ISCTE Business School
Instituto Universitário de Lisboa

LEAN AND AGILITY IN THE HEALTHCARE SECTOR:

THE CASE OF HOSPITAL DE LAMEGO

Luís Filipe Martins Órfão

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Supervisor:

Prof. Ana Lúcia Martins, Assistant Professor, ISCTE Business School, Department of Marketing, Operations and General Management

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Abstract

Healthcare services have been subject of various research aiming at process improvement under a lean approach. Another perspective – Agility – has also been used, though in a lower scale, in order to analyse the ability of different hospital services to adapt to demand uncertainties. Both perspectives have a common denominator, the assessment of effectiveness and efficiency of the services in a healthcare setting context. The present research aims to analyse the impacts of the combination of both perspectives in the effectiveness and efficiency of an hospital service.

The adopted methodology is based on a case study approach applied to the process of the ambulatory surgery service of Hospital de Lamego. Data was collected from direct observations, formal interviews and informal conversations. This process has been selected according to three criteria, which were fully met. The customer of the process was identified as well as his perception of value.

The process has been mapped using a flow chart, on a process modelling perspective, as well as through the use of Value Stream Mapping (VSM), Process Activity Mapping and Spaghetti Diagram, which have enabled the identification of three types of waste and improvement suggestions.

The results point out that leagility cannot be applied to the process, but the application of lean and agility would bring benefits in both efficiency and effectiveness, and contribute to value creation if improvements are introduced in hospital's human resources and facilities management.

Keywords: Lean Thinking; Agility; Leagility; Healthcare Services.

JEL Classification System:

M11 – Production Management;

I15 – Health and Economic Development

Resumo

Os serviços de saúde têm sido alvo de diversos estudos tendo em vista a melhoria de processos de acordo com uma perspetiva *Lean*. Outra perspetiva – *Agility* – tem também sido usada, embora em menor escala, de forma a analisar a habilidade de diferentes serviços hospitalares em se adaptarem às incertezas da procura. Ambas perspetivas têm um denominador comum, a avaliação da eficácia e da eficiência dos serviços dentro de um contexto de prestação de cuidados de saúde. O presente estudo destina-se a analisar os impactos da combinação das duas perspetivas, na eficácia e eficiência de um serviço hospitalar.

A metodologia adotada baseia-se num caso de estudo aplicado ao processo de um serviço de cirurgia de ambulatório no Hospital de Lamego. Foram feitas observações diretas, entrevistas formais e conversas informais para a recolha de dados. Este processo foi selecionado seguindo três critérios, sendo todos eles cumpridos. O cliente do processo foi identificado bem como a sua perceção de valor.

O processo foi desenhado usando um fluxograma, na ótica de modelação de processos, assim como através do uso de outras ferramentas como o *Value Stream Mapping*, *Process Activity Mapping* e *Spaghetti Diagram*, tendo sido possível identificar três tipos de desperdício, sendo apresentadas sugestões de melhoria.

Os resultados indicam que o conceito de *leagility* não pode ser aplicado no processo, mas a aplicação de medidas *lean* e *agile* traria benefícios tanto na sua eficácia como na sua eficiência, contribuindo para a criação de valor para o cliente, se as melhorias forem introduzidas na gestão dos recursos humanos e instalações do hospital.

Palavras-chave: Pensamento Lean; Agility; Leagility; Serviços de Saúde.

Sistema de Classificação JEL: M11 – Production Management; I15 - Health and Economic Development

Thanking Note

In memory of my uncle Antonino de Carvalho Rebelo Órfão who taught me that all battles deserve to be fought, even the ones we know we cannot win. His strength, joy, happiness and willingness to live gave me the support to develop this thesis on such area and that means the world to me. May he rest in peace.

To my parents, sister, girlfriend, family and friends, who were always by my side, giving me strength to raise my head and look forward during tough times. A special word to my dear friend Sergio Mendonça, with whom I spent long working evenings developing our thesis, pushing each other to the next level, I wish him all the best for his professional career.

To Centro Hospital de Trás-os-Montes e Alto Douro, especially to Dra. Ana Lúcia Marinho and Nursing Chief Jorge Sousa for hosting me at Hospital de Lamego and for demonstrating such interest and collaboration in the development of this thesis.

To my supervisor Ana Lúcia Martins to whom I am extremely indebted and sincerely thankful, a special word of gratitude. Her comprehension, enthusiasm, motivation and insightful critics were fundamental so that I could develop the present study.

"Efficiency is doing better what is already being done"

Peter Drucker

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1. Introduction

Maslow (1970) states that humans motivate themselves once their lower level needs are satisfied, and presented five stages of hierarchical needs, being the base of this hierarchy the biological and psychological needs. By satisfying these needs Humans can enter a physical and psychological balanced state that motivates them to improve. Thus, it is essential to the human nature that basic needs, as the ones referred, get satisfied.

A strong healthcare system might bring benefits to a country's social and economic environment (Bartlett, Rogan, & Butler, 2016). Public or private, paid or free, it is essential that one has a reliable and trustworthy system whenever needed, so that it could fulfil his necessities. However, this has always been a sensitive subject to every government. Although healthcare represents an important part of the social system, it has a lot of expenditure associated. Still, the public sector's spending faces a faster growing than private sector's (Bartlett *et al.*, 2016).

In Portugal, the public healthcare system, though paid, is considered almost free for its citizens and it represents a major part of the country's expenditure on its annual budget (Ministério das Finanças, 2016).

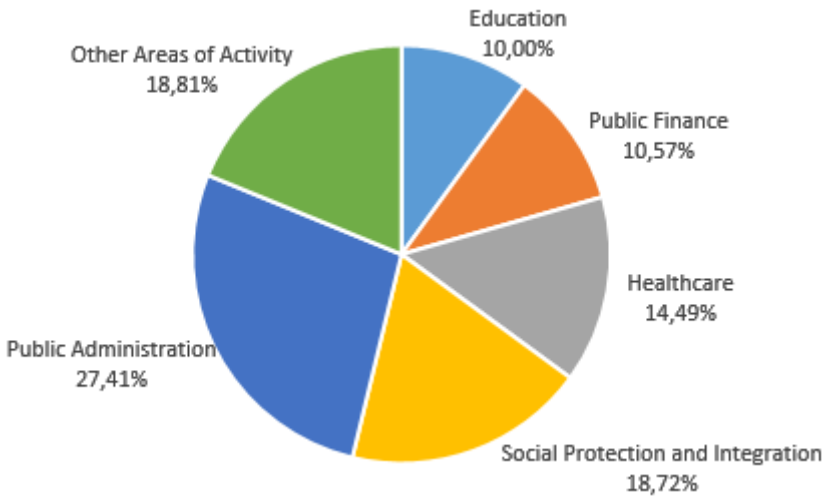

Figure 1 - Government Expenditure by Activity Area
Source: 2016 Government Budget

For 2016, as illustrated in Figure 1, the expenditure related to healthcare weighs 14,49%, representing the third biggest expense only after Public Administration and Social Protection and Integration Expenses (Ministério das Finanças, 2016). Because of the high costs associated to this sector combined with no relevant incomes, it is vital to optimize

all resources in order to develop efficient treatment process. By doing so, medical institutions can minimize costs and, at the same time, strive for service excellence.

Despite the financial crisis and austerity measures adopted in Portugal, the Portuguese healthcare system has been improving its general performance for the last years as indicated in the Euro Health Consumer Index 2015 (Björnberg, 2016). However, according to the same index (Björnberg, 2016), there was a small setback in 2015 mainly due to patients being less positive about waiting times, which demonstrates that there are always adjustments and improvements to be made, on a continuous basis.

1.1. Problem Stating and Research Goals

Lean thinking is a management philosophy widely studied in the industrial sector. More recently it has been subject of study on a context of application to the service sector (Aronsson, 2015; Aronsson, Abrahamsson, & Spens, 2011; Bonaccorsi, Carmignani, & Zammori, 2011; Bortolotti & Romano, 2012; Chaneski, 2005; Demers, 2002; Doğan & Unutulmaz, 2014; Hines, Martins, & Beale, 2008; Holmes, 2007; Juroff, 2003; Kim, 2013; Piercy & Rich, 2009a; Radnor & Johnston, 2013; Smart, Maull, Radnor, & Housel, 2003; Staats, Brunner, & Upton, 2011; Vinas, 2004; Wei, 2009), though with some adaptations to the original concept (Radnor, 2010; Radnor & Boaden, 2008). Studies have shown the benefits and efficiency improvements of its application in various services such as financial services (Piercy & Rich, 2009a), call centre operations (Piercy & Rich, 2009b; Sprigg & Jackson, 2006), IT (Staats et al., 2011) or offices (Chaneski, 2005; Chen & Cox, 2012).

The application of lean thinking has been also studied in the healthcare sector, with various studies in different wards of an hospital (D'Andreamatteo, Ianni, Lega, & Sargiacomo, 2015; Doğan & Unutulmaz, 2014). For instance, Aronsson (2015) studied the patient flow of an inpatient ward while Aronsson et al. (2011) studied the patient flow throughout the supply chain encompassing emergency ward, orthopaedic ward and operating room.

However, in the healthcare sector literature is parse on the study of lean within the hospital as a whole, though it is common to study single wards or departments (D'Andreamatteo et al., 2015). According to the same author lean thinking concept could be applied in a holistic way (not a strategy but a cross-sectional mindset throughout the hospital with impact in the culture of the hospital), but it is very difficult to study the

impact of lean in its entirety due to the different dynamics of each ward. For instance, the operations dynamics of an Emergency Room (ER) is completely different from the dynamics of a Paediatric ward. Nonetheless, even with different studies on distinct wards the results converge to the benefits of lean on healthcare services.

The emergency room, due to its urgency nature and unpredictability is one of the most studied wards. Nonetheless, literature has been sparse to the ambulatory ward, despite of the high weight it represents on clinical services (Björnberg, 2016). As a matter of fact, ambulatory surgery integrates all surgeries that are made on a non-urgent scenario, thus resulting in waiting lists and specific logistics to treat patients.

According to the Portuguese law 110-A/2007, of January 23rd, Ambulatory surgery can be defined as *"a programmed surgical intervention performed under general, loco-regional or local anaesthesia, which although usually performed on inpatient care context, it can be performed in own facilities with security and in accordance with the current legis artis, in hospital admission and discharge context, on a maximum period of 24 hours".*

Thus, it is crucial that the processes and activities related to an ambulatory surgery are efficiently and effectively performed, otherwise the patient has to be transferred to the inpatient care which implies the use of more hospital resources resulting in higher costs of care.

Healthcare managers face several challenges in operations that directly or indirectly affect the costs of the hospital (Radnor, Holweg, & Waring, 2012). Still, as in other services, the service provided has to be of high level in order to meet and/or exceed customer requirements (Allway & Corbett, 2002). Rethinking value and increasing process performance will consequently impact the costs, just as Bicheno (2008, p. 11) states: *"Don't manage cost; manage Value".* Thus, healthcare has to adopt a point of balance between patient service and providing efficiency in order to reduce costs while increasing the value of service (Brailsford & Vissers, 2011).

Another concept whose application to hospitals has been studied is the agility concept (Aronsson, 2015; Aronsson et al., 2011; Rahimnia & Moghadasian, 2010). Just as lean, an agility philosophy aims at efficiency and effectiveness gains. However, the two distinguish from each other in its fundamentals. According to Naylor, Naim, & Berry (1999), while lean is well suited in environments with predictable demand, an agile

strategy could be more appropriate when demand is unpredictable. The same authors still defend that, although different, both strategies could be complementarily used, in a leagile approach, where the boundaries of each strategy would be set by a customer's order penetration point, the decoupling point.

As already mentioned, Portuguese patients have been less positive about waiting times, either it is waiting for an appointment with the family's doctor, at the ER or waiting for a surgery that could happen from weeks to months. This waiting time may result on severe negative impacts for the patients if the problem is not treated in due course.

Hence, the present study will focus on the application of lean tools and the agility concept to optimise a specific service of an hospital, namely its Ambulatory Surgery which is the main service of the hospital, in order to assess the potential reduction of waste and consequently value creation. The aim of this thesis is *to analyse if the application of lean tools and principles allied to the agility concept create effectiveness and efficiency gains for an hospital pathway of ambulatory surgery and analyse the impact on the human resources and facilities management.*

Aiming at the aforementioned purpose, this thesis will be developed to reach the following partial goals:

1. Select the criteria that underlie the choice of the pathway;
2. Identify the customer throughout the whole pathway;
3. Map and analyse the process of the pathway;
4. Identify activities, resources and agents that are integral part of the process;
5. Identify and classify the types of waste observed;
6. Develop and suggest improvements to the process mapped.

1.2. Research Question

Taking into account the purpose of the present thesis, the following research question arise:

RQ 1: How can the effectiveness and efficiency of an hospital pathway of ambulatory surgery be affected by the application of the leagility concept?

1.3. Case Study Approach

This study is conducted under the case study approach, which focuses on understanding the performance of a management situation (Eisenhardt, 1989).

This approach is suited on the research of contemporary phenomenon observable in real-life events regarding organizational and management processes (Yin, 2009) as well as in areas with limited existent literature (Eisenhardt, 1989). It also is a good approach when it is needed a holistic and in-depth investigation of a research topic (Feagin, Orum, & Sjoberg, 1991).

A case study research, using an exploratory approach, is used to explore heterogeneous situations that require innovative solutions (Delgado, Ferreira, & Branco, 2010), though whose interventions have no clear set of outcomes (Yin, 2009).

According to Yin (2009), a case study should be developed whenever three requirements are met: i) a "how" or "why" question; ii) there is low or no control over the events and behaviours of the events analysed; iii) the research should be focused on contemporary events.

Taking into account the characteristics defined by Yin (2009) and the research question proposed on subchapter 1.2, the case study is defined as the suitable methodology to develop this research in order to identify, describe and assess how the use of the leagility concept can impact the sub-processes inherent to a clinical pathway of ambulatory surgery and the level of impact it represents to the hospital and patients.

1.4. Scope of the Study

This research will be developed in the Hospital de Lamego, located in the North region of Portugal. This hospital is a hospital of proximity so, beside the emergency services provided it is mainly focused on ambulatory surgery. This service is built around a service path which comprehends two types of surgery: ophthalmological surgery and general surgery.

