strategic objectives. It is very important to relate qualitative and quantitative measures, establishing the possible links between them. The following are examples of important health KPIs (Newell et al. (2008)):

- Delay time for the service;
- Time of user admission;
- Waiting time, after attendance and before being called for examination;
- Time of all activities, from the initial request to the completion of the process and delivery of results;
- Movement of people by process;
- Associated costs per process;
- Mistakes made;
- Quality of service;
- Satisfaction relatively to space;
- Satisfaction regarding the effectiveness and competence of the service.

Chapter 3

Problem Statement

In order to comprehend and qualify the proposed challenge, firstly it is important to describe the *AS-IS* situation. This chapter intends to give an overview of the initial situation of the company, regarding the addressed project and topics.

Along the description, all the steps in the value chain were outlined and discussed, to have a better outlook of the problem statement and perception of the potential improvements to be implemented.

In the first place, it was carried a detailed analysis and characterization of the general customer journey associated to healthcare, evidencing its main phases, relative to the firm that serves as the base of work of the dissertation. Afterwards, an analysis to the different Business Units was made, to have a better understanding of the B2C processes involved in a Care Unit day-to-day operations. Besides that, a detailed analysis of the entire customer journey was carried out, with a description of the different processes associated to it, with the intent of identifying improvement opportunities in each of them and eliminate other that may be unnecessary. Therefore, it is fundamental to give an explanation about how the information flow is conducted within the care unit, to give a better perception of the possible changes and improvements that can be implemented to the overall customer experience.

The final section of the chapter states the requirements of an expected *TO-BE* situation regarding the customer experience and all its interactions, considering optimized clients' flow and reduced Service Level Agreements (SLA) response times, since an exam booking, until the results delivery.

3.1 Customer Journey

The customer journey needs to include the complete experience a customer has with the company, encompassing all customer interactions across all channels, devices and touch points throughout every stage of the customer life cycle - from awareness to loyalty.

Mapping out the customer journey can be split into three distinct phases:

- **Before engagement:** In order to understand the best ways to engage the customer, when in need of a medical examination, it was fundamental to define the paths available until the first contact with the company, which are illustrated in Figure 8. That was perceived by collecting Voice of customer feedback;

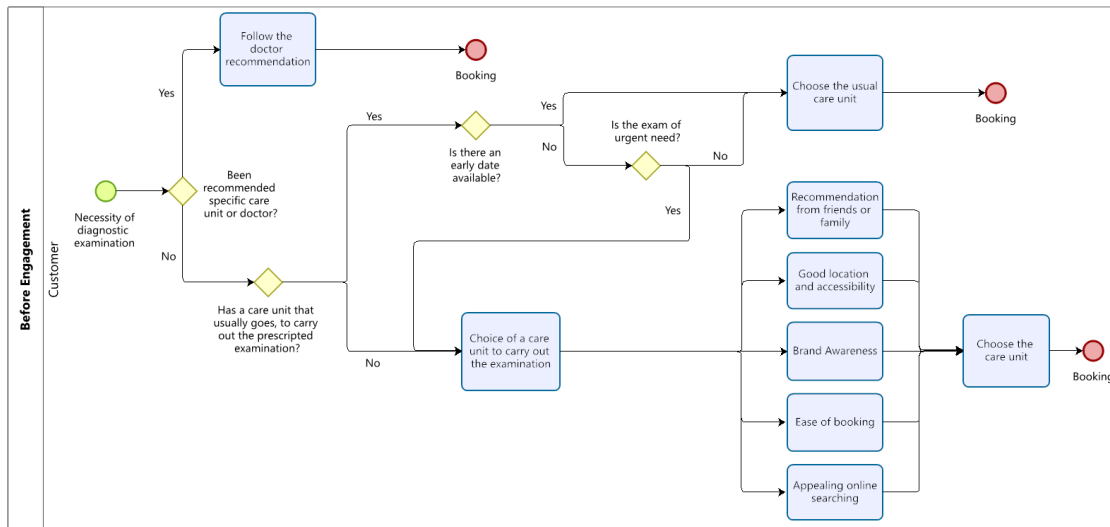


Figure 8: Customer Journey Before Engagement

It is important to evaluate the actual waiting time necessary for an exam realization, which is an analysis that is carried out later on this chapter. It is a decisive factor when in need of an examination, as the customer is strict when it comes to healthcare issues, and for that, the service should be available as soon as possible. Besides that, Figure 9 shows an impact and probability matrix that was developed in order to highlight the possible critical outcomes of what the customer usually values most, when deciding where to do a medical examination.

Risk	Risk Impact	Risk Probability
Unfavourable location and accessibility	Medium	Medium
Lack of brand recognition	Medium	Low
Difficulty to schedule an exam	High	Medium
Unappealing online searching	Low	High
Not recommended by friends or family	High	Low

Figure 9: Probability and Impact Matrix of decisive factors in choosing a medical facility

Considering that the necessary factors to evaluate are only those where the risk probability and risk impact are equal or above medium, it is one of the priorities of this dissertation to identify improvement opportunities relative to location and accessibility of care units to the customer and the easiness in scheduling an exam, that might be a decisive factor before engagement with a company, when considering that the customer already had previous experiences. Otherwise this aspect is held accountable in the engagement phase with the company.

- **Engagement with the company:** This phase starts when the customer has its first interaction with the company until its last interaction. It is the most important phase as it is when the company has the biggest active involvement and can most influence the clients. It represents most of the entire customer journey and was the phase that suffered a more exhaustive analysis;
- **After the experience:** When it comes to health, it is fundamental that the customer feels safe and that the experience was the best, for them to entrust a diagnosis on their health conditions again when needed. Loyalty plays an important role on maintaining a network of clients and to become closer to the customer's opinion about the experience, Unilabs uses a *Net Promoter Score (NPS)* as a metric to evaluate the satisfaction.

Focusing primarily on engagement with the company, providing a diagnostic service can be divided in a sequence of 4 big flows, as shown in Figure 10.

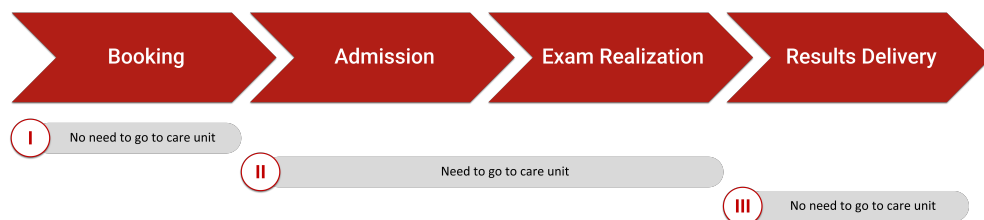


Figure 10: Customer journey phases during engagement

3.1.1 Booking Phase

The first phase of engagement with the company is the booking process, which plays an important role on the customer journey. It is the first interaction between the company and the customer and therefore it is fundamental to deliver an easy and efficient experience in this phase, as the first impression can be really decisive for a customer, when deciding to proceed or not with the service.

The booking process has the particularity of not being an actual scheduling of a date but is instead a request of booking which needs to be later validated by the contact center, where all the requests are centralized and managed. This booking request can be done through the website, the company's smartphone app *Saúde Unilabs* or directly through the *Contact Center*. The booking process is shown in Figure 11.

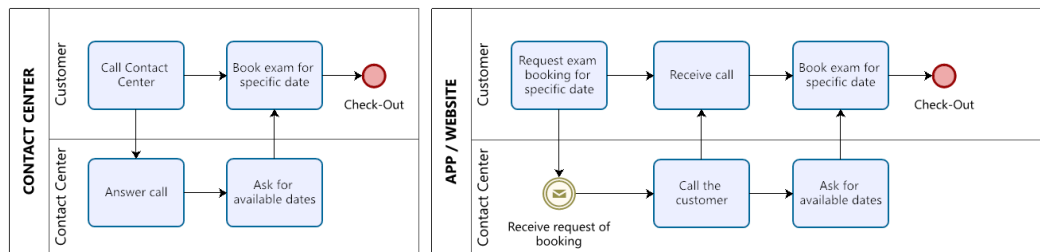


Figure 11: Booking Requests Channels

This step is not applicable to every situation, as there are some exams that do not require previous scheduling. Nevertheless, it is a necessary step of the value chain which is strongly influenced by the need of confirmation of the contact center. An analysis was carried out, concluding that on 26,9% of the requests, a later rescheduling is necessary when booking an exam, as the date initially requested by the customer is not actually available, presented in Figure 12a. Besides that, considering only the digital channels, it is important to refer that a rescheduling was necessary in 68,3% of the cases, being these the main responsible for the need of re-booking, when comparing to requests for medical examinations, by contacting directly the contact center, where it is directly booked, with no need of rework of the process.

This rescheduling process involves human resources from the contact center and the customer, leading to a more complex process and a higher *process lead time*. Furthermore, Figure 12b shows that the preference for these digital channels has been growing, since its availability, and therefore a growth of this rework is expected.

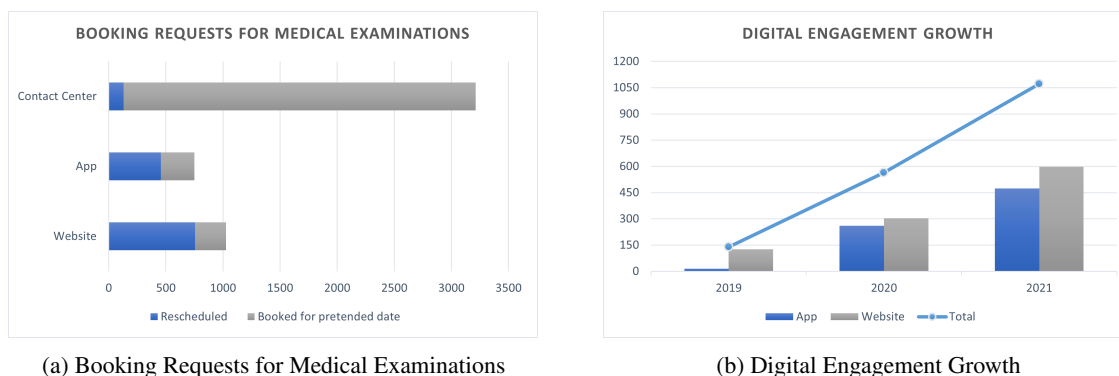


Figure 12: Booking Phase Analysis

The Contact Center is the main pillar in the booking process and is responsible for guaranteeing an actual booking, centralizing all the booking requests there. Due to the organic growth of the company in the last years, this department is increasing its capacity to be able to handle the increase in demand.