Considering the specifics of the ophthalmological surgery, this type of procedure is not subject of study, representing a limitation to the study due to the fact that it also is part of the pathway. However, the logistics and resource management are somewhat different from the other procedure so this could be a subject of study in the future

The type of surgery in scope of this thesis is the general surgery which has a pathway built around it that focuses on the patient since the first medical appointment, at the hospital, to medical discharge. The activities inherent to this pathway will be analysed and the results obtained from such study will be valid exclusively for this area of research.

1.5. Thesis Outline

In order to answer the research question proposed on subchapter 1.2 this thesis is developed according to the following macro structure:

- **Introduction:** presentation of the subject in study as well as the research question proposed and how it will be approached;
- **Literature Review:** it comprehends the theoretical review of the existent literature regarding several concepts that support the development of the thesis;
- **Methodology:** it shows how the thesis is developed, which tools are used, why are those tools used and the reasons to choose a case study approach as line of work;
- **Case study analysis:** analysis of the business process in study under the concept of leagility, identifying and discussing the wastes and decoupling points that may be subject of improvement;
- **Conclusions:** analysis of the research outcomes summarizing the results and improvement recommendations, as well as study's limitations and future research topics.

2. Literature Review

In this chapter, literature regarding the subject in scope of this research will be reviewed in order to understand what has already been studied and what is defended by different authors.

Firstly, it will be given a shortly overview of supply chain strategies, highlighting two strategies that, more than a concept, are a management philosophy, Lean and Agility. Then Lean approach is reviewed by verifying literature regarding its evolution, principles and characteristics, as well as its application to a services context. Agility approach is revised afterwards in both manufacturing and service contexts, narrowing the literature reviewed to the application of agile strategies in the healthcare sector.

As Lean and agile are two different strategies, a comparison of both is made in order to understand how can both be used is the supply chain, leading to the last point of literature review where it is analysed the leagility approach in the healthcare sector.

This chapter finishes by presenting a summary of the literature reviewed regarding the topics in study.

2.1. Supply Chain Strategies

Companies' ability to adjust and evolve is the key to increase competitiveness in the market. On a business environment as complex and dynamic as in the current days, companies try to take advantage of the opportunities and strengths, from both the market and the company itself, in order to become more competitive. Such ability to compete has started to be developed not between companies, but between supply chains (Christopher, 2011; Christopher & Towill, 2001; Fawcett & Clinton, 1997; Monczka & Morgan, 1997). This position is also supported by Gnanendran & Iacocca (2015) who refer that a supply chain is a series of value-adding stages that contribute to product differentiation.

Managing supply chains is complex and cannot be considered as something static that serves different contexts due to the uncertainty of products, market, suppliers and customers. As uncertainty is part of supply chains, Lee (2002) developed a framework based on demand and supply uncertainty in order to understand how supply chains should be managed.

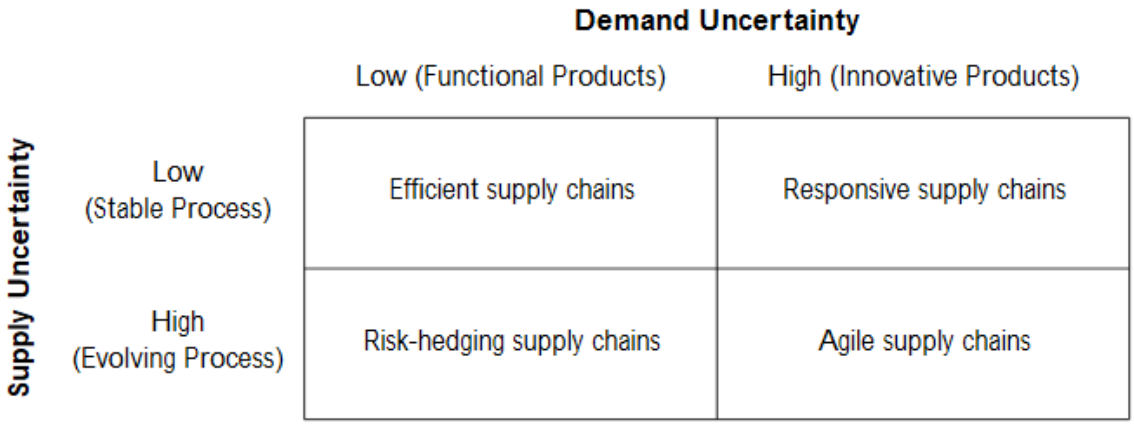

Figure 2 – Uncertainty Framework
Source: (Lee, 2002)

By looking at the framework designed by Lee (2002) in Figure 2, the strategy to be used should be adopted taking into account the uncertainty level of both supply and demand. Efficient and risk-hedging supply chains involve cost-efficiency strategies and risk diversification by resource sharing, respectively. Responsive supply chains comprehend the variety of customers' needs which implies responsiveness and flexibility. At last, agile supply chains combine the strength of the risk diversification and responsive supply chains in order to be responsive and flexible at the same time that resources can be allocated to meet demand. These supply chain strategies are explored in a more detailed way in the following subchapters.

2.2. Lean Approach

2.2.1. Lean Thinking Evolution

The foundations of Lean thinking are related to the innovations held by Toyota Motor Corporation while pursuing a method to improve overall efficiency (Hines, Found, Griffiths, & Harrison, 2011). These innovations comprehended mainly the elimination of waste (*muda*) but also the unevenness and excess of flow materials (*mura* and *muri*) on mass-production (Hines, Holweg, & Rich, 2004; Mccuiston & Delucenay, 2010).

Although Lean thinking was adopted by a Japanese car manufacturer, it took some time to western companies adopt this mindset (Hines et al., 2004). The turning point took place due to the studies conducted by MIT researchers, who analysed the gap between Japanese and Western automotive manufacturers (Hines et al., 2004; Piercy & Rich, 2009b). This analysis was published on the book *The Machine that Changed the World*, creating the approach referred to as 'Lean production' (Womack, Jones, & Roos, 1990).

The lean era was the peak on what concerns to car manufacturing, where efficiency and effectiveness was continuously seek, by developing and applying a diversity of strategies, techniques and tools (Hines et al., 2004; Husby, 2007; Piercy & Rich, 2009b; Suárez-Barraza, Smith, & Dahlgaard-Park, 2012). This evolution of lean thinking was made throughout time and can be grouped into five different stages, as originally developed by Hines *et al.* (2004) and later by Stone (2012).

The *Awareness* stage (Hines et al., 2004) coins the early steps of lean thinking and took place before the last decade of the 20th century. During this decade, only shop-floor practices were being covered and it was applied to manufacturing.

The next decade, from the early 90's until 2000, had marked two cumulative eras on what lean thinking regards, being named *Quality* and *Quality, Cost and Delivery* (Hines et al., 2004), where manufacturing techniques evolved from being only shop-floor techniques to embrace the management of the value stream, being value stream "the set of all the specific actions required to bring a specific product (…) through the three critical management tasks of any business: *problem-solving task* (…), *information management task* (…), and *physical transformation task*" (Womack & Jones, 2003, p. 19). In fact, during these two eras, as the names suggest, there was a focus on quality by linking lean and supply chain with the introduction of "pull" mechanisms. This evolution was possible due to the establishment of 5 lean principles (Womack & Jones, 2003), which have widen lean to a variety of industries (Cuatrecasas Arbós, 2002; Piercy & Rich, 2009b; Swank, 2003).

The fourth stage, named as Value System (Hines et al., 2004), intended to highlight the importance of value throughout the entire supply chain. At this point, companies were not only shop-floor focused on quality and cost reduction, but also on creating value to the customer.

The fifth and last stage is the most recent stage on the lean thinking evolution. This stage focus on the expansion of lean to other areas and integrate lean in the culture of organisations embracing its human resources (Baines, Lightfoot, Williams, & Greenough, 2006; Bayou & de Korvin, 2008; Hines & Lethbridge, 2008; Mccuiston & Delucenay, 2010; Piercy & Rich, 2009b; Radnor & Johnston, 2013). Stone (2012) defines this stage as more focused on performance and driven by 4 pillars: quality, cost, delivery and safety.

Withdrawing the understanding surrounding lean since its early ages, it is possible to note that its definition has also been subject of adaptations. Womack et al. (1990, p. 13) defined lean as a philosophy that "uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products.". It is, then, "a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with exactly what they want." (Womack & Jones, 2003, p. 15). These definitions have been subject of many improvements. For instance, Bayou & de Korvin (2008, p. 289) defined lean as "a strategy to incur less input to better achieve the organization's goals through producing better output, where ''input'' refers to the physical quantity of resources used and their costs, and ''output'' refers to the quality and quantity of the products sold and the corresponding customer services". In other words, it is the ability to efficiently respond to customers' requirements by "producing at the pace of customer demand and facilitating flow through the systematic elimination of non-value-adding activities" (Lyons, Vidamour, Jain, & Sutherland, 2011, p. 477).

2.2.2. Essentials of Lean

Although the roots of lean thinking are based on the automotive industry, five principles were set to allow its use in other industries (Womack & Jones, 2003):

1. **Value –** specify value perceived by the customer since value is only defined by the customer;
2. **Value Stream –** manage the value stream, step by step, to highlight waste and deliver value to the customer;
3. **Flow –** Ensure production is made through a flow without stops;
4. **Pull –** Producing at the pace of customers' pull by delivering what the customer needs when the customer needs it;
5. **Perfection –** Continuous improvements on the processes towards perfection.

The combination of these principles with the different eras on manufacturing, which are still complied nowadays (Chen & Cox, 2012; Rahani & Al-Ashraf, 2012; Vienazindiene & Ciarniene, 2013), makes it possible to realize that the focus changed from just quality to quality, cost and delivery and then to customer value, so that the customer could get

what they want in a timely manner, with good quality and at an affordable cost to both client and company (Hines et al., 2004).

However, in order to create value, it is important to reach a cost-value equilibrium, by reducing internal waste and increase customer value, as shown in Figure 3 (Hines et al., 2004).

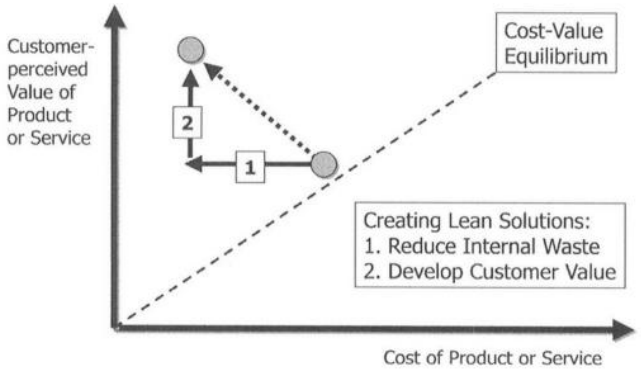

Figure 3 - Relation of Value, Cost and Waste
Source: (Hines et al., 2004)

Figure 3 demonstrates the relation between value, cost and waste. Hines at al. (2004) state that the line illustrating the cost-value equilibrium represents a product that costs as much as the value the customer is willing to pay for. Thus, in order to reach a point where the customer-perceived value is higher than the cost of the product or service, value should be increased by reducing internal waste, hence reducing the costs, and develop customer value by adding features or services that increase customer value perception.

One of lean's characteristics rely on the elimination of waste, by streaming the activities associated to a process. According to Hines, Silvi & Bartolini (2002), waste represents everything that does not add value to a process. Ohno (1988) has concluded that there are seven types of waste in manufacturing:

- **Overproduction:** relates to the production of products that although might create economies of scale, by producing too much or too soon can result in excessive stock;
- **Waiting:** represents the idle time that a product/component is not being used;
- **Transport:** regards to the excessive physical movement of people and materials, which does not add value to the process;

- **Overprocessing:** adoption of complex solutions rather than simpler ones, by using wrong tools or systems;
- **Inventory:** it is related to the excessive stock, constituting a bottleneck in the products' flow by stocking more products than the ones that are being dispatched, also impacting on storage costs;
- **Motion:** related to the movements of employees that could be done with a more ergonomic approach, resulting in employees being tired faster, hence reducing productivity;
- **Defects:** errors made along the process resulting in problems on the quality of the product.

However, as the value stream comprehends "the set of all the specific actions required to bring a specific product" (Womack & Jones, 2003, p. 19), there was a need to extend the waste removal to the entirety of the supply chain (Hines & Rich, 1997). These types of waste were renamed under a warehouse distribution setting by Jones (1995), on an after-market industry which is composed by a mix of manufacturing and service. Jones (Jones, 1995) reworded the original wastes to:

- Faster-than-necessary pace;
- Waiting;
- Conveyance;
- Processing;
- Excess stock;
- Unnecessary motion;
- Correction of mistakes.

These types of waste can be identified throughout the value stream, however the processes may not have the same weight, so it is important to define different types of categories in which waste could fit in (Hines et al., 2002). Each and every activity performed in a business process could be either Value Adding (VA), Necessary but Non-Value Adding (NNVA) or Non-Value Adding (NVA) activities (Hines et al., 2004; Hines & Rich, 1997). According to the same authors, value adding activities are those activities that make a product more valuable increasing the customer-perceived value of a product; necessary but non-value adding activities, also called Support Activities are those activities that may need to be performed, though it does not add value to the product in the eyes of the

customer; at last non-value adding activities are all those activities that are not necessary to the production of the product and not adding any value to the customer-perceived value of the product, and as these activities are wasteful ones, they should be eliminated.

2.2.3. Lean Sustainability

Besides the evolving aspect of Lean, it also exists at two complementary levels: operational and strategic. While at the operational level, companies could benefit the most from shop-floor tools, at the strategic level companies could use lean thinking on a strategic value chain aspect (Hines et al., 2004). In fact, if the strategic thinking is neglected, the company will only address to the cost axis of the graph presented in Figure 2, which might make them miss the core objective of lean: to deliver customer value (Hines et al., 2004). Nevertheless, in order to have a sustainable lean Programme, there are several other factors that should be considered. These factors could not always be seen, which makes it possible to create an analogy with an Iceberg (Hines, Found, Griffiths, & Harrison, 2008), as shown in Figure 4.

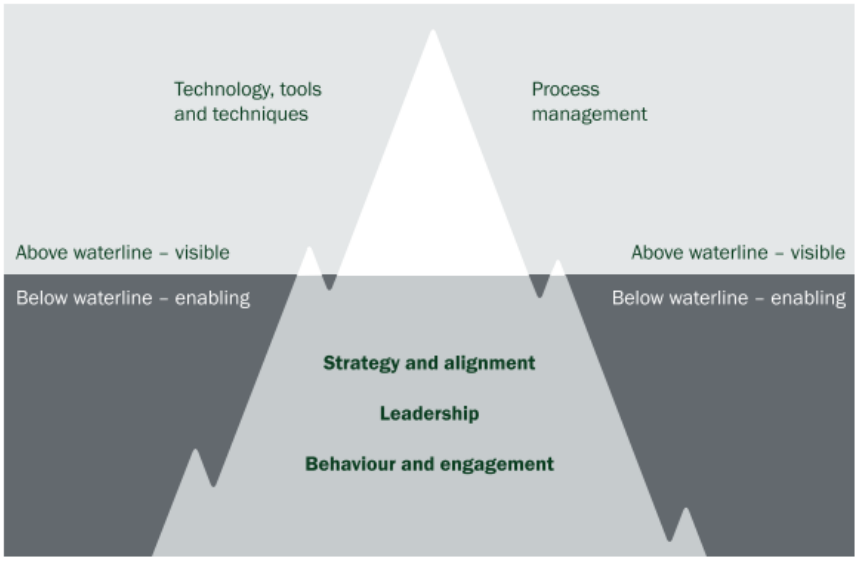

Figure 4 - The Sustainable Lean Iceberg Model
Source: Hines, Found, et al., (2008**)**

A sustainable lean company is the one where it is possible to see and act in both above and below the waterline (Hines, Found, et al., 2008). Above waterline elements refer to the tools and techniques used to lean the processes and get results. However, it is also important to address to the below waterline elements, being these the invisible elements that sustain the entire iceberg (Hines & Lethbridge, 2008). The same authors also refer that although there are two distinct levels – above and below waterline – all elements are

interdependent and only addressing all these components it is possible to reach a successfully sustainable lean transformation. According to Dennis (2006) there could be two implementation approaches of the iceberg model: a bottom-up approach which is quick win approach with immediate benefits but lacks of sustainability, and top-down approach involves culture transformation. Hines & Lethbridge (2008), on the other hand have stated that a combination of the two approaches would bring both immediate benefits as well as sustainability in the long run.

Therefore, it is vital to have an inspirational leadership that can adapt the behaviour of the employees, engaging them with a "*coherent strategy, vision and purpose*" (Hines, Found, et al., 2008). Moreover, engagement of employees is a vital part of this sustainable equation, because employees are the ones who have true knowledge of their tasks and what is happening on the field (Bonaccorsi et al., 2011). This sustainability is achieved if the processes are held throughout an unending circular chain of business operations that involve a continuous progression (Mccuiston & Delucenay, 2010). Hence, though lean mainly focuses on the management of materials' flow, layout design and timings of production and distribution (Bortolotti & Romano, 2012), it can be summed up as an integrated socio-technical system designed to eliminate waste (Bortolotti & Romano, 2012; Rachna Shah & Ward, 2007) by aligning production and demand, suppliers and employees (Al-Aomar, 2006; Bortolotti & Romano, 2012; Lyons et al., 2011), focusing on delivering value to the customer (Al-Aomar, 2006; Allway & Corbett, 2002). These generalized characteristics denote a general and embracing definition of Lean, which represent a change of paradigm, from lean production to lean management, allowing lean not to be applied only to production activities but to other activities within a company (Bortolotti & Romano, 2012).

2.2.4. Lean Thinking and Services

Even though the origins of lean thinking are based on the automotive industry, lean approach can also be applied to a wide number of manufacturing industries (R Shah, 2003), as well as to service companies (Allway & Corbett, 2002; Bonaccorsi et al., 2011; Bortolotti & Romano, 2012) though these are more complex and stochastic than the former (Al-Aomar, 2006) as well as not as efficient (Bortolotti & Romano, 2012).

All organizations, either manufacturing or non-manufacturing, have operational processes whose goal is to deliver value to the customer, thus, service organizations "need

to focus on delivery service and quality that meet or exceed customer expectations" (Allway & Corbett, 2002, p. 45). To do so, by using a lean approach, several phases need to be followed (Allway & Corbett, 2002):

1. **Assessment of the current state –** run a diagnosis to assess the operational level of excellence and waste opportunities;
2. **Determining the Target state –** define the final outcome, communicate and integrate it with business strategy;
3. **Stabilizing the operations –** push the company away from problems by analysing inefficiencies, design solution and evaluate its progress;
4. **Optimize Opportunities –** push the company towards improvements by spotting opportunities and ensuring a continuous flow of materials, people and information;
5. **Institutionalizing the Lean Approach –** develop a sustainable lean model that engage a multi-tasked workforce to embrace a lean culture.

By following all these steps it will be possible to reduce waste associated to the processes as well as identify value-added and non-value added activities in services' processes. Nonetheless, lean cannot be seen as an approach of process improvement focused on waste reduction (Liker, 2004). Instead, it should be seen as an approach that aims to add value and towards a constant pursuit of perfection (Kim, 2013).

Hence, Lean is a systematic approach that can be applied to both manufacturing and service industries, by embracing all the systems, processes and employees as well as customers and suppliers (Juroff, 2003).

Levitt (1972, 1976) introduced lean to services by stating that it would benefit from the principles applied in manufacturing. This, however, was not unanimous between scientific researchers at that time. Various researches stated that services would not benefit from lean due to the high variability associated to the services sector (Abdi, Shavarini, & Hoseini, 2006).

Nonetheless, service companies still faced multiple to challenges to offer the best service possible to their customers. In order to overcome those challenges different strategies of supply and operations management were studied. Bowen and Youngdahl (1998) defended, then, a shift of paradigm on the application of the lean concept to services. The authors advocate that lean could be applied to services, not with the same characteristics

of pure lean as in manufacturing, but with a mind-set of lean thinking due to the fact that the client is usually present in service processes (Abdi et al., 2006; Bortolotti & Romano, 2012; Bowen & Youngdahl, 1998; Wei, 2009) and processes are designed to bring value to the customer (Allway & Corbett, 2002).

Wei (2009, p. 821) defines service process as the one that "*does not change the shape or physical properties of materials*" leading to another aspect that is present in each stage of service processes: information. Maleyeff (2006) adds that in order to achieve Lean success, the whole company must be consistent with Lean goals. Moreover, as services organisations are focused on customers (Heskett, 1987), it is very important that information flows naturally so that the client could receive it in a fast and effectively way (Maleyeff, 2006) in order to meet and exceed the customers' expectations (Heskett, 1987).

Although the application of lean thinking is suitable in a service context, this sector would still have some challenges to overcome that would not be visible in the manufacturing area (Allway & Corbett, 2002). In fact, the differentiation between those kind of companies could be based on the IHIP (Intangibility, Heterogeneity, Inseparability of service delivery and consumption, and Perishability) that not only distinguish manufacturing from services, but also among services (Alsmadi, Almani, & Jerisat, 2012; Bortolotti & Romano, 2012).

Services are made by people to people and human resources take vital part in the entirety of services processes, thus it is vital that staff is involved at every level so that the service process could be efficient as whole and not the sum of its parts (Jones & Mitchell, 2006). Services have an intangibility associated to it, as there is no product along the process but a service, which would result in the impossibility of creating inventory, and it would also be difficult to forecast demand (Bowen & Youngdahl, 1998; Maleyeff, 2006; Wei, 2009).

Lean application has been widely studied throughout various services in distinct sectors. Swank (2003), Allway & Corbett (2002), Buzby, Gerstenfeld, Voss, & Zeng and Hammer (2004) studied the application of lean thinking in the Financial and Insurance sector; Bowen & Youngdahl (1998) and Womack & Jones (2005) studied how lean could be applied in delivery process and food preparation; Piercy & Rich (2009a, 2009b) and Sprigg & Jackson (2006) studied the impact of Value Stream Mapping (VSM) and standardisation of scripts in a call centre context; Hines, Martins, & Beale (2008)

identified wastes in the legal sector while Bowen & Youngdahl (1998) applied lean techniques in the airlines sector and Crute, Ward, Brown, & Graves (2003) in the aerospace sector.

The healthcare sector has not been ignored among researchers. In fact, despite of the sparse literature related to the lean thinking application in healthcare, it has recently become a hot topic of research, and some healthcare organisations have already applied lean thinking to their processes with promising outcomes (D'Andreamatteo et al., 2015). Jones & Mitchell (2006) gave an overview of the benefits of lean applied to healthcare highlighting the importance of value through Value Stream Mapping.

According to Young et al. (2004), there are similarities between production and healthcare services, since both are a complex interaction between individual activities. However, it is important to identify weak links or bottlenecks and know how to handle them, which requires strong leadership and employee commitment.

An opposing view is present by Kim, Spahlinger, Kin, & Billi (2006) that refer that although it is possible to apply lean in healthcare, it could be difficult since lean techniques used in other industries differ from healthcare and clinical departments act autonomously. These barriers could explain slow implementation of lean, despite the increasing interest in lean in healthcare (D'Andreamatteo et al., 2015).

Nonetheless, although it takes a long time to change the culture of an organisation so that its departments act as whole, Spear (2005) shows that some healthcare organisations are getting promising results by improving the way work is done with short-term measures.

Being the reduction of waste one of the characteristics of lean thinking, it is important to understand how waste can be perceived in a service context. Hence, Juroff (2003) renamed the categories, as represented in Table 1, opening its use to the service context characterized by value streams that might not be visible like it is in manufacturing.

Value Adding Activities (VA)	Value Adding Activities (VA)
Necessary but Non-Value Adding Activities (NNVA)	Non-Value Adding activities (NVA)
Non-Value Adding activities (NVA)	Waste

Table 1 – Categories of value adding activities

As already mentioned, lean in the manufacturing industry does not have the same characteristics as in the service sector. Thus, the original wastes identified by Ohno (1988) could not apply in its entirety in services context leading researchers to study how service

waste can be perceived. For instance, Hines et al. (2008), as previously mentioned, studied the extension of lean thinking to the legal sector, identifying various points of waste along the process while Swank (2003) proved that services, as in insurance companies, could use the same benefits of lean as in manufacturing by removing waste and Kumar & Bauer (2010) have shown that public sector faces some challenges on waste elimination.

Maleyeff (2006) took a step forward in the analysis of waste and established a connection between the original types of waste identified by Ohno (1988) and the types of waste present on services, developing seven categories of service waste:

- **Delays:** it can either be time wasted on delivering or queuing a physical file or other type of information;
- **Mistakes:** this type of waste could have internal and external consequences, either it impacts colleagues have to redo their work causing disruption of normal activities, or it impacts customers that could not get satisfied with the company;
- **Reviews:** actions made to check how work is performed in order to detect errors or omissions;
- **Movement:** related to the physical transportation of information and resources;
- **Duplication**: when the same activity or task is done more than once at different stages of the process
- **Process inefficiencies:** when resources are not used in the correct way or are used ineffectively in a specific task;
- **Resource inefficiencies:** related to the ineffective management of resources.

Although different from manufacturing, waste reduction can also be applied in a service context, being information a key element throughout a service. Thus, employees should handle information accordingly so that any of the above mentioned waste could be reduced or avoided.

Despite of the importance of waste reduction and elimination, a lean approach should not be entirely focused on such characteristic (Bortolotti & Romano, 2012; Hansen & Olsson, 2011; Hines et al., 2004, 2002, Womack & Jones, 2005, 2003). It should be seen as management philosophy integrated at all levels of the company embracing a culture of continuous improvement so that it reaches its ultimate goal: maximize costumer value

(Chen, Yu, & Chen, 2015; D'Andreamatteo et al., 2015; Doğan & Unutulmaz, 2014; Hansen & Olsson, 2011; Kim, 2013).

2.3. Agility

Besides the lean approach, another management philosophy that can be used as a supply chain strategy is agility which has been considered as a new concept of competitiveness (Zhang, 2011).

Agility concept was introduced by a study developed by a group of investigators at the Iacocca Institute (Eshlaghy, Mashayekhi, Rajabzadeh, & Razavian, 2010; Rahimnia & Moghadasian, 2010; Sharifi & Zhang, 1999) which creating a research topic that has been widely studied over the years (Sherehiy, Karwowski, & Layer, 2007), despite the fact it had been a less popular study subject when compared to lean (Naylor et al., 1999).

Although two characteristics of agility are speed and response to change and uncertainty (Yusuf, Sarhadi, & Gunasekaran, 1999), its origins are partially based on a manufacturing method known as flexible manufacturing system which is associated to the key characteristic of agility: flexibility (Christopher & Towill, 2001).

Accordingly, Sherehiy et al. (2007) referred that there are three distinct flexibility taxonomies:

- Numerical flexibility, which regards to the number of employees or the number of working hours as response to fluctuations in demand;
- Functional flexibility, that relates to the development of employees' skills to be more capable of doing other types of tasks;
- Financial flexibility, which concerns to a paying system adapted to each individual.

These types of flexibility could be present in the organisation to achieve organisational flexibility when a response to changes in the environment is given by adjusting internal processes and procedures (Reed & Blunsdon, 1998).

In a business environment that is highly complex with unpredictable changes (Gunasekaran, 1999), agile supply chains give companies flexibility in order to adapt to the changes in their business environment (Abdollahi, Arvan, & Razmi, 2015; Christopher, 2000).

According to Yusuf et al. (1999, p. 36), agility can be defined as *"A manufacturing system with capabilities (hard and soft technologies, human resources, educated management, information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness"*. Additionally, Christopher (2000, p. 38) defines agility as "*the ability of an organization to respond rapidly to changes in demand, both in terms of volume and variety*".

Aronsson (2015) defends that an agile supply chain should be: a) responsive, in order to quickly respond to market opportunities, b) adaptable, so that it can easily be adapted to the customers, and c) robust, to withstand and overcome variations from the market

Thus, agility needs to encompass an understanding of the market since an agile supply chain is sensitive to it, by embracing a particular mindset transversal to the entire organization and its supply chain, whose application should be downstream the supply chain where it is possible to see what the customer really wants and respond to it (Christopher, 2000)

2.4. Lean vs Agility

While lean is related to the elimination of waste, it does not enable a company to meet customers' needs in a promptly manner (Naylor et al., 1999). The same authors define agility as "using market knowledge and a virtual corporation to exploit profitable opportunities in volatile marketplace" (Naylor et al., 1999, p. 108). While lean focus on the elimination of variation, agility focus on minimizing it (Aronsson, 2015).