3.1.2 Admission Phase

The admission and the exam realization are both done on the same day and at the care unit. The admission process is explained more exhaustively later on this chapter since it can differ depending on the exam to be performed. Nevertheless, independently of the examination, this phase is mandatory and can not be ignored. At this point of the journey, the client must wait until being called to the reception, where a receptionist confirms the customer's personal and clinical information, related to the exam that was previously booked or related to clinical examinations that no previous booking request is needed. Finally, the customer is redirected to the proper waiting area or exam room, depending on the type of examination.

The main variables, manageable by the company, that may influence the efficiency and quality of the service provided at this phase are: 1) the waiting lines generated in a care unit; 2) the resources used and produced; 3) the clinical information flow of the customer; 4) the guidance provided to the next phase. Regarding waiting lines, the queues are managed manually, becoming a difficult task to manage the call order, respecting the first-come first-served principle, for each medical speciality. When it comes to the resources used and produced, there are considerable amounts of paper processed during a working day, representing an additional expenditure. The clinical information flow of the customer relies a lot on technological databases and depends also on the internal organization of how it is communicated. The guidance provided to the waiting area or exam room is usually done by an assistant, without whom leads to a destabilization of the flow of customers in the unit, leading to an inefficient operational area. These factors are addressed with more detail later on this chapter.

3.1.3 Exam Realization Phase

A medical examination must follow a set of medical procedures that cannot be eliminated, as they are necessary to guarantee a safe environment when treating the client. However it is time consuming and, therefore, the *bottleneck* of the four phases outlined. Since there is a limited margin for improvement in the lead time of this part of the journey, the improvements must be focused on technological evolution and medical equipments innovation. This way, the customer experience is enhanced, since, in most cases, the exam itself is uncomfortable.

3.1.4 Results Delivery Phase

The results delivery can be done in person at the Care Unit, by e-mail, in the website portal or in the *app*. Depending on the exam performed, the results may be reports explaining the conditions analysed or in case of imagiology, along with these reports, the images that serve as the basis for analysis and that were obtained during the exam, are also delivered. To have a better understanding of the flow associated to the different channels available, Figure 13 maps the journey of the customer during this phase.

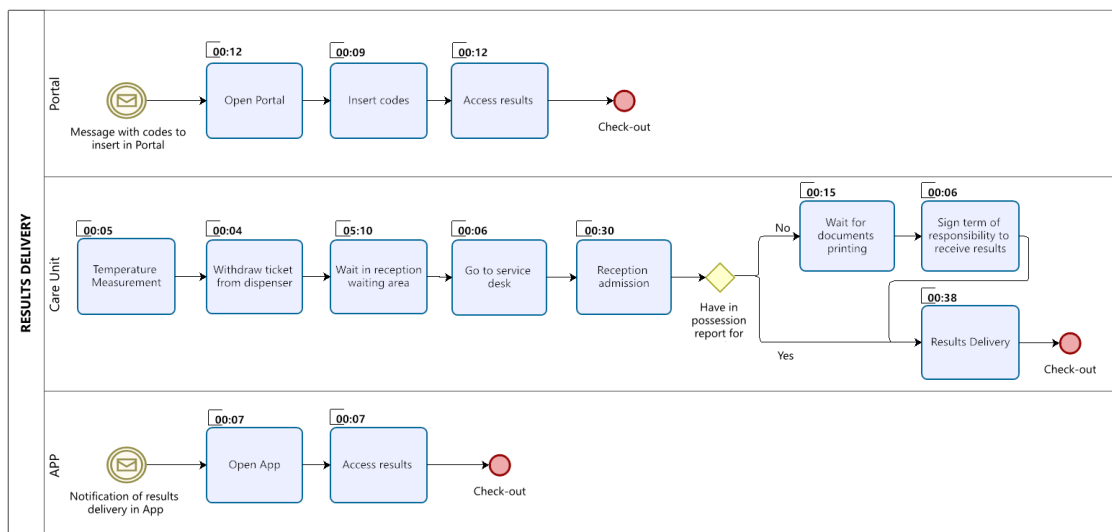


Figure 13: Results Delivery Swimlane

The digital channels are the most suitable, as the *PLT* of each of them is considerably smaller and the entire process easier, with no need to travel to the unit to get the results. When it comes to an imagiology exam, it is not possible to receive the images through the app and therefore the customer may be forced to choose another option.

3.2 Diagnostic Process Analysis

The company counts with, as of today, 1050 care units, in Portugal. A care unit can provide a variety of diagnostic services, that can be segmented in two main groups, explained with further detail in chapters 3.2.1 and 3.2.2.

It is first necessary to understand the tasks, its duration and the stakeholders associated to each process in order to guarantee a successful integration of the different medical valences and flow between each of them, on a daily basis operations. For that, the day-to-day operations were followed closely to give a clearer vision of the value chain.

In this section, for each group, a more exhaustive analysis is made to the booking and admission phases, to get a better view of the entire journey both from the customer's perspective and from the internal side.

3.2.1 Clinical Analysis

The clinical analysis aims to participate in the diagnosis, evolution and prevention of diseases, including an extensive portfolio, depending on the type of analysis and information to be provided. This Business Unit has the particularity of not needing to be booked and so, the first step is, in most cases, the admission. For some types of clinical analysis it is necessary to be under certain physical conditions, such as fasting, which implies that this complementary means of diagnosis is

available mainly during the morning. It can be performed on a variety of samples: blood, urine, feces, tissues, and occasionally on other matrices, being the most regular blood.

It may be necessary a prior travel to the unit for the supply of a container, depending on the sample. In case the samples to be examined are urine or feces, the client has the option to acquire the container on the unit, or to buy it in a pharmacy. After the sample collection has taken place, it is conducted to a laboratory, where the analysis and a final report with the results are made and later sent to the client.

Pathological Anatomy

It is important to mention a particular case, which is categorized inside the clinical analysis, but is considered a different business unit with a proper focus to its development, which is the Pathological Anatomy.

It is a branch of pathology and medicine that deals with the diagnosis of diseases based on the macroscopic examination of surgical and microscopic parts for the examination of cells and tissues. The biological material can be obtained from biopsies, surgical specimens, cytologies or preoperative examinations, such as gastroenterology.

This analysis is fundamental to clarify situations where the clinical symptoms and the radiological exams do not allow to reach a definitive conclusion, by studying localized damage and realizing a qualitative detection of certain proteins. There is no specific room for this type of medical specialty, being possible to use an ultrasound room for a biopsy, or a clinical analysis room in case of a cytology. After the sample collection, the sample is taken to a central laboratory, dedicated only to pathological anatomy. While the analysis is undergoing, it is possible to verify the need for some complementary examinations (immunohistochemistry).

The clinical analysis is a business unit that does not require to pass by the booking phase and the customer can go directly to the care unit for the admission. The customer journey associated to the admission phase is presented below in Figure 14, mapping the different streams of Clinical Analysis and how they connect between each other.

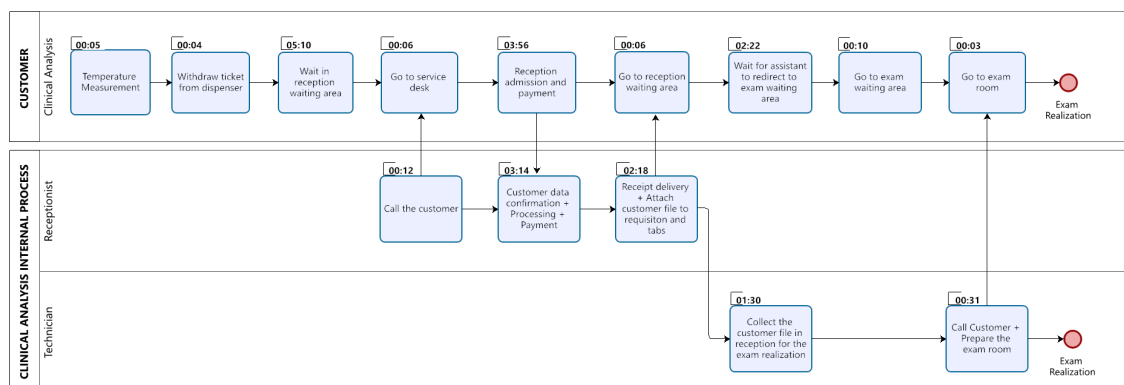


Figure 14: Clinical Analysis Admission Swimlane

3.2.2 Radiology

Radiology is a medical discipline that uses medical imaging to diagnose and treat disease, including a wide variety of complementary exams of diagnosis. Each of these exams has its own procedure, requiring different equipment, timings and processes, from booking to results delivery.

Even though it is possible to evidence dissimilarities between the different exams, there are standards followed, going through the four main flows of booking, admission, medical examination and result delivery. In this specialty, the exams are conducted by technicians, who capture the necessary images for later observation of a doctor. Afterwards, the doctor records the visual analysis and the diagnosis, which is then transcribed by typists to the final report that is sent to the client after validation. Regarding this standard there are two exceptions, being the first the orthopantomography, which is the only exam that does not require a booking and after its completion, the client may leave the unit with the images without a report. The last exception is the ultrasound, which is the only exam that is conducted only by the doctor, who reports it to a recorder while the images are being transmitted in the monitor.

As previously defined for clinical analysis, in radiology there are some particular cases that require further diagnosis through other specialties.

Cardiology

This medical speciality offers a broad portfolio, including medical diagnosis to heart and blood vessels disorders and disposing of a variety of exams. Besides booking an exam, it is possible to book a medical appointment, taking place at the care unit.

There are exams, such as the electrocardiogram with stress test, that are only performed with the presence of a doctor, since after the exam realization, conducted by a technician, a medical appointment is needed to evaluate the physical condition of the customer.

Gastroenterology

Gastroenterology is the branch of medicine focused on the digestive system and its disorders, resorting to minimally invasive imaging, such as endoscopes, to examine the interior of a hollow organ or cavity of the body.