Differences between lean and agility are evident. Some authors, such as Christopher (2000) and Rahimnia & Moghadasian (2010) defend that lean should be used in high volume, low variety and predictable environments, while agility is more used in unpredictable environments, with high variety and considerable demand.

The agility concept was developed to adapt to changes and uncertainty (Ismail & Sharifi, 2006). Rahimnia & Moghadasian (2010) state that in order to be agile it is important to focus on service level embracing flexibility and responsiveness. According to Aronsson (2015), agility mainly relies on three characteristics: i) responsive, quick response to changes and uncertainty; ii) adaptable, ease to take different courses; and iii) withstand variations, uncertainty and variability. Mason-Jones, Naylor, & Towill (2000b) refer that agility might be the next step of lean: once lean's principles are routinely implemented,

one can look after agility. However, the same authors refer that it may not be possible to generalize due to the business environment of each company.

According to Aronsson (2015), agility, from a process point of view, could create flexible capacity in order to manage and redesign the flow of goods either by extending the use of a resource or adjusting the amount of a resource ahead or as response to demand.

2.5. Leagility Concept

As mentioned, lean and agile are different strategies that can be used in the supply chain. Ben Naylor et al. (1999) state that although different, both strategies could be used complementarily, coining the term leagility.

However, although these two concepts are different from each other, it could not be used simultaneously yet they complement each other (Aronsson, 2015). Mason-Jones, Naylor, & Towill (2000a) defend that lean and agility can be combined in total supply chain perspective. Christopher and Towill (2001) showed that a hybrid approach could be made by combining lean and agile strategies. More recently, Abdollahi et al. (2015, p. 681), based on Ben Naylor et al. (1999), defined leagility as a: "*combination of agility and leanness in one supply chain via the strategic use of a decoupling point*".

The decoupling point works as the separator of the planning part of the supply chain from the customer oriented part of the supply chain (Naylor et al., 1999). The same authors defend that in this point stock is retained so that it is possible to apply the most suitable strategy, where lean and agility can be adopted upstream and downstream the decoupling point, respectively. Mason-Jones et al. (2000a) established that the decoupling point differentiates low product variability in push stages related to a lean strategy, from high variable demand present on pull stages and associated to an agile strategy.

Mason-Jones & Towill (1999, p. 16) define the decoupling point as "*the point in the product axis to which the customer's order penetrates. It is where order driven and forecast driven activities meet. As a rule, the decoupling point coincides with an important stock point – in control terms a main stock point – from which the customer has to be supplied*".

Gnanendran & Iacocca (2015) state that the decoupling point should be seen not in an operations view, but in a supply chain optic, considering the characteristics of the product.

Accordingly, Mason-Jones et al. (2000b) state that optimal performance can be ensured by matching supply chain strategies with product type, using the decoupling point in strategic locations throughout the supply chain, with a leagile approach.

2.5.1. Leagility in Healthcare

A good healthcare system is driven by the quality of its services delivered to all people whenever and wherever it is needed (Doğan & Unutulmaz, 2014). However, a system so wide like this has persistent issues, such as excessive treatment costs, long waiting times, long travelling distances and shortages of staff, that contribute to lack of efficiency (Doğan & Unutulmaz, 2014). In order to fight this problem, the healthcare system has started to look after practices that can enhance the improvement of efficiency (Aronsson, 2015), such as lean or agile. Hence, the healthcare sector has been a hot topic of study regarding leagility (Rahimnia & Moghadasian, 2010).

Chen, Yu, & Chen (2015) analysed a patient-referral process concluding that leagility should be applied to integrate the hospital information systems. Aronsson, Abrahamsson, & Spens (2011) studied the decoupling point using a leagile strategy, referring that in healthcare the decoupling point cannot be used to differentiate lean from agile, because there is a constant throughout the entire process: the patient, as a customer. It is recommended that this differentiation should be based on characteristics like volume and variety of each sub-process, where low variety and high volume regards to lean; and high variety and low volume regards to agility.

Rahimnia & Moghadasian (2010) share a similar perspective as the previous authors when declaring that a health system supply chain must be hybrid. Accordingly, leagility can have functional-innovative services depending on the location of decoupling points and stage of the supply chain, where lean applies to functional services whether agility applies to innovative services.

Therefore, it is possible to have both strategies of lean and agility throughout the supply chain, but divided by one or more decoupling points.

2.6. Summary

Up to today a great amount of studies show the impact of lean thinking applied to the industrial context. More recently this approach has been applied to the services as well, including the healthcare sector.

Agility in other hand, was being paid less attention, but it is now seen as a hot topic on its application to services. Studies have shown that agility can be applied to the healthcare sector, despite of the sparse literature around this subject. More recently there has been some developments regarding the application of lean in the healthcare sector showing that healthcare operations could highly benefit from agility strategies.

However, most the authors agree that lean and agile, though different, can complement each other. Nonetheless, literature shows that the division between lean and agile, namely the Decoupling Point, on a leagility approach applied to services may have various perspectives. The location of the decoupling point can maximize both strategies but it depends on how the supply chain is designed.

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3. Methodology

To conduct a study as specific as this, several tools and research methods were selected and applied in order to have the most accurate data and results. Throughout this chapter it will be presented a detailed and contextualized justification for each step taken during the development of the thesis, taking into account the problem stated and the proposed goals.

A theoretical framework is also presented in this chapter to support the selection of the lean tools that best fit the analysis of the process observed under the goal of this research.

3.1. Case Study Approach

The reason why the case study approach was adopted, is due to the fact that it will investigate, assess and explain a specific present circumstance regarding the ambulatory surgery pathway of a Portuguese Hospital.

According to Yin (2009, p. 2), case studies are the preferred method when:

> "(a) "how" or "why" question is being posed, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context."

As Yin (2009) stated, this type of approach is suited when there is a need to investigate current phenomenon in depth, when there is no clear evidence of boundaries between the referred phenomenon and its real life context. Moreover, case study is the preferred method when actor's behaviours should not be manipulated and there can be various sources of evidence including direct observation and interviews of the agents involved in the events studied.

Thus, the case study approach was selected as a line of work on the development of this thesis in order to give an insightful overview of the way the ambulatory surgery pathway is set and how can lean and agility concepts create effectiveness and efficiency gains to the referred pathway.

3.1.1. Characterisation

According to Yin (2009) there may be three types of case studies: (a) exploratory, (b) descriptive or (c) explanatory, which differ from each other on the type of research question, the extent of control over events and the degree of focus on contemporary or historical events, though they can be complementary to each other.

This case study has an exploratory and descriptive approach. There is a description of the events in its real-life context which are the basis to obtain information of the features of the processes studied. Then this information is used to understand how lean tools and the agility concept could help to improve the processes in scope of this thesis.

3.1.2. Design

Yin (2009) distinguishes case study designs in two axes (single/multiple and holistic/embed), resulting in four case study designs. The present case study is a holistic single-case design due to its nature. The aim of this research is to study the pathway of a single ward – the ambulatory pathway. This pathway comprehends general surgery and ophthalmological surgery. Both processes have common points but vary in resources and tasks. As ophthalmological surgery patients follow a different path within ambulatory surgery service, it is not considered as subject of study.

Therefore, the holistic single-case design is appropriate to the development of this study as it considers only the general surgery as single unit of analysis.

3.1.3. Research Ethics

This study began during an informal conversation between the author of this thesis and the director of ambulatory surgery service who approved the development of this study.

A letter was addressed to the Hospital's Board of Directors requesting a formal authorization which was granted after being discussed on the Hospital's Ethics Committee, that can be consulted in Annex 1.

In the beginning of the interviews each respondent was given an agreement of participation in the study, where it was explained the scope of the study, its objectives and the confidentiality conditions. These agreements, accessible in Annex 2, were written in accordance with the Declaration of Helsinki and Oviedo Convention, and were approved by the Hospital's Ethics Committee.

3.2. Data Collection

The data used during the development of this thesis comes from various sources, namely interviews, informal conversations, direct observations and statistical documents analysis.

Informal conversations took place during the break hours and off-peak times with nurses, medical auxiliaries and administrative assistants.

Direct observations were made in order to map the current process flow and to identify possible wastes alongside the process.

The number of interviews to be performed was initially planned to be as of a reaching point of theoretical saturation, which occurs "*when additional analysis no longer contributes to discovering anything new about a category*" (Strauss, 1987, p. 21). However, due to the nature of the Service and the dynamics and specifics of the functions and tasks of the hospital's staff, it was agreed with the Service Director and Service's Chief Nursing Officer that the interviews would be limited to them. By doing so, there would be no interference in the operations held by remaining staff. The interviews took place on the 7th of March 2016, with the service's Chief Nursing Officer, Jorge Sousa, and on the 10th of March 2016 with the Ambulatory Surgery Service Director, Dra Lúcia Marinho.

Still, it was possible to collect all the necessary info and map the process from start to end, from the informal conversations, direct observations and interviews, reaching a point of theoretical saturation, since no new information was added to the data already gathered, by the end of the week.

All data was collected during five working days from the same week, between the 7th of March 2016 and 11th of March 2016, exception made to the statistical documents which were received via email and analysed afterwards. From the five days, two were allocated to conventional surgery, while the remaining three were reserved for ambulatory surgery.

3.3. Process Selection

This research is based on the study of a process in the healthcare sector, specifically a public hospital. In order to provide a more relevant case study, the process is supported in the following criteria:

- Relevance: the process should be of great importance to the entity that has kindly accepted the development of this thesis, namely Hospital de Lamego. Therefore, the process should have a great weight in the global operations of the hospital so that the solutions to be presented could have an impact on a greater scale.
- Presence of Human Resources: this will be one of the metrics when analysing the process, hence, the process should have a wide variety of human resources, both in terms of volume and specialization.

- Waste: The main purpose of this study is to study how leagility can be applied to the healthcare sector. As already mentioned, the application of agility can take place after streaming the processes. Thus, being the basis of lean the pursuit of waste (Aronsson, 2015), the process must have waste so that it can be eliminated, allowing the application of agility.

3.4. Tools Selection

The understanding of value streams requires the mapping of value adding processes, from start to end, in order to run further inspections and analysis (Vergidis, Tiwari, & Majeed, 2008). The design of such value stream could be made under different tools.

For the purpose of this thesis two tools will be selected, in addition to the ones presented in the mapping toolkit: Value Stream Mapping (VSM) and Business Process Modelling (BPM).

According to Rother & Shook (1999, p. 3), Value stream is " all the actions (both value-added and non-value-added) currently required to bring a product through the main flows essential to every product." By mapping the value stream, one is looking at the big picture in order to improve the whole and not the parts (Rother & Shook, 1999).

Value Stream focus on the process of value adding throughout the processes studied (Hines & Rich, 1997). Therefore, an analysis should be performed along the supply chain, in every stages and embracing every agents, so that waste could be identified, hence value could be promoted (Hines & Rich, 1997). According to the same author, the achievement of such goals implies some barriers and challenges that need to be surpassed, namely the lack of visibility of value and waste, as well as not choosing the appropriate tools to reach lean purpose. Still, VSM intends to give a general overview of the process prior to a detailed analysis of the sub-processes, hence aiming at a holistic approximation towards process improvements (Bicheno & Holweg, 2009; Hines & Lethbridge, 2008; Piercy & Rich, 2009b; Poksinska, 2010).

However, besides Value Stream Mapping, it is important to use other tools to better handle the waste identified.

Business Process Modelling helps to define the flow of processes. However, it does not add any value to the process itself (Vergidis et al., 2008). Thus it is important to run an analysis of the business process in order to identify waste and increase the perception of

value. Hammer & Champy (1993) defend that a business process is focused on the product and is affected by external and internal events. In services such interference may be caused by the human involvement and the uncertainty related to it (Johnson, 2008). Such detail would be taken into account when the process is designed by a value stream mapping tool.

In addition to these tools, it will be made a selection of lean tools which is based on the VSM toolkit configured by Hines et al. (2002).

3.4.1. Value Stream Mapping

Value stream is the set of actions that compose the path a product follows from its early stage into the ultimate stage, the acquisition by the customer (Rother & Shook, 1999). By adopting a value stream perspective one is looking at the whole system rather than small processes, which allows one to see and implement a value-adding flow (Chen & Cox, 2012).

Value Stream Mapping (VSM) is another tool used to design business processes and understand the flow of information within a department or organisation. It is a "*pencil and paper tool*" (Rother & Shook, 1999, p. 7) mostly used to illustrate the flow of information, resources, and timing periods, such as cycle and waiting times while product a good or providing a service (Kim, 2013). The same author states that the process of manufacturing a product or delivering a service should serve as basis to create a current and future state value stream map. Rother and Shook (1999) mention that value stream mapping follows four stages (Figure 5).

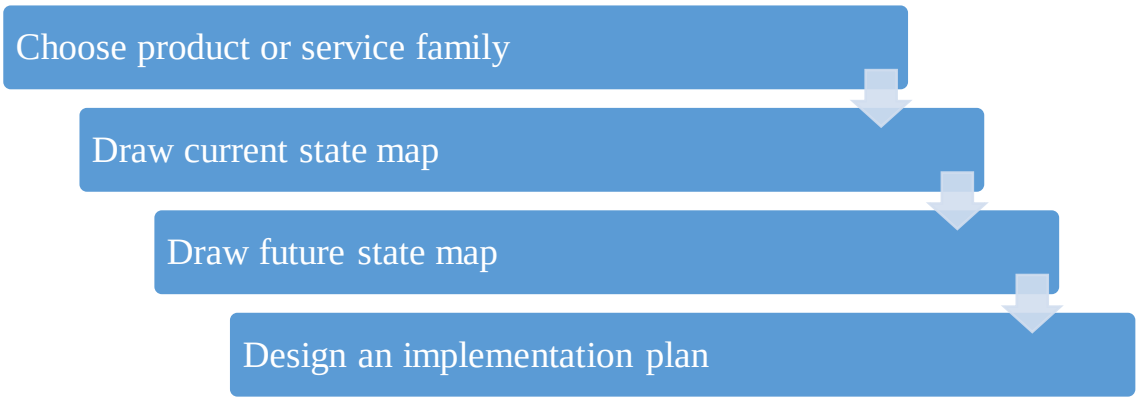


Figure 5 – Four stages to VSM
Source: (Rother & Shook, 1999)

The use of such tool has been widely used given the great amount of studies using it (Chaneski, 2005; Chen & Cox, 2012; Hasenjager, 2006; Hines & Lethbridge, 2008;

Hines, Martins, et al., 2008; Hines & Rich, 1997; Krings, Levine, & Wall, 2006; Piercy & Rich, 2009a, 2009b; Tischler, 2006; Vinas, 2004), which include both manufacturing and services context.

In a services context, the healthcare sector is one of the services where value stream mapping is used. Kim et al. (2006), Grant & Wilcox (2008), King, Ben-Tovim, & Bassham (2006), Lummus, Vokurka, & Rodeghiero (2006), McClean, Young, Bustard, Millard, & Barton (2008) used VSM to map patient flow. Bushell & Shelest (2002), Kent (2008), Mazur & Chen (2008), Parks, Klein, Frankel, Friese, & Shafi (2008) applied VSM in order to eliminate waste of healthcare processes, whereas Dickson, Singh, & Cheung (2009) Jimmerson, Weber, & Sobek (2005), Kent (2008), Kim, Hayman, Billi, Lash, & Lawrence (2007), Laing & Baumgartner (2005) used VSM pursuing process improvements.

3.4.2. Business Process Modelling

Business processes can be modelled by the use of various techniques. One of the most used techniques of process modelling is the Flow Chart due to its simplicity and flexibility allied to an ease graphical representation (Lakin, Capon, & Botten, 1996).

The use of the flow chart in this thesis aims to describe the sequence of the process activities on an effective and informal way in order to provide a quick and easy understanding of the pathway. Such technique allows a mental image of the process enabling the perception of the process as a whole.

Nonetheless, due to its simplicity it has limitations regarding the allocation of resources, staff responsibilities, events and rules (Aguilar-Savén, 2004).

Even so, the flow chart diagram, under Business Process Modelling (BPM) analysis, is selected in order to give a general and clear overview of the process, serving as the first step to understand the clinical and patient pathway.

For this thesis, the flow chart will be developed using Bizagi Process Modeller software. In order to make the design and its interpretation as clear as possible, only some graphical elements were selected from the palette that Bizagi software offers. In Table 2 it is possible to find which elements are used in this study as well as its description.

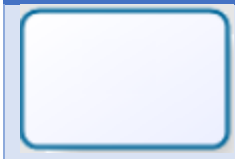
Icon	Element	Description
	Task	Used to describe the activity being made
	Multiple Start Event	Indicates when a process starts under multiple triggers but only one is required to start the process
	Intermediate Event	Indicates when an event happens representing a key milestone that impacts the process, though not determining its start or end
	Exclusive Gateway	Indicates the existence of alternative paths, where only one is chose
	End Event	Indicates when the process ends

Table 2 – Bizagi Modeller software graphical elements

3.4.3. Lean Tools Selection

3.4.3.1. Value Stream Mapping toolkit

VSM gives a general overview of the process so that it is possible to easily recognize the flow of materials and resources inherent to it (Hines et al., 2002). However, due to the nature of big picture mapping, VSM has some gaps that should be filled in, in order to address the types of waste identified accordingly (Hines et al., 2002). This waste analysis could be made under the use of other specific lean tools (Hines et al., 2002).

The use of such tools list the flow of activities and materials enabling the identification of waste. Once waste is identified, a thorough analysis is needed in order to understand how lean is applied to the ambulatory surgery pathway, under a healthcare context. Hines and Rich (1997) have designed a toolkit that summarizes some of the most useful tools, which was later adapted by Hines et al. (2002), as illustrated in Table 3, based on the original types of waste.

	Process Activity Mapping	Production Variety Funnel	Quality Filter Mapping	Demand Amplification mapping	Process Costing
Overproduction	Maybe	No	Maybe	Maybe	Yes
Waiting	Yes	Maybe	No	Maybe	Yes
Excessive transportation	Yes	No	No	No	No
Inappropriate processing	Yes	Maybe	Maybe	No	Yes
Unnecessary inventory	Maybe	Maybe	No	Yes	Yes
Unnecessary motions	Yes	No	No	No	Yes
Defects	Maybe	No	Yes	No	Yes

Table 3 – Detailed Value Stream Mapping toolkit
Source: (Hines et al., 2002, p. 35)

This toolkit serves as basis when one needs to map the value stream, by detailing which tool could be used to deal with each specific type of waste (Hines et al., 2002). By identifying the hypothetical or real existence of a determined waste it is possible to choose the most appropriate mapping tool. Mapping the value stream is not confined to the use of these tools as there are other that are useful as well. Moreover, the tools presented were originally designed to an order fulfilment setting but have the possibility to be used in other contexts.

The types of waste presented in the matrix are related to manufacturing. However, since such tools have a broad range of situations where it can be applied, some adaptations might be needed. As disclosed on subchapter 2.2.2, the original types of waste were redefined under a service setting, therefore, in order to apply such toolkit to services, one must run a comparison between manufacturing types of waste and services types of waste.

Ohno (1988) introduced the seven types of waste, which were then renamed under a warehouse distribution setting by Jones (1995), on an after-market industry which is composed by both manufacturing and service; Maleyeff (2006) adapted the types of waste to a service context as it was reviewed on subchapter 2.2.2 and subchapter 2.2.4. Although the authors adapted the types of waste to manufacturing and services context, a matching between the two contexts was not made by them.

Context	Manufacturing Waste	Service Waste
Types of Waste	Waiting	Delays
	Inappropriate processing	Reviews
	Defects	Mistakes
	Overproduction	Duplication
	Unnecessary motion Excessive transportation	Movement
	Inappropriate processing	Process inefficiencies
	Inappropriate processing	Resource inefficiencies

Table 4 – Service Waste and Manufacturing Waste comparison
Source: Adapted from Machado (2012, p. 26)

An attempt of establishing a link between service waste and manufacturing waste was made by Machado (2012), as presented in Table 4. Accordingly, waiting can be associated to delays because of the impact it has in the delivery of a good or service. Inappropriate processing may relate to reviews, process inefficiencies and resource inefficiencies because of the double or triple checking made to work done or in progress. With the use of the correct tools, work would be done in an appropriate way, eventually dismissing any reviews of work badly done resulting in an input of working matching the expected output. Defects is associated to mistakes due to errors that can occur during the process. Overproduction may relate to duplication due to the amount of similar actions that are made repeatedly, producing faster than necessary hence resulting in excessive stock. Lastly, unnecessary motion and excessive transportation relates to the excess physical movement of a person, material or information.

Once the exercise of association of categories of waste is completed, it is possible to adapt the toolkit designed by Hines *et al.* (2002). Based on the work developed by the same authors, Table 5 was created in order to give a broad overview of the usage of some lean tools in the services area.

	Process Activity Mapping	Production Variety Funnel	Quality Filter Mapping	Demand Amplification mapping	Process Costing
Duplication	Maybe	No	Maybe	Maybe	Yes
Delays	Yes	Maybe	No	Maybe	Yes
Movement	Yes	No	No	No	No
Reviews	Yes	Maybe	Maybe	No	Yes
Process Inefficiencies	Maybe	Maybe	No	Yes	Yes
Resource Inefficiencies	Yes	No	No	No	Yes
Mistakes	Maybe	No	Yes	No	Yes

Table 5 – Value Stream Mapping toolkit adapted to services
Source: Adapted from Hines et al. (2002, p. 35)

Apart from the tools presented in Table 3 and Table 5, there are some other tools that might be useful while running a lean analysis on service processes (Bicheno & Holweg, 2009). For the purpose of this study another tool may be used, regardless of the types of waste identified as a supplement to the process analysis, the Spaghetti Diagram.

3.4.3.2. Spaghetti Diagram

According to Hines et al. (2002), the Spaghetti Diagram is a tool that illustrate the flow of information and physical activity in the workplace, which enables the identification of transport and motion waste (Bicheno & Holweg, 2009), or from a service optic, movement and resources inefficiencies waste.

To do a spaghetti diagram, one has to design the physical layout of the workplace and then draw lines to trace the movements of the customer, documents or persons (Bicheno, 2008). Once done, it is possible to clearly see the movement of resources, identifying its length and assess the appropriateness of some movements on a value adding perspective (Bicheno & Holweg, 2009).

This tools can be used, then, to map the best route in order to reduce wasteful movements of the process' resources (Bicheno & Holweg, 2009).

3.5. Summary

In this chapter it was presented the methodology followed in the development of this thesis. An exploratory case study approach with a holistic single-case design was selected since this study focuses on contemporary events within real-life context

It was presented how the criteria of the selected process which rely on three aspects: a) importance of the process, b) presence of human resources, and c) existence of waste.

Regarding the mapping tools there was a distinction between the tools adopted in the analysis of this case study. First an overview of the processes is given using Value Stream Mapping, BPM Flow Charts at a strategic level, narrowing to the use of lean tools such as the process activity mapping and spaghetti diagrams at a more operational level.

4. Case Study

The information written until this point serves as foundation to the following chapter, where the lean tools selected on the methodology are applied to the case study in scope of this research.

In the first place Hospital de Lamego will be presented and its choice will be contextualized. Then, it will be presented the reasons that sustain the selection of the process in scope of this thesis. The design of the process using, primarily VSM and BPM, will assist on the schematizing of the different stages of the value chain and to determine external and internal customers, value and waste associated to the activities and tasks performed.

Waste identification will enable the selection of the appropriate lean tool to achieve effective and efficient outputs, resulting of the analysis of the process. Once waste is identified and minimized or eliminated, agility concept is applied analysing the location of one or more decoupling points.

The redesigned process is finally analysed so that it is possible to assess the effectiveness and efficiency improvements, hence responding to the research question proposed in subchapter 1.2.

4.1. Hospital de Lamego

The Hospital de Lamego is part of Centro Hospitalar de Trás-os-montes e Alto Douro (CHTMAD), directly covering a population of 300.000 inhabitants. It still covers, in special cases, the northern part of the districts of Vila Real and Viseu, the south part of Bragança and the eastern part of the district of Porto, widening its covering range to around half million inhabitants. CHTAMD is composed in its totality by five hospitality units, as illustrated in Figure 6.

Figure 6 – CHTMAD holding structure

Most of the units are located in the district of Vila Real, exception made to Hospital de Lamego which is located in the district of Viseu, adjacent to Vila Real. The list of units is as follows:

- Hospital de S. Pedro – the central hospital and head office of the Centro Hospitalar, located in Vila Real and the one which has more services and medical staff available;
- Hospital D. Luiz I – located in Peso da Régua, it is considered as a complementary unit of the Hospital de Vila Real;
- Hospital Distrital de Chaves – located in Chaves, the northern end of the district and near Spain, it is more than 60 Km's away of Vila Real;
- Hospital de Proximidade de Lamego – located in Lamego and 40 Kilometres away of Vila Real, it offers a wide range of services such as non-surgical emergencies and childbirth, but it was built under the concept of proximity to the population resident nearby and it is intended to be specialized in ambulatory surgery;
- Unit of Palliative Care – located in Vila Pouca de Aguiar, its services are specialized in giving continuity care to palliative patients.

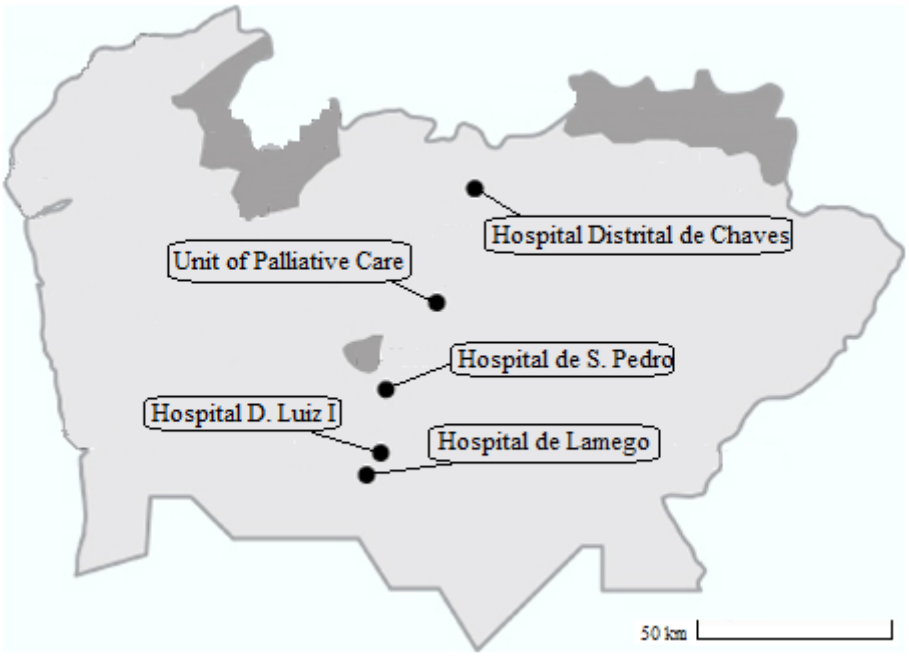


Figure 7 - Regional distribution of CHTMAD units
Source of scale: Google Maps

As seen on Figure 7 the units disperse broadly along the region and each one of them has a specific role on service care. Hospital de Vila Real is the main hospital of CHTMAD and it is usually overcrowded and its patients experiences long waiting lists. To reduce

those waiting times and increase general satisfaction of the population, regarding public health services, Hospital de Lamego offers its services focused mainly on Ambulatory surgery, as explained in Table 6. Hence, it is common that the number of planned surgeries exceeds the procedures in other hospitals.