This specialty is the longest in terms of booking and medical examination, due to the fact that the exams done in this area are of increased risk. Besides booking the exam and having a medical prescription, it is necessary to follow some procedures, such as giving the client filling information about health conditions to ensure that the exam can be performed and knowing if the exam will be with sedation or not, being that more than 90% of exams are sedated.

In case the exam is conducted under sedation, it requires the intervention of an anesthesiologist, who needs to analyse some other exams. Therefore, during the booking process, the client is asked to do some previous exams and, depending on the results, it may be possible to book the pretended digestive system examination.

All the care units that provide gastroenterology diagnostic are prepared with rooms for recovery after the exam completion, being this an additional and fundamental step before the check-out.

Nuclear Medicine

Nuclear Medicine is a specialized area of radiology that uses very small amounts of radioactive materials, or radio-pharmaceuticals, to examine organ function and structure. This branch of radiology is often used to help diagnose and treat abnormalities very early in the progression of a disease, such as thyroid cancer.

The extent to which a radio-pharmaceutical is absorbed by a particular organ or tissue may indicate the level of function of the organ or tissue being studied. Thus, diagnostic X-rays are used primarily to study anatomy. Nuclear imaging is used to study organ and tissue function. It is important to mention that this type of examinations are not indicated for pregnant women.

Figure 15 represented below depicts the customer journey associated to the booking phase and its different streams in Radiology. To each stream is associated an SLA, which refers to the standard time defined until the Contact Center actually books the exam, in case of the stream is the Contact Center, or until it interacts with the customer to confirm or reschedule the requested booking date, for the remaining options.

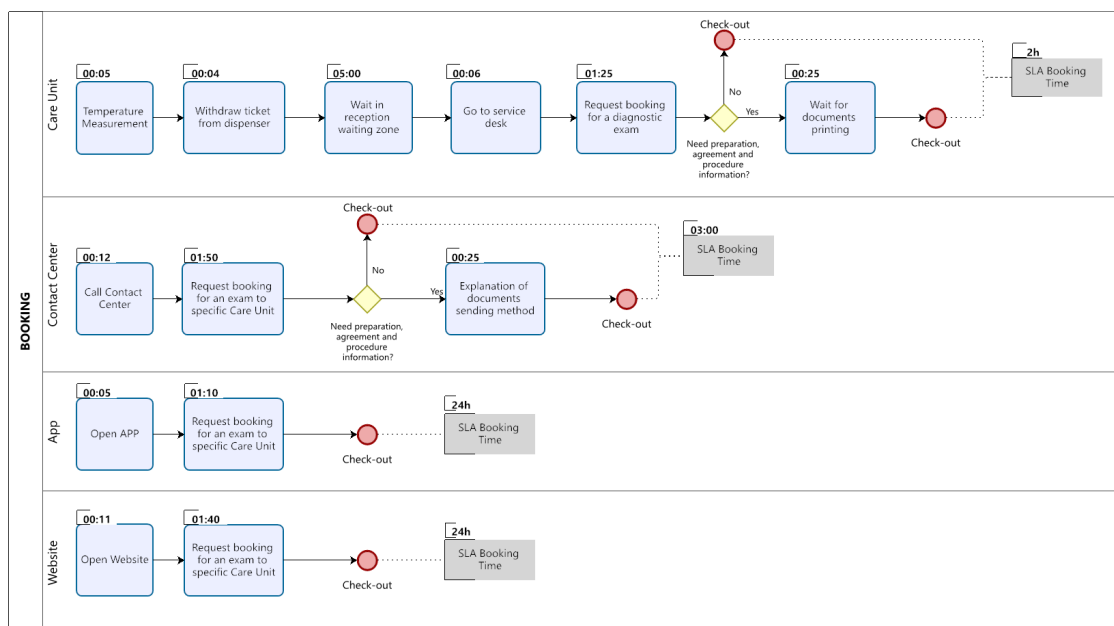


Figure 15: Radiology Booking Requests Swimlane

As presented above, the fastest way to book an exam would be through the App or the website, however, as of today, the booking process done by the customer is actually a request of booking which is later scheduled by the *Contact Center*, independently of the stream. Therefore, it is important to mention that the quickest way to have an exam booked is by directly contacting the *Contact Center*, as they mostly book those directly after the call ends. The easiest process,

focusing on the customer experience, is through the app and website. The two digital streams show great potential for the future of the customer experience, which is going through a digital transformation globally in every sector, with no exception of the healthcare industry.

While the booking process is centered in the *Contact Center*, the Full-Time Equivalents (FTEs) tend to grow over time as the network of clients grows and, subsequently, the incoming requests for bookings. Any stream to book an exam is currently experiencing internal rework as it needs to be re-evaluated and rescheduled.

The admission phase relative to the realization of an imaging examination is represented below in Figure 16. It differs from clinical analysis as in most exams the customer must deliver a medical request and there are some procedures and consents that need to be delivered to the customer, as radiology portfolio of exams includes more invasive and delicate medical procedures, of which the customer must be aware before being submitted to it.

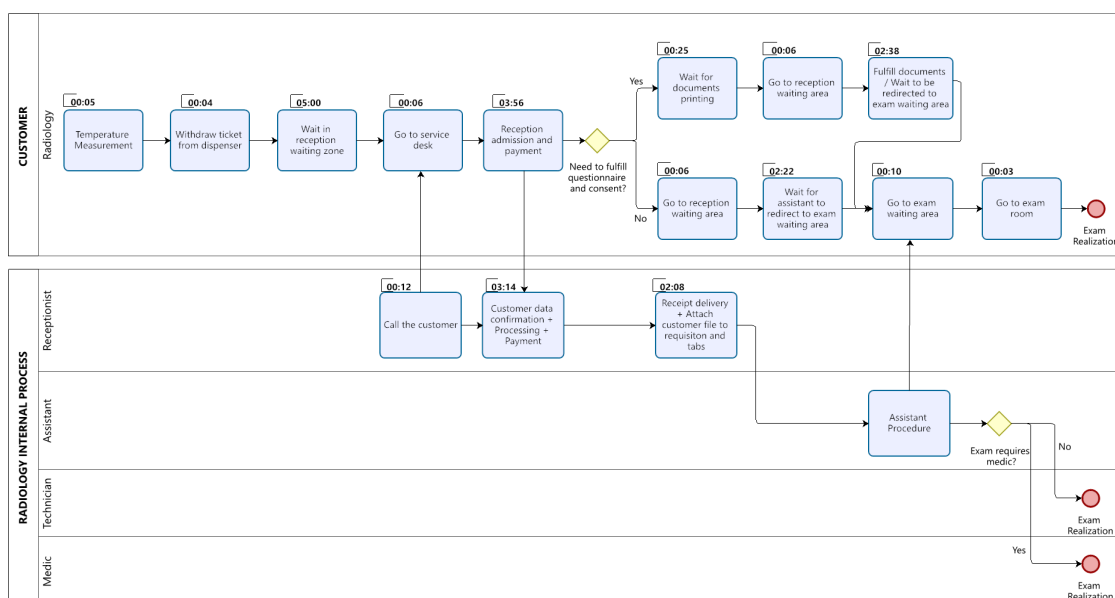


Figure 16: Radiology Admission Swimlane

3.3 Network Units Management

With a considerable network of 1050 units spreaded around the country, it was carried a close follow-up on the daily basis operations in a variety of units, with different characteristics. There are some manageable factors, common to every care unit, independently of the operational differences that may arise, referred in chapter 3.1.2.

The impact of those factors are evidenced and depend mostly on the demand, and therefore a global analysis is necessary to be able to estimate and understand better the weight of these variables identified and what steps should be taken by the company in order to improve the entire customer experience along with all the internal processes associated to it. In Figure 17 is presented the volume of medical procedures registered in 2019, along with their annual increase, considering

2018 and 2019. The year of 2020 was not included due to the pandemic of *Covid-19*, which affected critically the market and the consumption and did not allow to consider it as a normal year of consumption. Therefore, excluding it is the best practice, in order to not compromise the analysis of the organic and natural development of the business.

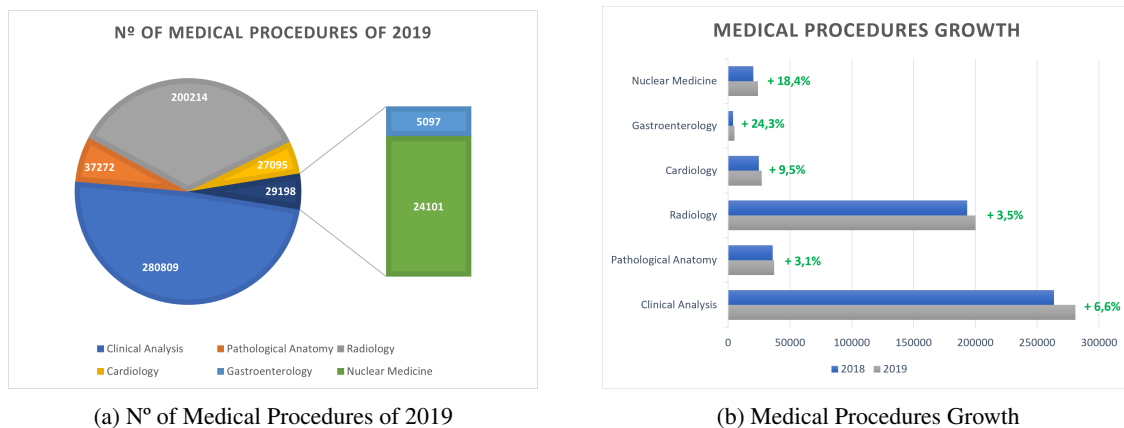


Figure 17: Analysis of Medical Procedures Registered

3.3.1 Waiting Times

Due to the growth of business, the waiting times generated become a serious concern to the company. Waiting is one of the main concerns to be aware when providing a service, in order to add value to the customer. Speed in business matters and in healthcare being able to provide a trustworthy health condition diagnosis to a customer as quick as possible is key to become a market leader. When waiting times become too high, it influences negatively the customers' behaviour towards the company, making them less patient and even changing to a similar service provided by competitors. Thus, there are two types of queues that were considered as fundamental parts of the analysis of waiting times in care units:

Booking Phase Queues

This waiting time is related to the booking of exams and finding an available date. The company knows that customers that need to wait more than 7 days for a medical examination, look for similar options with competitors. Therefore, it is necessary to first understand the actual booking waiting times, to do a medical examination, in order to understand what are the necessary precautions to have into account, when dimensioning care units, and the changes that can be made to facilities that are already operational, to prevent the waiting time from reaching the time limit referred.