	Lamego	Vila Real	Régua	Chaves	CHTMAD
Ambulatory Surgery	3364	2558	0	1138	7060
Inpatient Surgery	4	2507	0	770	3281
Total Surgeries	3368	5065	0	1908	10341
Programmed Surgeries (%)	99,88%	50,50%	0,00%	59,64%	68,27%

Table 6 – Number of surgeries performed in 2015 at CHTMAD by clinical unit
Source: CHTMAD's management information office, Clinical activities follow-up maps, 2016

As mentioned, Vila Real and Chaves are the main hospitals of the region, with a wide range of services offered to the population. Despite of their robustness, these hospitals cannot keep up with the numbers presented by Hospital de Lamego. Hospital da Régua is an inpatient hospital, so it has no weight on the total number of surgeries, but the fact Hospital de Lamego has performed almost the same number of surgeries as the other two hospitals combined shows that there is a focus in specialisation of services, namely Ambulatory ones. Surgeries are scheduled between 8 AM and 6 PM with a limited number of patients per day. This number might vary every day and takes into account the type of patient, the type of surgery, the complexity of the procedure and the type of anaesthesia used. In case of more complex surgeries or surgeries that need a longer time in the operating room, surgery's period might be extended until 8 PM or 8:30 PM.

Since Hospital de Lamego's primary service is the ambulatory surgery it is intended that this service sets higher standards of quality in the ambulatory pathway when compared to other hospitals that offer distinct services to its patients. Such quality can be perceived by looking at Table 6 where it is showed that almost 100% of the programmed surgeries are executed, which infers a low rate of cancellations. Yet, there is always room for improvement in order to meet the mission of the hospital (CHTMAD online, 2016): "provide healthcare services of high quality and professionalism to patients' satisfaction, promoting professional and personal accomplishment of our employees, valuing, permanently, the importance of their role to the success of the institution".

4.2. Process Selection

Hospital de Lamego was selected to develop this thesis due to its nature and mission and it is essential that the whole ambulatory pathway is well designed in order to enhance the use of resources, reduce CHTMAD waiting lists and increase the perception of quality on the services provided, since the ambulatory surgery is the main service of the Hospital de Lamego, meaning that it has a major weight on the hospital's general performance. The application of the concepts of lean and agility could be of use on such particular operations management and to be of help to achieve even higher standards of quality (Abdollahi et al., 2015; Kim, 2013).

The ambulatory surgery in Hospital de Lamego has a defined pathway assuring that the patient passes by all stages of care. This pathway has its main focus on the patient, which is an integral component of the value stream since the patient is present in the different stages of the process. Despite the view of the process as whole it can be divided in three different stages that take place in different moments in time, shown by Figure 8.

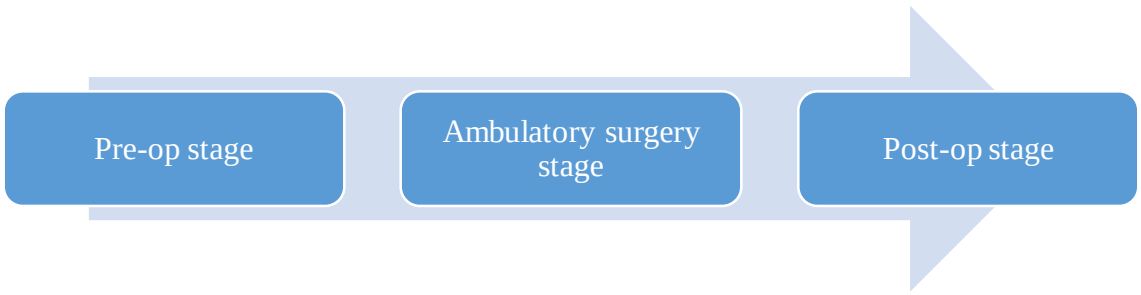


Figure 8 – Ambulatory surgery stages

The first stage involves the actions taken prior to the medical decision to perform a surgery on the patient. This stage contemplates a screening of patients where exams are made in order to assess the physical condition of the patient. The second stage comprehends all the activities performed immediately before and after the surgical procedure, as well as the surgery itself, from the check-in until the medical and nursing discharge. The last stage includes the medical and nursing care activities performed by the staff in order to assure that the patient recovers properly from the procedure.

However, even though there is a possibility to divide the pathway in different processes, which could be analysed individually, the study focuses on the process as a whole, since all the stages of the process are interconnected and share resources. Therefore, as the hospital's core services are related to the ambulatory surgery, the pathway can be studied as a whole, though it can be divided in three sequential stages.

Although this process is focused on the patient, all stages have in common the support the staff gives to the patient throughout the process. From the start to the end of the pathway, a wide variety of employees, each with specific competences, from administrative staff to clinical staff, attend the patient and assist him in every stage so that the procedure can run as smoothly as possible. However, there are some wasteful activities that being eliminated could increase the customer-perceived value of the clinical service provided.

Since the pathway obeys the criteria defined in subchapter 3.3, namely relevance of the process, incorporation of human resources and existence of waste, the ambulatory surgery pathway represents a good subject of study according to the purpose of this thesis.

4.3. Value Identification

The client, or patient, takes an important role in the process. From the initial medical appointment until the follow-up activities, the hospital is providing its services which are being evaluated by the patient. It is important that all stages of the ambulatory pathway add value to the process. Value is perceived by the patient not only on the last stage of the process, but throughout the whole pathway, on a continuous basis, not being independently perceived as individual cases. Therefore, this research adopts the perspective of the patient, according to Womack & Jones (2003), being important to identify what is value to the patient.

As already mentioned, CHTMAD covers an area of almost 40.000 square kilometres with around 500.000 inhabitants. Being Hospital de Lamego allocated to perform almost all ambulatory surgeries of CHTMAD, patients might have to travel a long way to the hospital. Provinces served by the hospital are widely dispersed throughout the region, thus, each journey to the hospital is not only time consuming but also of high cost.

Likewise, it is important to notice that the hospital advises the patient to be accompanied by a friend or family member. Although it is optional in the pre-op and post-op stages, the presence of someone to accompany the patient after the surgery is mandatory so that the patient is given surgical discharge. Thus, each journey to the hospital might impact with both patient and accompanying person time.

Another aspect that is important to underline regards to information. A surgical procedure might bring up some questions and increase the levels of stress of the patient, hence it is

important that the patient gets all the information and support along the process in order to reduce the levels of stress and anxiety.

At last, due to the long waiting lists, patients condition could worsen. Thus, the patient values a reduced waiting period so that his or her condition could be treated as fast as possible.

Taking into account the identification of value written above, creation of value will be present at two levels: a) the reduction of the number of visits to the hospital and b) the surgical waiting periods.

4.4. Process Overview

Hospital de Lamego's was originally designed to host the majority of CHTMAD's ambulatory surgery, along with Hospital Distrital de Chaves, due to the distance between the two hospitals. Besides this type of surgery, Hospital de Lamego still provides other types of care, though the core service is the ambulatory one.

Value stream mapping, as the name states, maps the value stream of the process. In other words, it illustrates the different flows of materials and information with graphical icons, providing optimum value to the customer.

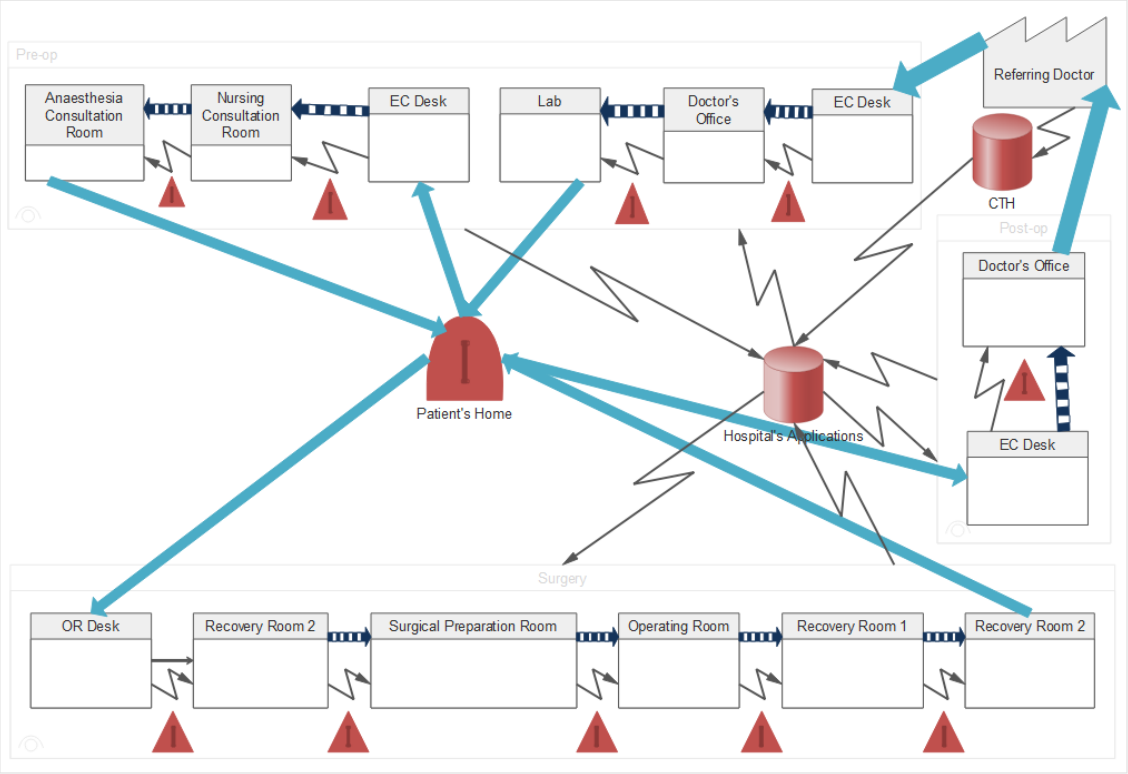


Figure 9 – Value Stream Mapping of Ambulatory Surgery Pathway

Value stream mapping schematizes the different locations – offices or rooms – where the patient goes to. It is divided in three categories, so that it is possible to identify to which stage of the pathway each location corresponds. As the patient is the transformed resource of the process, it was considered the referring doctor as the supplier of demand, being the patient's home the place where he or she awaits a call to go to the hospital, functioning as a waiting point. From these points it is possible to see that the patient goes four times to the hospital, including two in the same stage: pre-op. This could be a possible source of waste and will be further analysed.

From the visualization of Figure 9 it is also possible to see that information flows electronically. Electronic information flows relate to the information stored in the system that will be used in the following stages. Still regarding the electronic information flow, there are two main control points. The first is the application *Consulta a Tempo e Horas* (CTH), which is a communication tool used only by the referring doctor to inform the hospital that there is a patient that needs to be seen by a specialty doctor. This application connects directly to the other control point, which represents hospital's applications, so that the patient's record could be created or updated. This second information control point is common through the hospital and could be accessed by every office in each of the three stages of the process.

Through the visualization of the value stream mapping it is possible to identify the three main stages described in subchapter 4.2. The first stage takes place at the External Consultations (EC) ward, after the patient gets referred to a specialty consultation, by the referring doctor. The second stage, held at the Operating Room (OR) ward, comprehends the surgical operation, while the third and last stage involves the follow-up appointment. As a common point of these three stages there is the waiting point – patient's home – which represents the location of the patient between stages.

The process flows under a push strategy, meaning that the patient is pushed from one office to the other and cannot be the other way around. For, instance, the doctor cannot pull the patient to his office before the check-in is made. Thus, the pathway follows subsequent activities where the patient is pushed from the former to the latter.

4.5. Types of Waste and Mapping Tool Selection

Firstly, it is important to emphasize that in the development of this study, there was no focus on time measuring. Since the period of data collecting was limited to one week, the

observations made were focused on the human resources and facilities management. Bearing in mind the process' overview, described in subchapter 4.4, as well as the data collected from interviews with the Service Director and Nursing Chief, plus the information obtained from the *in loco* observations it was possible to identify some features translated to three types of waste as listed in Table 7.

Type of Waste	Service Features
Movement	Excessive amount of visits to the hospital; EC and OR wards are distant to each other.
Resource Inefficiencies	EC have a resident anaesthesiologist; Operating rooms are not working at 100%; Anaesthetic induction room is not being used.
Process Inefficiencies	Excessive amount of visits to the hospital.

Table 7 – Types of Waste and service features
Caption – EC - External Consultations; OR - Operating Room

Waste can be better handled and eliminated by using the most appropriate tool. Taking into account the types of waste identified in the process as well as the value stream mapping toolkit in Table 5, the most appropriate lean tool to use is the process activity mapping.

4.6. Ambulatory Surgery Pathway

An overview of the ambulatory surgery pathway was already presented in subchapter 4.4. However, such presentation has only provided the big picture of the pathway so that one could understand the basics of the process inherent to it. In order to lean the pathway, it is important that a detailed analysis of the process and its activities is developed. In this subchapter the process is presented in a more detailed way using the tools already identified. Furthermore, an analysis is conducted so that it is possible to confirm the types of waste present in the process and elaborate solutions that aim at the elimination of those types of waste.

4.6.1. "As is" Process mapping

An "As is" representation intends to show the current actions taken in the process, meaning that it is based not only on the information gathered during the interviews, but mainly by observing, in the field, how everything is done.

Process mapping intends to give a detailed presentation so that an understanding of the process could be more easily achieved. To do so, some tools were selected, each one with

different purposes, but converging to an ultimate goal of describing the process and assessing process improvement opportunities. The mapping process is done by focusing on the patient, as integral part of the pathway, due to the fact that it represents both the transformed resource and the customer. Thus, as the pathway is centred in the patient, mapping is done by following the patient throughout the process.

4.6.1.1. BPM Flow Chart

As previously mentioned, the ambulatory surgery service comprehends a sequential pathway the patient must follow. This pathway represents a macro process, composed by several activities performed in all stages of patient care assuring a close monitoring of the patients' medical condition from the moment the patient enters the hospital for an appointment with a specialty's doctor until the moment the patient is given hospital discharge. Such monitoring requires a high level of intra and inter-departmental coordination, so as to minimize waste, increase value and improve process' performance. In order to understand the process scheme, its flow has been mapped using a BPM language. Figure 10 illustrates the flow of the process since its start to the end.