Considering that the booking waiting time starts from the day the exam is booked, until the day of its realization, Figure 18 shows the waiting times per week, in a variety of Radiology exams, in the region of Porto. The data obtained was based on a weekly average and for a period of 5 weeks.

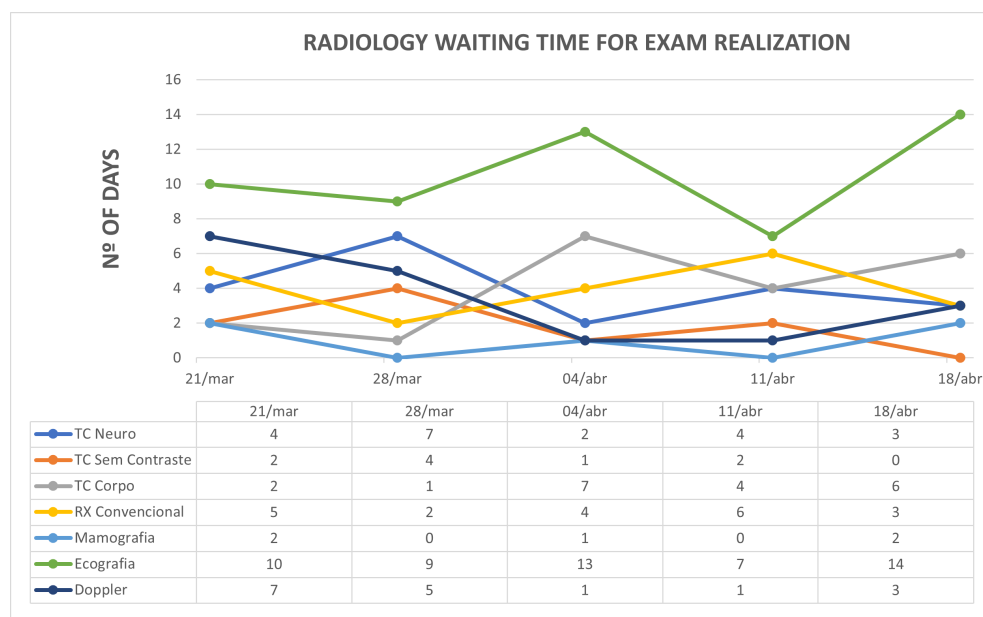


Figure 18: Radiology Waiting Time for Exam Realization

The waiting times measured above are proof that there must be an increase of the operational capacity in the facilities. Almost every exam had at least one week where a customer had to wait for 7 or more days or more to do an examination. This analysis helps understanding if the construction of new facilities in any region is justified and also to be able to dimension its layout, including receptions and exam rooms, in order to guarantee a flow where queues of 7 days are not generated. Besides that, an expected growth in demand will impact significantly this issue. The digital engagement is growing and customers are starting to choose digital channels over other options, less autonomous. As for today, the customers can not book an exam by themselves and the Contact Center will have to increase their workforce to match the growth in demand, otherwise it will make the waiting queues situation worse. Therefore, changes in this phase must happen in order to add value to the company and ultimately to the customer, which is the main objective.

Admission Phase Queues

In this phase, there are waiting lines formed due to the daily demand of medical examinations. The fact that the order of customer's arrival is managed manually, as the demand started to grow, the customer experience was being affected by the lack of management quality and there are now assistants allocated specifically to organize queues and guarantee an orderly flow. This represents an increased expenditure to the company.

To get a better understanding of the needs in this matter, Figure 19 gives an overview of the daily entrances, by hour, in a standard care unit. It is possible to understand the behaviour of the demand, highlighting the hours with greater affluence. This analysis gives a general perception of the number of entrances per hour for each medical business unit, to serve as a basis for the design of the attending in the admission. There must be considered changes that eliminate non-value

activities during the customer journey in the admission phase, along with the implementation of techniques that help accelerate the management of each customer, since the time they arrive the unit, until their guidance to the next phase.

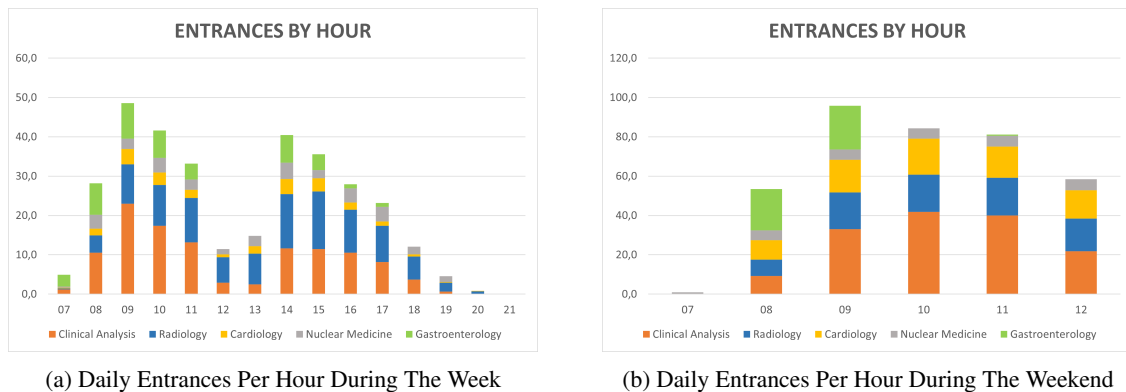


Figure 19: Daily Entrances of a Standard Care Unit

3.3.2 Care Unit Flow

The operational activity on a care unit includes the flow of three aspects: the flow of customers, materials and staff (includes technicians, doctors, assistants, receptionists and typists). These must be taken into account when dimensioning a care unit and for the study undergoing in the dissertation, the priority flow chosen was the customer's flow. It is composed by the paths the customer performs, since the time they arrive and enter in a unit, until the moment they leave. These paths may be made with different purposes, in particular: booking, exam realization and results collection. The booking and results collection are both phases that generate flow in the reception area, only. When it comes to the exam realization, the flow starts at the reception, with the admission phase, followed by an waiting room and then, depending on the exams to perform and the needed preparations for them, it can extend itself for a different number of rooms or common spaces.

As for today, on bigger units, there is an assistant dedicated to guide the customers to the specific rooms or areas, after the admission in the reception. This represent additional costs associated to the necessary workforce, for the standard care unit. Improvements in this part of the experience may be beneficial both to the customer and the company, finding a more autonomous option to the customer flow, starting in the reception, passing to the next rooms, until the customer leaves the unit. This can lead to a more efficient flow, improving operational activities, towards providing a better service to the customer and reducing costs.

3.4 Overview

Through daily monitoring of the tasks that are performed in a diagnostic centre, tasks with no added value have been found that can be improved or replaced. It is important to be aware of these

gaps, from a customer perspective, once the ultimate goal of the company is to add value to the customer while being able to maximize sales and revenues.

The 4 phases outlined show great improvement opportunities and a good occasion to include digital tools to support customer's tasks and administrative processes. The booking phase will significantly impact all the stakeholders once it is done in real-time through the digital channels, without the need of confirmation and rescheduling of the Contact Center, which will be under less work pressure, with the expected demand growth. The processes related to the admission and results delivery phases can also change to more autonomous touch points, by transferring part of the tasks to remote based tasks, giving more flexibility to all the stakeholders.

Therefore, the waiting times related to the booking and admission phases can be significantly reduced, allowing for a unit to be able to manage a higher number of customers per day. This also represents a good opportunity to idealize new units designs, taking into account its new capabilities and the innovative digital flows.

Once the medical examinations are the *bottleneck* of all flows, one of the objectives of the project is to eliminate all tasks that do not add value to the process and that can be decreased to reduce the PLT associated to a medical examination. This phase is highly influenced by the necessity of processing a considerable amount of administrative activities. By transferring these administrative processes to the customer side, with digital tools, the flow becomes more autonomous, giving more flexibility to the customer and to the company daily operations on a care unit. This *bottleneck* defines the responsiveness, constituting the objective of the company, in the future, to increase the speed of the equipment to increase this capacity.

Finally, the development and monitoring of KPIs is crucial to evaluate the project success. Below follow the chosen KPIs:

- **Net promoter score > 75%:** There must be established a high standard for the customer satisfaction;
- **Booking waiting time:** A reduction is expected;
- **Admission waiting time:** A reduction is expected;
- *Value chain total time:* A reduction is expected;
- **Number of customers that enter a unit:** Guarantee that all the customers are served during the day
- **Results delivery on time > 85%:** Increase the results delivery success rate, according to the defined theoretical time.

Chapter 4

Improvement Initiatives

The present chapter intends to define and apply methodologies that will serve as improvement solutions to the situation described on the previous chapter. This project aims to improve the quality of the service provided and therefore the customer experience. To that end, this chapter intends to develop improvements on units operational efficiency, focusing on the support of digital tools and digital implementations, that can eliminate non-value added activities and improve the quality of the value-added activities that the customer is willing to pay for.

Accordingly, after presenting the digital changes throughout the value-chain that encompasses the customer interactions with the company, it is mapped the final customer journey that is covered during the different phases of engagement.

Afterwards, a standard unit design is idealized, considering all the improvements made, along with the calculation of operational benefits and savings achieved. Upon carrying out this analysis, it was done the design of an ideal layout, with the support of a team of architects, considering the demand analysis and the company objectives, mentioned in Chapter 3.

4.1 Digital Implementation in Processes

The healthcare sector is undergoing an operational transformation, towards a more digital experience, for both the company and the customer. This is leading to an increase of autonomy in processes and efficiency. The company has chosen to direct their efforts towards this approach, improving the digital experience, internally and externally.

Being the objective to maximize the operational efficiency, arose the necessity of redefining processes in some of its strands. Some of the tasks previously identified show themselves redundant and costly to the company. The actual daily operations on a care unit still rely on many manual tasks and the different flows generated are a consequence of outdated processes.

Real-time Booking

When in need of a medical examination, the engagement with the company passes by 4 phases: booking, admission, exam realization and results delivery. Starting with the booking process, as

it was already stated throughout the project, with the increase of demand, the growing number of booking requests is leading to a complex management of the Contact Center by having the task of actually scheduling and confirming the desired dates of the customers. There has been a notorious acceptance and growth of the digital pathways such as the app and website, which represents a good drive to implement digital improvements to this subject.

In order to change the booking process to a one-step solution, instead of a more complex interaction between the stakeholders, there was a big effort of the company in developing a new information systems network. It allows the customer to directly book an exam through the app or website, by providing real time availability dates on these channels and eliminating the additional step of rescheduling and confirmation. Previously, it was necessary to manage the customer's requests on an internal platform, presented in Figure 20, which gives the queue of incoming requests and their status, whether it needs to be confirmed and the customer contacted or if it is already booked. The data is blurred once it is related to customers' personal data and it can not be shared.

Estado	Aplicação	Nome	Localidade	Data Nasc.	Telemóvel	Telefone
Pendente	ARA	Maria Antónia Fernandes Rodrigues				
Pendente	ARA	Regina Maria Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	APP	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				
Pendente	ARA	António José Gomes				

Figure 20: Booking Requests Queue

This improvement had a great impact in terms of the service quality, from a customer's perspective. The Table 1 shows the operational impact on the company with the implementation of the new one-step booking process. Even though the actual number of requests made through the app and website represent about 30% of the incoming booking requests, it was possible to reduce the workforce dedicated to this task in more than 50%, due to the fact that this task *lead time* is significantly higher, when comparing to the booking requests made via telephone by customers, as these are booked during the call. Each FTE represents an average cost of 15000€/year to the company, registering considerable annual expected savings with this innovation.

Table 1: Operational Variation in Contact Center Costs

Situation	# FTE	Cost/Year
AS-IS	16	240 000€
TO-BE	7	105 000€
Δ	9	135 000€

4.1.1 Customer Flow Idealization

Given the high number of entrances per hour, on a standard care unit, waiting lines are formed very easily, which leads to a difficult management of the priorities of arrival, considering the different specialties of exams pretended. There is an assistant who is responsible for organizing the waiting lines and guaranteeing that the priorities are respected in the care units. Customers can travel to a unit with different purposes, either to book an exam, perform an exam or collect their results. Therefore, there are different flows happening at the same time, on the reception area.

Furthermore, after the admission phase, usually the customer is redirected to another waiting room, depending on the exam to be performed. Once a care unit can be prepared to perform exams of a variety of medical specialties, the exam rooms need different preparations in terms of equipments and materials. Therefore it is necessary to have multiple exam rooms, leading to having also different waiting areas, depending on the medical speciality, in order to maintain a more organized and efficient flow of customers. As the customer is redirected to the next phase by the receptionist and does not have any other guidance, customer dissatisfaction becomes a common problem to this issue, because they end up going to the wrong rooms, without any support along the way. To this concern, once the company thrives on deploying a customer centricity culture, it was idealized a new customer flow, depending on two main improvements:

Implementation of Ground Lines

In order to provide a better experience to the customer, regarding the guidance inside a care unit, it was implemented a system of ground lines, working as a visual management tool. It uses instinctive visual cues to make succinct, accurate information within the workplace available at all times to those who need to know it. Figure 21 shows the selections of colors by medical valence and an example of ground lines implemented in a unit and appendix A.1 presents an example of a care unit layout with the planning of ground lines. This investment is aligned with the objective of improving the customer experience, by providing a clear and more autonomous guidance, without the need of assistance of the staff to direct the customer to the respective room or waiting area. It also reduces overall movements in the unit, granting a more organic flow.

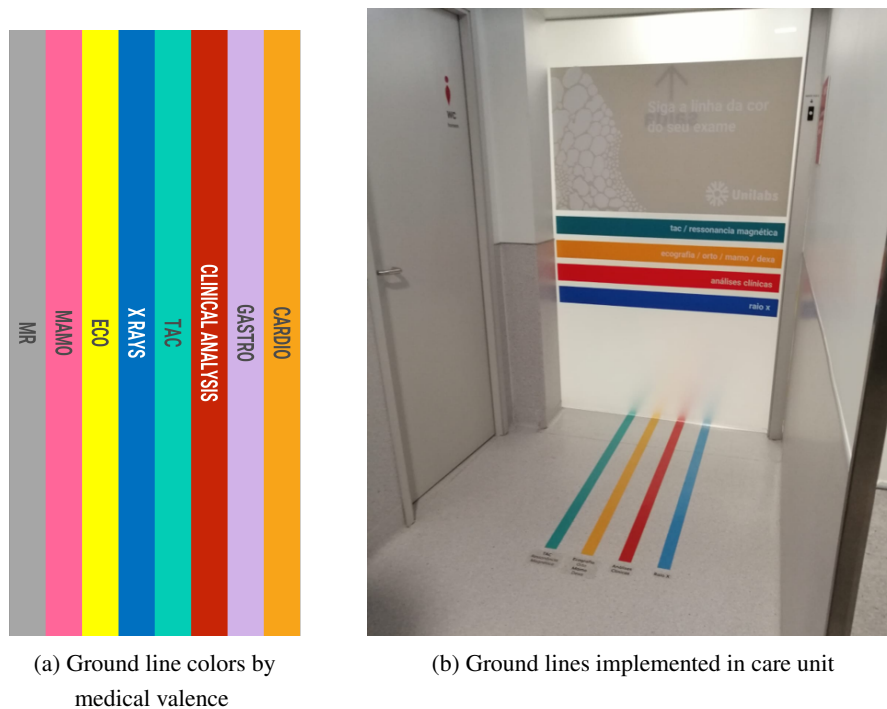


Figure 21: Ground lines as a visual management tool

Waiting Lines Management System

Complementary to the ground lines, it was implemented a new attendance system, relying on ticket dispensers that include the different options of interaction for the customer to choose, with an embedded system with the receptionists computers, in order to manage the call order in a more efficient way. Figure 22 explains the entire process, starting by the customer, who takes a ticket from the dispenser and then the receptionist manages the waiting line system and the customer's clinical data, during the interaction between both stakeholders.

In addition, it is possible to integrate the ground lines with this system, and the ticket printed from the dispenser already comes with the color associated to the flow that the customer will have to follow after the interaction in the reception. The dispenser system allows a receptionist to have a visual perception of real time queues, already segmented by the type of attendance (booking, exam realization or results delivery). Therefore, the flow of customers on the reception area becomes more organic, allowing to optimise the occupancy rate, monitor and reduce the waiting time.

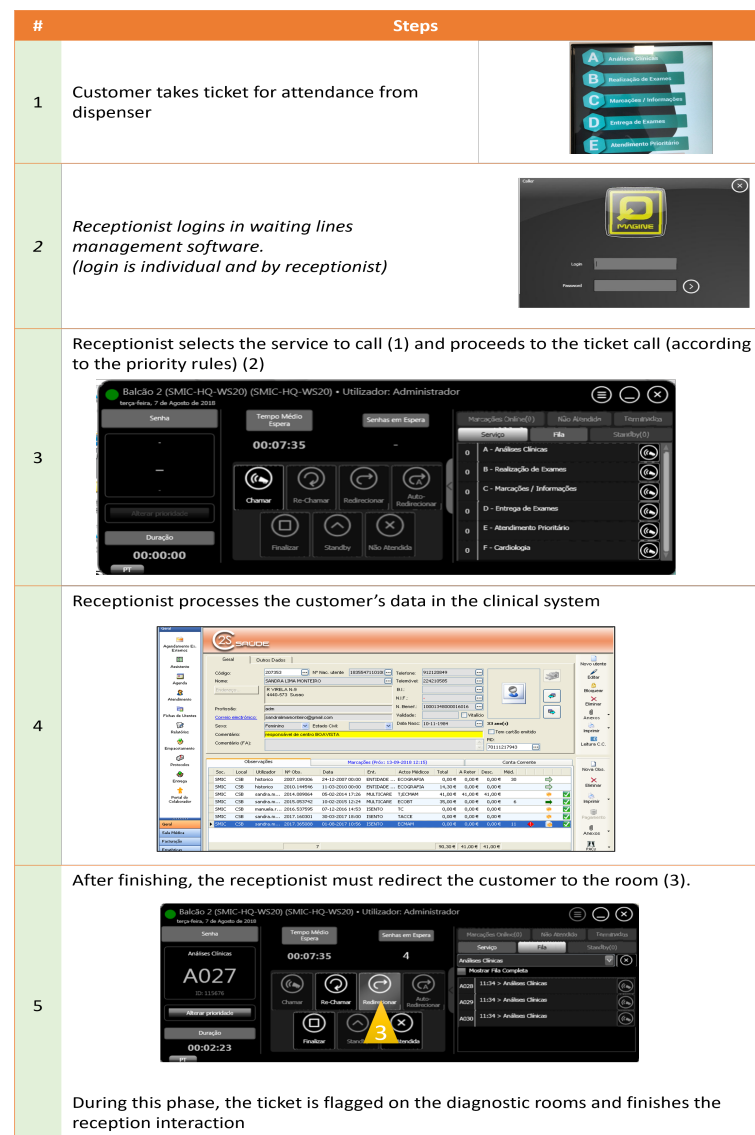


Figure 22: Waiting Lines Management System Workflow

4.1.2 Fast-Track Diagnostics

The objective of the company is to offer an unique experience to the customer, providing the best service, as autonomously and quickly as possible. It is a goal that benefits both the customer and the company, as it also represents reduction in workforce, while offering a better service level. Following this purpose, it was idealized a new and innovative experience for the customer, complementing the digital improvements that were already implemented. It is an innovative pathway of interaction between the customer and the company, relying on the digital channels. It consists in joining the following factors:

- **Digital engagement:** The number of customers using the digital channels is growing, adapting to the trend evolution. Customers tend to embrace this change, as it allows them to have

a more autonomous and more controllable management of their activities and interactions with companies, being a great opportunity to launch a digital tool to improve operational outcomes and the service provided to the customer;

- **Real-time booking:** With the implementation of this feature, it is possible for the customer to book an exam remotely, anywhere, just by accessing the app or website, with no need to confirm dates or any other information;
- **Virtual payment and admission:** This feature was developed as part of the fast-track diagnostics innovative experience, allowing the customer to pay and confirm personal information remotely, right after booking an exam. This is a huge change in the process of engagement with the company, facilitating the entire experience, both to the customer and to the company, as it leads to less traffic on care units, during the admission phase, where previously the customer had to go through all those stages.
- **Virtual access to results:** Besides having access just to the exam report, in case the customer performs a radiology examination, the images are sent along with it, which also eliminates the necessity of travelling to care units to collect diagnostic images.