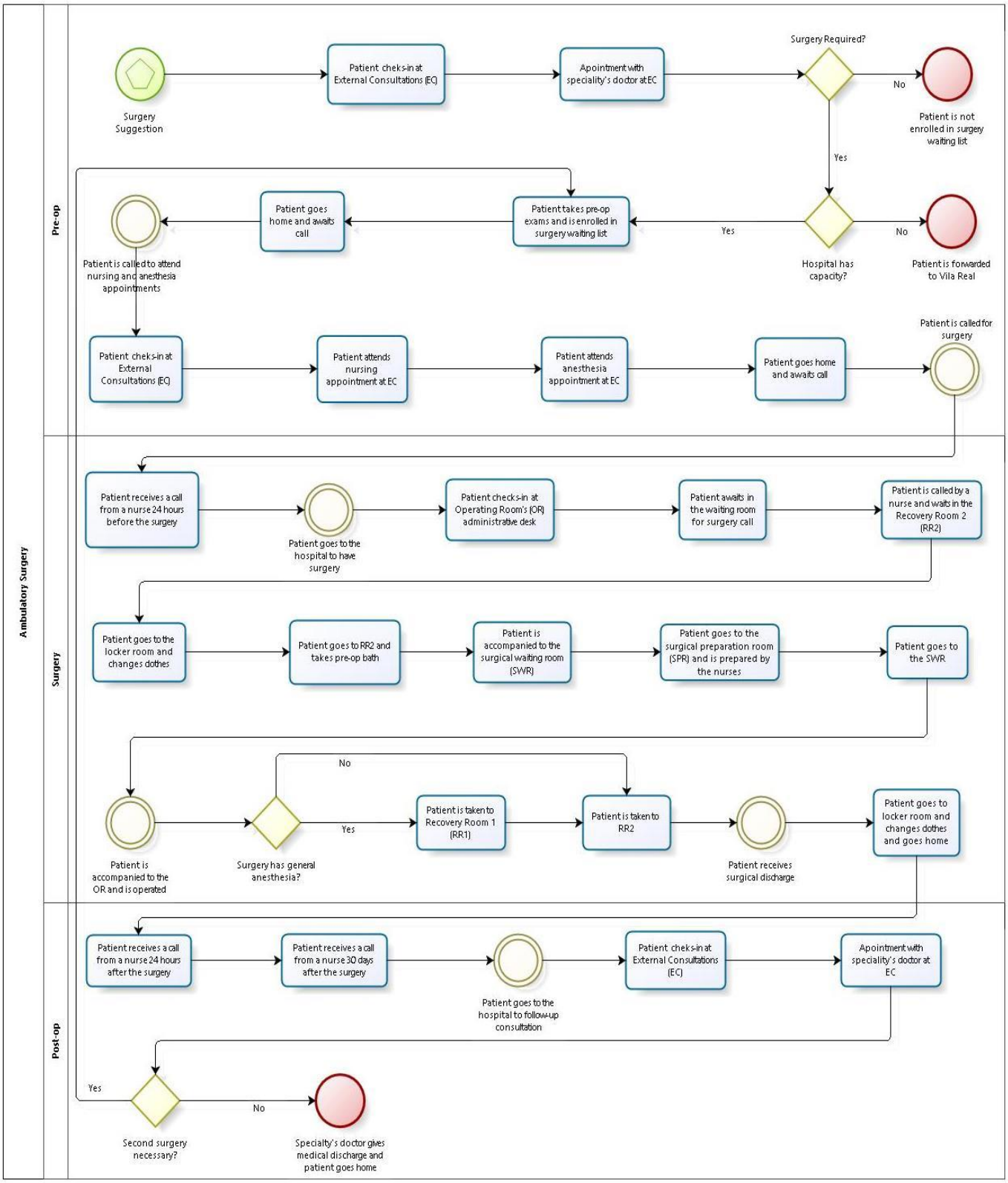


Figure 10 – Ambulatory Surgery Flow Chart

The process is initiated by multiple triggers. In fact, a patient can start the pathway being directed by the Family doctor, Specialty doctor or an Emergency doctor, who suggest a hypothetical need of surgery and delivers the patient file to the Hospital so that the patient is called to an appointment, thus entering the pathway.

After being informed about the need of his presence at the hospital, the patient goes to the hospital and checks-in at the External Consultations desk giving his data and letter informing that they have an appointment with the doctor scheduled for that day. The administrative staff enters the data in the system and ask the patient to wait for his call in the waiting room. After the waiting period, and when the patient is called, he goes to the doctor's office.

During the meeting held in the specialty's doctor office, the need of a surgery is assessed by the doctor by evaluating the condition of the patient. The decision is made taking into account the recommendations of the referring doctor as well as exams results and data contained in the patients file. The doctor then decides whether a surgery is needed or not, informing the patient.

If it is not needed, the patient is not enrolled in the surgery's waiting list and goes home leaving the pathway. In the other hand, if a positive decision is taken the doctor enrols the patient in the waiting list and checks if the hospital has capacity to take care of that patient. This capacity involves the type and complexity of the surgery, resources and patient's condition and if the hospital does not have capacity to perform such operation, the patient is forwarded to Vila Real, where the central hospital is located.

In case Hospital de Lamego has capacity, the patient follows the ambulatory pathway by being accompanied to another room to complete some physical exams. These exams are composed by blood tests and ECG, which are a standard for the great majority of patients. Once the exams are completed, the patient goes home and waits for a call from the hospital to schedule a nursing and anaesthesia appointment.

On the scheduled day, the patient returns to the hospital and checks-in at the external consultations desk so that the administrative staff can confirm his presence and ask him to wait for his call in the waiting room. When the patient is called, a nurse accompanies him to the nursing room where the patient is checked, under criteria specified on a checklist, to assess his clinical condition.

As soon as the appointment is over, the patient his accompanied to the anaesthesiologist who runs a group of questions to decide which anaesthesia the patient should have before the operation. Once the nursing and anaesthesia appointments are concluded, the patient returns home and waits to be called for surgery, by letter.

Once the surgery is scheduled and the patient is informed by letter the date of the surgery, a call is made by a nurse, 24 hours before the operation to confirm the patient's presence in the following day and remember the instructions given when the letter was sent. In the following day the patient goes to the hospital and checks-in at the Operating Room's administrative desk. The administrative staff confirm the data and ask the patient to wait in the waiting room.

A nurse calls then the patient and escort him to the Recovery Room 2 (RR2), where gives an overview of the procedure and the steps the patient needs to follow. Once done, the patient goes to the locker room to change clothes and returns to RR2 to take the pre-op bath. As soon as the bath is taken the patient is accompanied to the surgical waiting room (SWR)

From this room he proceeds to the surgical preparation room and is prepared by the nurses who trichotomy the area to be cut, run a checklist to check vital signs, sides and medication, verify the signed informed consents and confirm the patient's belongings and the information registered in the anaesthesia appointment.

Once done, the patient goes to the SWR and waits until is carried to the Operating Room so the procedure could start. As soon as the operation is finalised, the patient is taken to the recovery room, however the destination room depends on the given anaesthesia.

If the patient received a general anaesthesia, the patient is carried to the Recovery Room 1 or anaesthesia room where the stay until they wake up and recover their functions, which usually happens in a short period of time after the end of the surgery. As soon as the anaesthesiologist gives discharge from RR1, the patient is carried to the Recovery Room 2, where he can recover for up to 24h, under medical and nursing supervision.

When the patient is almost at the plenitude of his capacities he is given surgical discharge from the surgeon, anaesthesiologist and nurse. At this point he goes to the locker room to change clothes and heads home always accompanied by a familiar or friend, with nursing staff contacts in case he needs assistance.

Within 24 hours after the surgical discharge patient receives a call from a nurse to check if the recovery is going well. This call is repeated 30 days after the surgery. The patient is later contacted by the administrative staff to go to a follow-up medical appointment.

The patient goes then to the hospital, checks-in at the External Consultations desk and waits in the waiting room to be called to get to the doctor's office. Once the patient is called, he goes to the doctor's office who assess if there is a need of another surgery, while the patient's file and body is examined.

If another surgery is needed, the doctor re-enrols the patient in the surgical waiting list and asks him to take specific exams to check his condition and serve as basis to a new surgery. If cicatrisation is running well and no side effects emerged, the doctor gives the patient medical discharge and the patient goes home ending the ambulatory surgery pathway.

4.6.1.2. Process Activity Mapping

Although the flow chart gives an overview of the process' flows, it is important to understand what happens in each step of the process. Hence the use of another tool was fundamental to check not only how information flows, but how activities are performed through the pathway. Process activity mapping is made in order to break the process into sub units, either activities or tasks, so that the process could be more easily understood as well as to identify waste, value added activities and the agents entitled to it.

#	Activity	V.A./ N.V.A./S.A.	Nr. P.
1	Patient checks-in at External Consultations (EC) desk	V.A	1
2	Patient waits in the waiting room	N.V.A	-
3	Patient is called to the specialty doctor's office	N.V.A	1
4	Doctor consults patient	V.A	1
5	Doctor enrols patient in Surgery Waiting List	S.A	1
6	Doctor elaborates surgery proposal form	S.A	1
7	Doctor fills in proposal for complementary exams	V.A	1
8	Patient goes to lab and takes complementary exams	V.A	2
9	Patient goes home	N.V.A	-
10	Patient returns to the hospital	N.V.A	-
11	Patient checks-in at External Consultations (EC) desk	V.A	1
12	Patient waits in the waiting room	N.V.A	-
13	Patient is called to the nursing office	N.V.A	1
14	Nurse consults patient and clarify ambulatory surgery procedures	V.A	1
15	Patient goes to the Anaesthesia office and anaesthesiologist consults patient	V.A	1

16	Patient goes home	N.V.A	-
17	Patient is notified of the surgery's date	V.A	-
18	Nurse calls patient 24 hours before surgery	V.A	1
19	Patient returns to the hospital	V.A	-
20	Patient checks-in at Operation Room (OR) desk	V.A	1
21	Administrative staff registers patient's info and delivers it to nurse	S.A	1
22	Patient waits in the waiting room	N.V.A	-
23	Nurse calls patient and escort him to Recovery Room 2 (RR2)	V.A	2
24	Nurse gives him surgical overall and explains the procedure	V.A	1
25	Patient goes to locker room and changes clothes	S.A	-
26	Patient returns to RR2 and takes pre-op bath	S.A	-
27	Assistant takes patient to the surgical waiting room (SWR)	S.A	1
28	Nurse calls patient to the Surgical Preparation Room (SPR)	N.V.A	1
29	Nurse develops pre-surgery tasks	S.A	2
30	Patient waits in the SWR	N.V.A	-
31	Patient is called to the OR	N.V.A	1
32	Anaesthesia Nurse receives patient and confirms anaesthesia checklist	V.A	1
33	Surgical team proceeds to "Time-Out"	V.A	7
34	Surgery is performed	V.A	7
35	Patient is taken to Recovery Room 1 (RR1)	S.A	7
36	Anaesthesiologist checks vital signs	V.A	3
37	Anaesthesiologist gives anaesthesia discharge	V.A	1
38	Patient is taken to RR2	S.A	1
39	Nurse supervises patient's recovery	S.A	1
40	Anaesthesiologist gives anaesthesia discharge	V.A	2
41	Surgeon gives surgical discharge	V.A	1
42	Nurse gives nursing discharge	V.A	1
43	Patient goes to locker room and changes clothes	S.A	-
44	Nurse gives recovery guidance manual	V.A	1
45	Patient goes to OR desk	N.V.A	-
46	Administrative staff give discharge documents and satisfaction survey	S.A	1
47	Patient goes home	V.A	-
48	Nurse calls patient within 24 hours	V.A	1
49	Nurse calls patient within 30 days	V.A	1
50	Patient returns to the hospital	N.V.A	-
51	Patient checks-in at External Consultations (EC) desk	V.A	1
52	Patient waits in the waiting room	N.V.A	-
53	Patient is called to the specialty doctor's office	N.V.A	1
54	Doctor consults patient	V.A	1
55	Doctor gives medical discharge	V.A	1
56	Patient goes home	V.A	-

Table 8 – Process Activity Mapping
Caption: # - Activity Number; V.A – Value Adding; NVA – Non-Value Adding; SA – Support Activities; Nr. P. – Number of persons involved in the activity.

In Table 8 are identified the sequence of activities performed since the start until the end of the pathway. This table encompass the activities performed within the hospital. In subchapter 4.6.1.1, where the flow chart is presented, the trigger of the pathway is the hypothetical need of a surgery. As this trigger can have three different sources which are out of the pathway, they are not considered in the table.

The first activity starts when the patient arrives at the hospital and goes to the EC desk. Here the administrative staff fill the check-in information in order to enrol the patient in the appointments for the day (activity #1). After some waiting time in the waiting room (activity #2) the patient is called and goes to the doctor's office (activity #3). Here, the doctor checks the file of the patient with the information coming from the trigger that was previously recorded in the patient's file and brought up when the patient checked-in (activity #4). The patient is also examined while in the office so that the doctor can come to the conclusion whether the patient needs surgery or not. In case of a positive conclusion, the doctor enrols the patient in the Surgery waiting list (activity #5) and fills specific forms to propose surgery (activity #6) and complementary exams for the patient (activity #7). When the appointment is finished, the patient goes to the lab to take blood samples and takes an ECG (activity #8). These exams are usually taken by the patient in the same day as the doctor's appointment, otherwise the patient has to take exams on the morning of the nursing and anaesthesia appointment. Once the exams are taken the patient goes home (activity #9).

When the nursing and anaesthesia consultation's day come, the patient follows the exact same steps as before but instead of going to the doctor's office, he goes to the nursing office (activities #10, #11, #12, #13). Here, the nurse attends the patient following a checklist of questions and procedures and gives him the ambulatory surgery manual to guide the patient through the pathway (activity #14).

Patient leaves the nursing office and proceeds to the anaesthesia office waiting for his call at the door. This consultation his performed by an anaesthesiologist who checks the results of the complementary exams done by the patient and crosses with a reference checklist updating the patient's file (activity #15). If the patient meets the criteria he follows the pathway, otherwise his file goes to Vila Real. In either decisions, the patient is free to go home (activity #16) and waits for the notification of the surgery's date and time, by letter or phone call (activity #17).

24 hours before the surgery the patient receives a call from a nurse of the ambulatory surgery department, to confirm the patient's presence in the surgery, updating his file, and remembering the guidelines given at the time of the nursing consultation (activity #18).

On the surgery day the patient returns to the hospital (activity #19) but instead of going to the External Consultations he goes to the downstairs floor and checks-in at the OR desk (activity #20), where the administrative staff fills his file and gives the informed consent so that the patient could sign (activity #21).

After waiting in the waiting room near the OR (activity #22) desk a nurse calls the patient (activity #23) and accompanies him to the Recovering Room 2 (RR2) where explains how the procedure is done and tries to lower the stress levels of the patient while gives an overall for him to dress up (activity #24).