Combining the changes mentioned above, Figure 23 presents the innovative customer experience idealized, through the company's app *Saúde Unilabs*, highlighting the key digital enablers and customer journey moments.

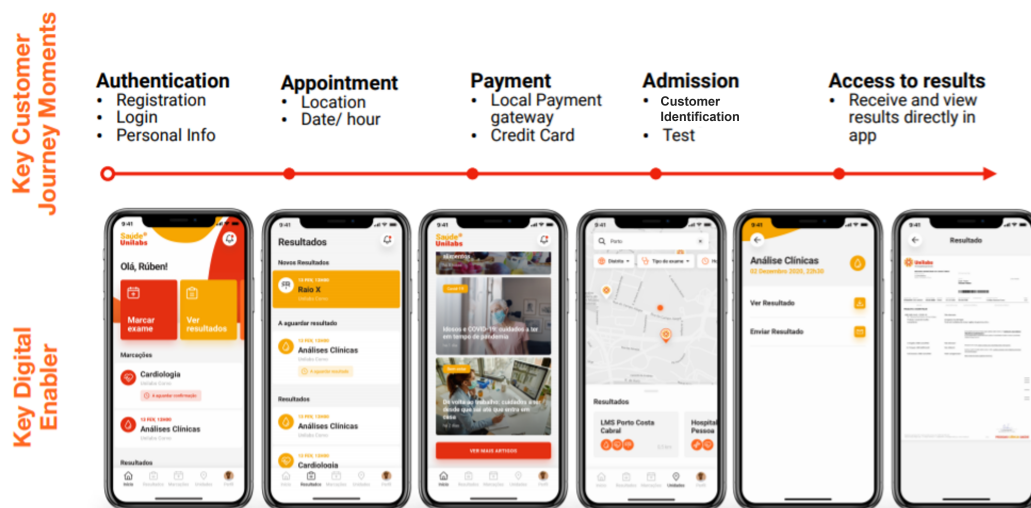


Figure 23: Value chain of new digital customer touch points

The fast-track diagnostic process can work as a key lever to improve the company's service in a key touch point to the customers in their units. In parallel, this idea can also bring significant savings to the administrative FTE dimensioning. Comparing the AS-IS and TO-BE situations, Figure 24, gives a visual simulation of the changes that this approach brings to the company and the customers.

With the new digital experience the company is able to digitize the entire process and transfer the entire administrative process to the client side, such as the appointment date, data entry and payment, turning it into a more autonomous process. Besides that it helps reduce call center workload, increase operational efficiency and maximize revenue, by being able to serve more customers during a day, while maintaining the same service level.

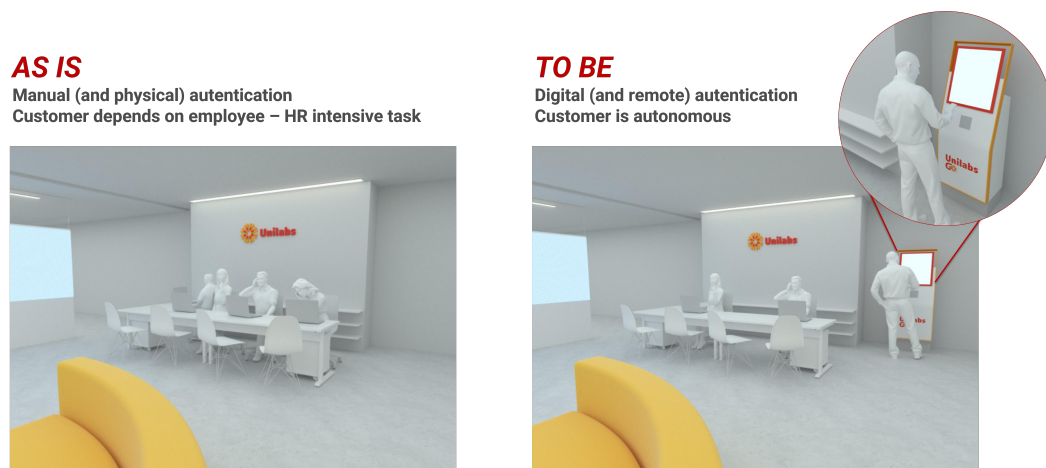


Figure 24: Comparison between the manual and digital experiences

4.2 Network Management

The customer experience department is considerably extensive, counting with 1050 care units. Therefore, a well structured and organized management of it is mandatory, to guarantee an organic growth of itself. The structural hierarchy of the department, shown in figure 25, divides the units by 7 regions, being each of them led by a director, followed by a group of cluster managers, who are responsible for a more restricted group of units, and then by sub-cluster coordinators, who are directly involved in the operation efficiency and management of their group of units.

As the units daily operations involve a lot of processes and a variety of stakeholders, this managerial role is really important. It becomes essential to monitor all the behaviours and processes, with the goal of meeting the company KPIs and also being responsible for perceiving improvement opportunities, with a close follow-up of the daily operations in units.

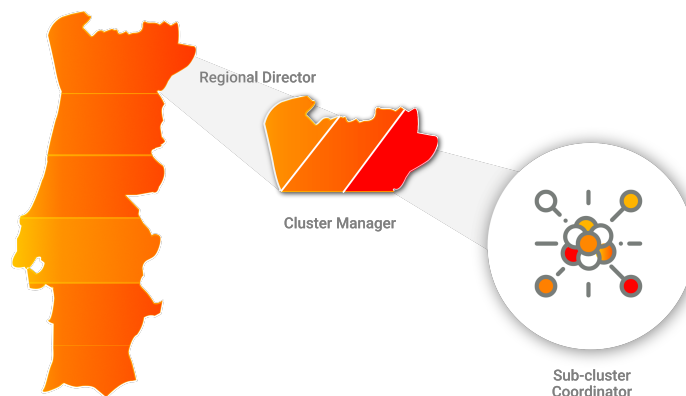


Figure 25: Structural hierarchy of the customer experience department

There are identical problems that arise in units of different regions, at different times, the same way there are improvement opportunities identified in some that can be useful in others. Therefore, in order to deploy a customer centricity culture and the philosophy of continuous improvement, throughout the entire network, it was implemented a new framework, presented in figure 26. It consists in management techniques, starting with the Daily Unilabs at every unit, which is a 15 minute meeting with every employee, everyday, to track the daily objectives and outline the Plan Do Check Act (PDCA) tool. This methodology helps improve the daily operations efficiency, based on a lean thinking and by providing a better monitoring quality. Moreover, all the PDCA are visible to every stakeholder, and integrated with the company's internal systems. This led to achieve an increase in KPI's that were previously defined:

- The NPS increased from 71% to 80%, on a period of two months and a half, showing a positive trend of the customer satisfaction
- An increase of 22% in digital results delivery was registered, with the daily unilabs implementation
- The percentage of exams delivered in-time grew from 79% to 88%, showing an increase in operational efficiency

The customer experience structure has generated several optimization levers to be explored, counting on new digital tools that helps the company to speed up the process.

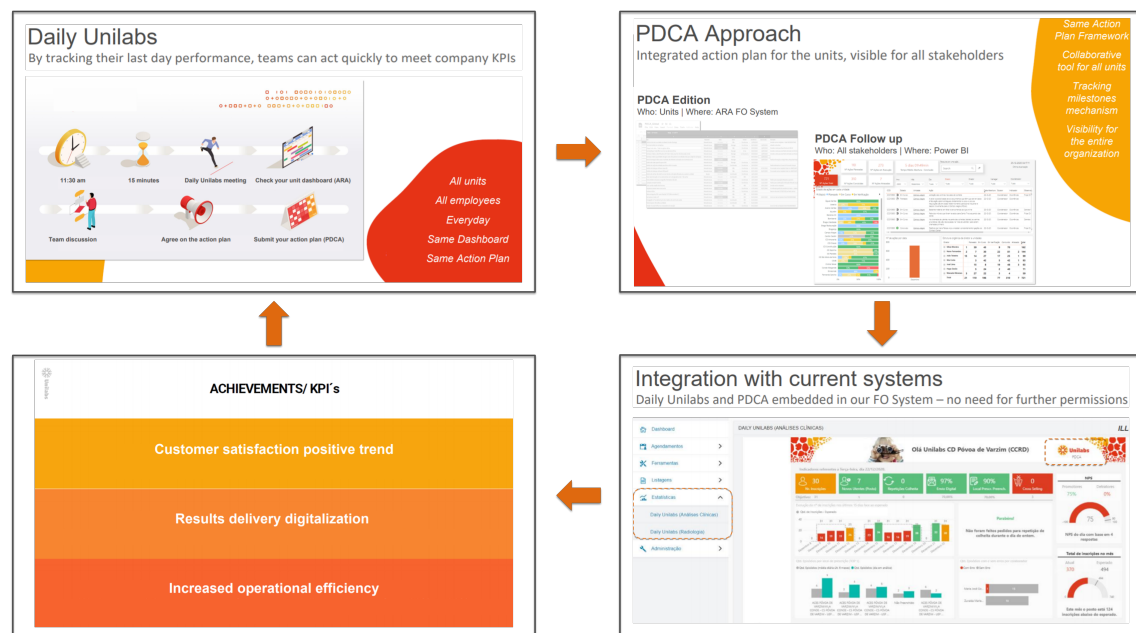


Figure 26: Units management approach

4.2.1 Standard Unit Dimensioning

Implementing a series of digital improvements directly impacts the service provided and changes the entire customer journey. Along the same line of reasoning, these changes impact the operational efficiency on a unit daily operations, allowing to standardize FTEs and optimize units. The digital transformation works as an enabler to increase sales while being able to reduce the number of units and the workforce. A revision process of the units network size was already undergoing and these implementations complement the main objective of that revision, which is to maximize productivity.

According to the company's optimization plan, more than 100 units were closed or relocated during the last 6 months, even with increasing sales volumes, generating considerable synergies for the group. The decision of closing units, from February, comes by weighting the estimated new manageable flow of customers in each unit, the number of units per sub-cluster zone and the sales revenue that each of them generates and can generate in the future. With the estimated increase of customer's admission in units, this reduction is planned by reallocating customer's, without eliminating the existence of units in key locations and making customer's have to travel a bigger distance or even choose a competitor over the company. Consequently, closing units directly impacts the number of FTEs necessary. Besides that, the digital transformation is a key lever to this, as it transfers the administrative processes to the customer side, turning it into a more autonomous process. The availability of the new fast-track journey allows to reduce significantly the workforce necessary on units' daily operations.

These network optimization changes are represented in figure 27, where it is possible to verify

that until February, besides reducing the number of units in 91, a reduction of 38 FTEs was considered, which is not proportional in terms of workforce productivity. After the AS-IS establishment of February, the implementation of digital tools leveraged this productivity, leading to a bigger estimated reduction of FTEs, when comparing to the number of units to close.

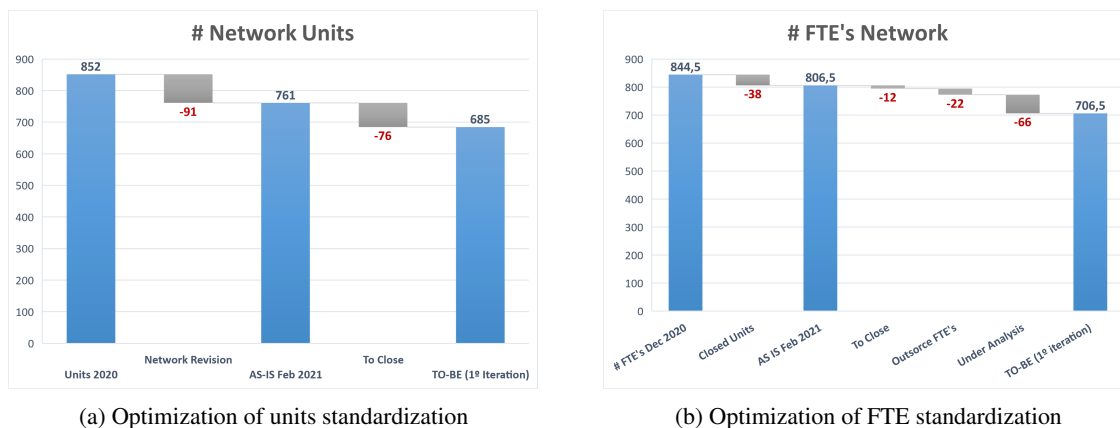


Figure 27: Network optimization with digital improvements

4.3 Diagnostic Center Layout Design

The digital transformation of the customer experience and of the internal daily operations enabled the idealization and development of a brand new concept of a diagnostic care unit. The idea is based in a one-day-clinic stay, with integrated service centers, leading to the design and projection of a new diagnostic center that centralizes all the existing Unilabs clinical areas. The company's stronger presence is in the region of Porto, and therefore, it was chosen as the place to move forward with the project and construction.

By taking advantage of a unique market positioning in the diagnostic sector, followed by a strategy of M&A, this innovative service is based on a one stop shop model that intends to provide the ultimate diagnostic service to the customer. The layout is a two floor facility, designed with the purpose of being prepared to admit customers in need of a diagnosis, to state their medical condition and later be evaluated by a doctor, if that is the case. The objective is that, during the stay in the unit, the customer passes by every phase, since the admission until the results delivery phase, leaving with the complete diagnostic and report. Besides that, it was included in the design other medical specialties, rented to independent doctors, to partake in the consumer shift towards a more integrated diagnostic. Figure 28 shows the proposed layout for the floor 0, which is where all the diagnostic service provided by the company takes part and figure 29 shows the layout of floor 1, which is where the additional medical specialties will be included.

The opportunity came from savings in recurrent capital expenditure (CAPEX) and FTEs, from downsizing and closing old units, as well as increased revenues from non-loss of clients due to the improved waiting lists and from internal prescriptions that decrease premises costs, resulting

in efficiency gains. It is strongly aligned with Unilabs strategy of providing integrated diagnostic services, improving the customer experience and loyalty. The diagnostic center has capability to serve 500 daily customers, which is the higher number registered, when comparing with any other care unit.



Figure 28: One Stop Shop floor 0 layout design

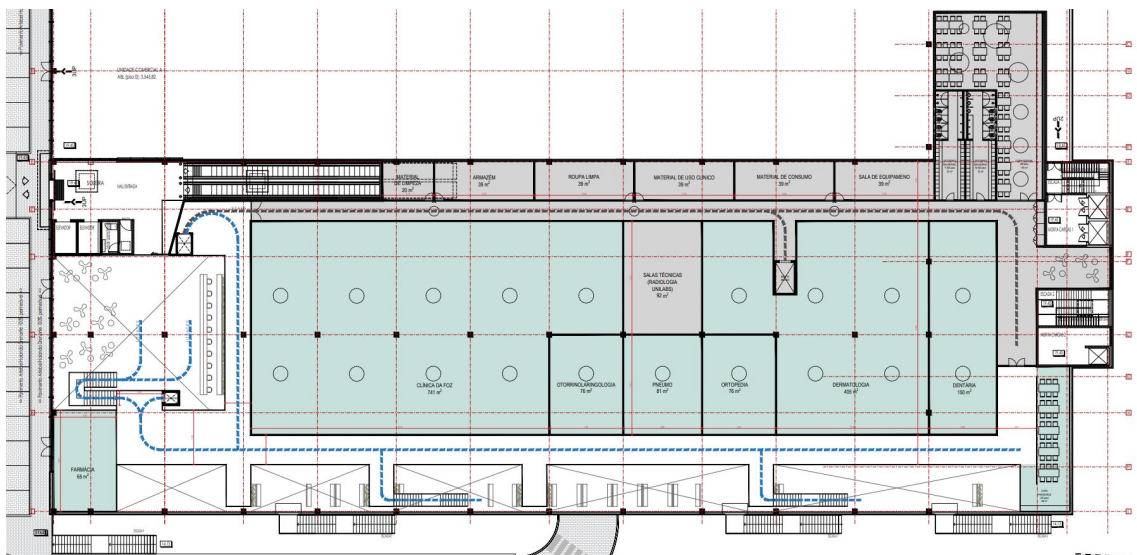


Figure 29: One Stop Shop floor 1 layout design

As it was already referred, to the *layout* design it were taken into account: the idealized digital flow of customers, including the transference of administrative tasks to the customer's side, allowing part of them to be done remotely with support to the digital channels; the release of space on the reception; a more oriented and organized flow of customers in care units. Therefore, as a result of merging all the improvements and applying them on a *layout* for an innovative concept

of a care unit, figure 30 maps the digitally transformed customer journey and their different touch points.

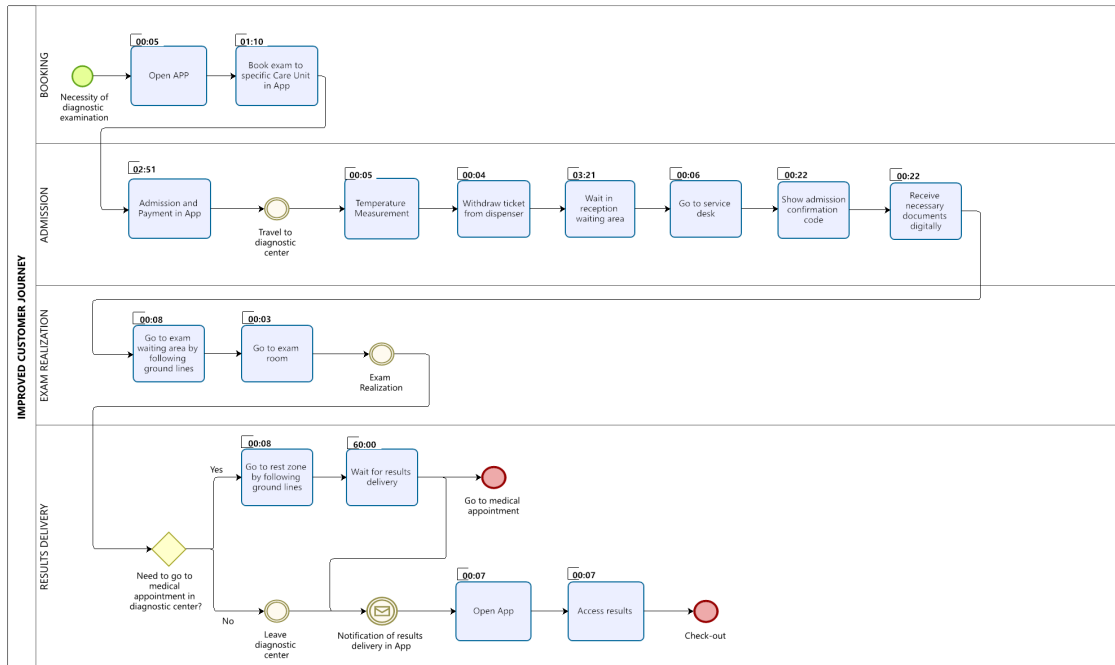


Figure 30: Improved Customer Journey Swimlane

Chapter 5

Conclusion

As the market leader in clinical diagnosis, Unilabs is recognized by the quality of services provided. However, as a result of the rapid growth through M&A, Unilabs customer service could not response as efficient as expected. Also, the increasing competitiveness in the healthcare sector resulted in the necessity of improving customer's service level. In fact, providing the best quality of service to clients is the main objective for company's success and it is the more effective way of enhancing its market share in comparison with the other competitors. In order to address the customer experience within the company, the objective of this project went through analysing and restructuring the entire value chain. This restructuring has the main objective to standardize and deploy a customer centricity culture in the organization, increasing the operational efficiency in its structure and existing processes.

The digital implementations in the customer journey and in the daily operations and management of diagnostic centers, foresees and will obtain a higher return on operational income, mainly because it allows for the units to be prepared to receive and admit a higher daily number of customers per hour and by eliminating identified non-value added activities, that are resource and time consuming. Likewise, the layout design of the new innovative concept of diagnostic center led to map the entire customer journey, with the purpose of idealizing the key touch points.

The improvement initiatives covered on the dissertation, such as the digital implementation in processes, the network management and the layout design of a diagnostic center aimed at improving the attendance capability, the PLT of the entire value chain and the standardization and optimizations of units daily operations, in order to rationalise the operational costs associated with each task. Besides that, it was given priority to a more customer focused approach, in order to enhance the customer satisfaction and therefore strengthen the customer's engagement with the company and brand loyalty. That was achieved by transferring some administrative processes to the customer side, such as the the appointment date, the data entry and payment, which gives the customer much more flexibility and autonomy in managing their requests. To the company, it gave the opportunity to close units and restructure the internal structure by reducing FTE, all of these changes while being able to increase sales and revenues.

During the project development, some difficulties came up, specially in the adaptation of the

employees to the new methods of work, with the implementation of new internal information systems databases and new management software to support daily operations. It is a cultural barrier that is being overtaken, with the adaptation of these new methods, which is a comprehensive difficulty, which must be closely followed.

Lastly, as the construction of the diagnostic center is planned just for the next year, it was not possible to verify all the expected improvements that were stated throughout the project. Nevertheless, some of the digital improvements, such as the fast-track diagnostics and the customer flow optimization are already implemented. Even with some adaptation difficulties, the stakeholders have shown great motivation during the transition process, as it facilitates their work, while providing a better service experience to the customer and also an increase in productivity.

Future Works

Upon development of the project and in order to ensure that the company remains with a culture present with the philosophy of continuous improvement, there must be new goals defined. The continuous improvement is an ongoing process that stimulates the permanent aim to keep improving service level by increasing efficiency and reducing operational costs. Therefore, to keep improving the customer experience, two measures were recommended:

- Development of health smart reports, complementary to the experience offered via the company's app. That approach stimulates the transition and engagement of the customers with the digital channels, while providing more value-added activities, from a customer's perspective, as it provides detailed information that explains and interprets medical reports. The efforts in improving the digital service are key to these matters;
- Expansion of the idealized one stop shop model of diagnostic center by making a careful and detailed analysis to the demand and productivity improvement opportunities around the country, to define a key location for the opening of a second diagnostic center, once this new digital experience estimates significant sales and revenues increase.

Bibliography

- Berwick, D. M. (1996). Basic facts about the EU pharma market I . Market volume. *BMJ (Online)*, 1(March):1–12.
- Berwick, D. M. (2003). Improvement, trust, and the healthcare workforce. *Quality safety in health care*, 12(6):448–452.
- Bolton, R. N., McColl-Kennedy, J. R., Cheung, L., Gallan, A., Orsingher, C., Witell, L., and Zaki, M. (2018). Customer experience challenges: bringing together digital, physical and social realms. *Journal of Service Management*, 29(5).
- Boyd, D. E., Kannan, P. K., and Slotegraaf, R. J. (2019). Branded Apps and Their Impact on Firm Value: A Design Perspective. *Journal of Marketing Research*, 56(1):76–88.
- Følstad, A. and Kvale, K. (2018). Customer journeys: a systematic literature review. *Journal of Service Theory and Practice*, 28(2):196–227.
- Grewal, D., Levy, M., and Kumar, V. (2009). Customer Experience Management in Retailing: An Organizing Framework. *Journal of Retailing*, 85(1):1–14.
- Haass, O. and Guzman, G. (2020). Understanding project evaluation – a review and reconceptualization. *International Journal of Managing Projects in Business*, 13(3):573–599.
- Hicks, C., McGovern, T., Prior, G., and Smith, I. (2015). Applying lean principles to the design of healthcare facilities. *International Journal of Production Economics*, 170:677–686.
- Homayounfar, P. (2012). Process mining challenges in hospital information systems. *2012 Federated Conference on Computer Science and Information Systems, FedCSIS 2012*, pages 1135–1140.
- Joosten, T., Bongers, I., and Janssen, R. (2009). Application of lean thinking to health care: Issues and observations. *International Journal for Quality in Health Care*, 21(5):341–347.
- Kandampully, J., Zhang, T., and Jaakkola, E. (2018). Customer experience management in hospitality: A literature synthesis, new understanding and research agenda. *International Journal of Contemporary Hospitality Management*, 30(1):21–56.
- Ker, J. I., Wang, Y., Hajli, M. N., Song, J., and Ker, C. W. (2014). Deploying lean in healthcare: Evaluating information technology effectiveness in U.S. hospital pharmacies. *International Journal of Information Management*, 34(4):556–560.
- Lemon, K. N. and Verhoef, P. C. (2016). *Understanding customer experience throughout the customer journey*, volume 80.

- Matt, C., Hess, T., and Benlian, A. (2015). Digital Transformation Strategies. *Business and Information Systems Engineering*, 57(5):339–343.
- McColl-Kennedy, J. R., Zaki, M., Lemon, K. N., Urmetzer, F., and Neely, A. (2019). Gaining Customer Experience Insights That Matter. *Journal of Service Research*, 22(1):8–26.
- Newell, S., Edelman, L. F., Staples, D. S., Webster, J., and Henfridsson, O. (2008). *Information Systems Information Systems*.
- Prado-Prado, J. C., Fernández-González, A. J., Mosteiro-Añón, M., and García-Arca, J. (2020). Increasing competitiveness through the implementation of lean management in healthcare. *International Journal of Environmental Research and Public Health*, 17(14):1–26.
- Ramori, K. A., Cudney, E. A., Elrod, C. C., and Antony, J. (2021). Lean business models in healthcare: a systematic review. *Total Quality Management and Business Excellence*, 32(5-6):558–573.
- Rosenbaum, M. S., Otolara, M. L., and Ramírez, G. C. (2017). How to create a realistic customer journey map. *Business Horizons*, 60(1):143–150.
- Sharma, A., Harrington, R. A., McClellan, M. B., Turakhia, M. P., Eapen, Z. J., Steinhubl, S., Mault, J. R., Majmudar, M. D., Roessig, L., Chandross, K. J., Green, E. M., Patel, B., Hamer, A., Olgin, J., Rumsfeld, J. S., Roe, M. T., and Peterson, E. D. (2018). Using Digital Health Technology to Better Generate Evidence and Deliver Evidence-Based Care. *Journal of the American College of Cardiology*, 71(23):2680–2690.
- Smith, I., Hicks, C., and McGovern, T. (2020). Adapting Lean methods to facilitate stakeholder engagement and co-design in healthcare.
- Taiichi, O. (1990). *Toyota Production System, Beyond Large-Scale Production*. CRC Press.
- Tempelman, J. H. and Schildmeijer, R. (2018). *Lean In practice*, volume 128.
- Thuemmler, C. and Bai, C. (2017). *Health 4.0: How virtualization and big data are revolutionizing healthcare*.
- Tseng, M. M., ma Qin Hai, and Su, C. J. (1999). Mapping customers' service experience for operations improvement. *Business Process Management Journal*, 5(1):50–64.
- Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., Choi, Y. S., Quan, X., and Joseph, A. (2008). A review of the research literature on evidence-based healthcare design. *Herd*, 1(3):61–125.
- Verhoef, P. C., Lemon, K. N., Parasuraman, A., Roggeveen, A., Tsiros, M., and Schlesinger, L. A. (2009). Customer Experience Creation: Determinants, Dynamics and Management Strategies. *Journal of Retailing*, 85(1):31–41.

Appendix A

Appendix A

A.1 Ground Lines planning in care unit

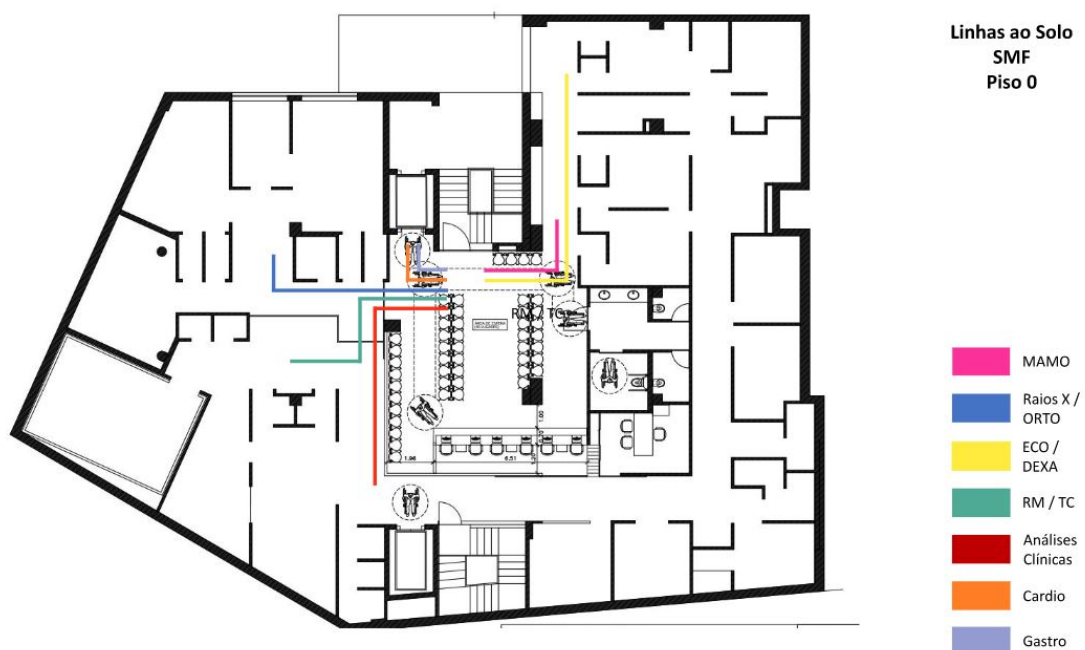


Figure 31: Ground lines planning of floor 0



Figure 32: Ground lines planning of floor 1