The patient goes to the locker room and changes clothes (activity #25) and returns to the RR2 in order to take the pre-op bath (activity #26). Once done the patient goes to the surgical waiting room accompanied by an assistant (activity #27). In this room the patient waits until a nurse calls him (activity #28) to the Surgical Preparation Room (SPR) where pre-surgery tasks are performed (activity #29). These tasks involve vital signs checking, venous catheterization, trichotomy, therapeutic administration and filling of a surgical checklist. Once done the patient returns to the SWR (activity #30) until is called to the Operating Room (OR) (activity #31).

An assistant accompanies the patient to the OR where an anaesthesia nurse receives him and confirms the surgical checklist elaborated at SPR (activity #32) so that the procedure could begin. Before the beginning of the procedure, however, the surgical team, which is composed by one assistant, one anaesthesia nurse, one scrub nurse, one circulating nurse, one anaesthesiologist and two surgeons, executes the "Time-Out" (activity #33) which consists on the verification of safe surgery: correct surgery, correct area, correct patient. Being everything correct, the procedure begins (activity #34).

As soon as the procedure finishes, the patient is taken to the Recovery Room 1 (RR1) by the anaesthesia nurse and anaesthesiologist who deliver the patient to the nurse of RR1 (activity #35), who usually go check on patient's vital signs (activity #36) every once in a while. This room is a short-period stay room because it is intended that the patient remains in this room until he recovers from anaesthesia. As soon as vital signs stabilize,

the anaesthesiologist gives anaesthesia discharge (activity #37), filling an appropriate form and the patient is taken to RR2 (activity #38) where a nurse receives him and supervises his recovery during the day (activity #39). Once the patient is fully recovered the anaesthesiologist gives him anaesthesia discharge (activity #40) by completing the form filled in RR1 at the same time the surgeon and nurse give surgical and nursing discharge, respectively (activities #41, #42). These three discharges are only granted if he gets a score higher than 9 points according to the PADS criteria (Postanaesthesia Discharge Scoring System).

The patient can then change clothes in the locker room (activity #43) and before leaving, nurse gives him a recovery guidance manual (activity #44) requesting him to go to the OR desk to check-out. After leaving RR2 patient goes to OR desk (activity #45) where administrative staff prints and delivers the discharge documents and a satisfaction survey (activity #46) allowing the patient to go home (activity #47). On the surgical discharge document, it is scheduled the date of the follow-up appointment. Within 24 hours and 30 days from the surgery, a nurse calls the patient to check how the recovery is progressing (activities #48, #49).

On the follow-up consultation day, the patient returns to the hospital and follows the same steps as before as in the first appointment at EC (activity #50, #51, #52, #53). At the doctor's office the patient is examined (activity #54) so that the doctor can give medical discharge (activity #55). Being medically discharged, the patient is now treated and goes home, concluding the ambulatory surgery pathway (activity #56).

4.6.1.3. Spaghetti Diagram

The former mapping tools have described the overall value stream and the sequence of activities. In both it has been possible to observe that the pathway is extensive and requires some movement of the patient, which is the resource of focus in this study. In order to understand the movement associated to it, it is important to draw it and get a graphical overview of the physical movement of the patient.

The spaghetti diagram is a layout tool that aims to illustrate the physical movement of information or resources. In the case of the present study, the spaghetti diagram reflects the movement of the patient at the pre-op stage, which encompass two different phases that take place in different moments in time. The diagram shows the steps followed by

the patient between events, either walking or being carried by someone (family, friend, nurse or non-medical staff).

By visualizing Figure 11 and Figure 12 it is possible to understand how the patient physically moves throughout the hospital in the pre-op stage, which is the stage that contemplates more than one visit to hospital.

Figure 11 – Pre-op stage phase 1 Spaghetti Diagram

The first phase of the pre-op stage holds the first contact of the patient with the hospital. In this stage the patient goes to the reception in order to check-in for the specialty consultation. Before this consultation he or she waits in the waiting room and when the patient is called he goes to the doctor's office.

Depending on the doctor's decision, the patient might leave home or stay in the hospital to run complementary exams. In the second case, he returns to the waiting room and waits to be called. At this point, the patient needs to go to two different rooms. As he gets called he goes to the ECG room to take an electrocardiogram and returns to the waiting room in order to be called to the clinical biology room to give a blood sample to analysis.

After this step the patient leaves the hospital and returns in another day to have the nursing and anaesthesia consultations

Figure 12 – Pre-op stage phase 2 Spaghetti Diagram

The nursing and anaesthesia consultations are the second phase of the pre-op stage. The patient arrives to the hospital, checks-in at the reception and goes to the waiting room located at the end of the corridor. When the patient is called he goes to the nursing room, heading back to the waiting room as soon as the nursing consultation has ended. The patient then waits until is called to the anaesthesia room where the anaesthesia consultation is held. Once the consultation is finished, the patient leaves the hospital.

As perceived in the three mapping tools (flow chart, value stream mapping and process activity mapping), both phases of the pre-op stage encompass different activities that require extra movement of the patient. Thus, in order to understand how these movements are considered as value or as waste, an analysis of the pathway is made in subchapter 4.6.2.1 taking into account the selected tools.

4.6.2. Pathway Analysis and Waste identification

According to the data gathered from the observations and interviews, as well as the graphical descriptions of the process, it is possible to infer that the pathway already is very efficient and straightforward with a great focus on the patient. However, as lean pursues perfection through continuous improvement, there are always some improvements that can be made in order to make the pathway even more effective and efficient.

The Process activity mapping allows to compute good metrics related to the value adding and non-value adding activities. According to this lean tool, there is a relative amount of waste.

	Number of activities	Relative Frequency
Value adding activities	29	51,79%
Non-value adding activities	15	26,79%
Support Activities	12	21,43%
Total	56	100,00%

Table 9 – Summary of Valuing activities

Table 9 gives a graphical summary of the activities regarding the addition of value to the process. It states that out of 56 activities, 29 are value adding activities while 27 are non-value adding activities, though 12 of them were listed as support activities because they are needed in the process as it is currently in spite of not adding value.

Moreover, from the total number of activities, 48% of them, distributed between non value adding activities and support activities, do not bring any value to the process, being 27% the percentage of activities that should be eliminated in order to make the process leaner than it was.

Looking at the Value Stream Mapping, illustrated in Figure 9, and the BPM flow chart schematized in Figure 10, one can identify the number of visits to the hospital the patient needs in order to be treated. In case the patient is not successfully treated in the surgery, it means that the pathway will re-start implying additional visits of the patient to the hospital.

The spaghetti diagram also gives an insightful view of the steps taken by the patient, where it can be seen that there are back and forth movements that could be avoided resulting in a more constant flow.

In addition to these tools some service features were observed, resulting in the types of waste identified in subchapter 4.5, which can be now analysed so that measures, to eliminate or minimize waste, could be defined.

4.6.2.1. Movement

As it was already described, all the hospitals in CHTMAD are widely disperse around the northern area of Portugal. Hospital de Lamego provides its services to all citizens within a radius of 60 Km. Each visit to the hospital represents a source of additional travel costs, time spent and reduction of well-being, for both patient and families.

The patient goes to the hospital 4 times along the pathway: 2 in the pre-op stage, 1 in surgery stage and 1 in the follow-up stage. Although this waste is not directly visible in process activity mapping, it is possible to see that the majority of the non-value adding activities are condensed in the pre-op and post-op stages. These stages, though important, are not the core of the pathway, which encompass the activities held on the surgery day.

Another aspect that falls on this category of waste regards to physical location of the services. The external consultations ward and the operating room ward are located in different floors. As the ambulatory surgery involves a long pathway, information, materials and human resources could travel a long distance to go from one ward to another. As the patient is a transformed resource of the process, he has to walk a longer distance between offices than if both services were close to each other. From the hospital point of view, there are also some movements of doctors between these two services representing wasteful movements of this valuable resources.

4.6.2.2. Resource Inefficiencies

The anaesthesia consultation is made by an anaesthesiologist. Doctors specialized in this function are scarce not only in the hospital but also in CHTMAND as well as in the whole country. As a matter of fact, during the summer of 2016 some news brought by the media revealed the patients' frustration regarding the cancelation of some surgeries in CHTMAD because of the lack of anaesthesiologists (TVI online, 2016).

Due to the scarcity of anaesthesiologists, it makes them a valuable resource, in terms of functionality, because no surgery can occur without the proper sedation. Since this kind of human resources is so scarce, it has to be managed as efficiently as possible so that the benefits of using it overcome the costs associated to it.

The results of the anaesthesia consultation are of great importance because it gives the criteria of sedation and is the final assessment to decide if the patient can have surgery in Lamego, or if he is forwarded to Vila Real. Thus it is required that this consultation is made by a trained professional who can fill in the pre-anaesthesia form based on the complementary exams and clinical record of the patient.

4.6.2.3. Process Inefficiencies

The fact that the patient has to go to the hospital at least four times to complete the pathway also represents process inefficiencies. In the pre-op stage, the patient has to go at least two times to the hospital in different moments of time. The first contact is made

just with the specialty doctor to assess the condition of the patient and decide whether a surgery is justified, or not. Then, the patient goes home and return to the hospital to be assessed by a nurse and an anaesthesiologist. In the meantime, patient has to take complementary exams, which are usually done on the day of the first consultation, but in case it does not happen, another trip to the hospital has to be done. Thus, the pre-op stage sub process could be subject of readjustments due to the fact that the patient has to go several times to the hospital, just to be observed.

From an internal point of view, an unnecessary number of visits represents also inefficiencies in the processes, namely in the administrative processes. Every time a patient goes to the hospital, a check-in needs to be made involving the personnel at the check-in desk resulting in the repetition of tasks from the administrative staff. Hence, a reduction of the number of visits would be beneficial for both the client and the hospital.

4.6.3. Improvement opportunities

Once the different types of waste are identified, it is now possible to address some improvement opportunities to the process that aim to eliminate waste, or, at least, minimize its impacts in the process.

Firstly, it is important to notice that there is a transversal point to the three types of waste identified which is the number of visits a patient makes to the hospital associated to the value preposition, exposed in subchapter 4.3.

The process, although studied as whole can be divided in three parts. In the first part it is where the amount of visits has a higher impact, hence, it makes sense to reduce in order to lean the process at this point by reducing the number of visits on the pre-op stage. To do so, one must look to the activities held in each visit: in the first one the patient is consulted by a specialty doctor and usually takes complementary exams, while in the second one, the patient is consulted by a nurse and anaesthesiologist.

As the nurses present at the External Consultations (EC) are not part of the ambulatory surgery department, their time is allocated 100% to the EC, which means that they are always present at this ward. The anaesthesiologists, for instance are not part neither of the EC department nor the Ambulatory department, but to the Anaesthesiology department, meaning that although the anaesthesiologist at EC is resident, the ambulatory department has no control of his agenda, resulting in a resource that his only available to run consultations at EC.

Nevertheless, according to American Society of PeriAnesthesia Nurses (ASPAN) the anaesthesia consultation can be conducted either by an anaesthesiologist or nurse (ASPAN online, 2015). Thus, this type of consultation could be held by a nurse with proper training and the presence of an anaesthesiologist could be optional according to the flexibility on the management of this resource, which will be further analysed in subchapter 4.6.4.

This optional condition allows the possibility to rearrange the pre-op stage in order to have the consultations with the specialty doctor, nursing and anaesthesia as well as the execution of complementary exams to be on the same day. To do so, the patient could be consulted by the doctor, exiting directly to the lab to take the complementary exams, and then be headed to the nursing office to have nursing and anaesthesia consultations and finally go home.

The expiration date of the complementary exams could represent a barrier to the implementation of this improvement suggestion. According to the Direção Geral de Saúde (2015, p. 23), "exams results obtained from the clinical process of the patient, executed up until 6 months before the surgery, are, as a general rule, acceptable in case of no significant changes have been registered in the clinical history of the patient". As surgeries in public hospitals have a limited period of 9 months to be performed (Ministério da Saúde, 2015), there is a gap of three months where exams could have expired if the surgery takes place after the 6th month of waiting, since after the 9th month the patient can be referenced to a private hospital without waiting lists (Ministério da Saúde, 2015). Hospital de Lamego's, according to the data of Hospital de Lamego's surgeries waiting period of the second quarter of 2016 (Ministério da Saúde Online, 2016), experienced an average waiting period of 113 days as illustrated in Table 10.

Specialty	Waiting Time (days)
General Surgery	116
Reconstructive and Plastic Surgery	18
Vascular Surgery	220
Gynaecology	78
Ophthalmology	50
Orthopaedics	79
Otorhinolaryngology	235
Average	**113,7**

Table 10 – Hospital de Lamego's total and average surgery waiting time
Source: Adapted from Ministério da Saúde Online (2015)

However, as identified in Table 10 there are clinical specialties whose waiting periods exceeds the 6 months (or 180 days), namely vascular surgery and Otorhinolaryngology. For these cases, it is suggested that a prescription of exams should be sent via mail to the patient's home so that he or she can take the exams on a clinical facility of patient's choice (either at Hospital de Lamego or other healthcare centre near to the patient's home) and send the results to the hospital via mail, so that it could be attached to the patient's file and assessed before the surgery.

By doing so, it is possible to reduce the number of visits from 2 to 1 in the pre-op stage. Nonetheless, and while the surgery visit is mandatory, the follow-up represents an additional trip to the hospital. In this stage, the patient is consulted by a doctor to assess if the cicatrisation process is according to the medical standards and there are no side effects of the surgery.

As this consultation's nature relates to the evaluation of the healing process, it can be held differently than it is. So, the follow-up stage could consist on two points of action: push the patient to the referring doctor after monitoring his or her condition via telemedicine which is a medical approach that has been taken into account in surgical follow-ups (Armstrong, Semple, & Coyte, 2014; Dobke, Bhavsar, & Herrera, 2011; Mishra, Kapoor, & Mishra, 2009; Pap, Lach, & Upton, 2002; Sousa, 2014; Turk et al., 2011; Wirthlin et al., 1998).

According to the World Health Organisation (WHO, 2010, p. 9), telemedicine is "*the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*". As previously mentioned in subchapter 4.1, the hospital covers a wide area and a broad range of potential patients, whose transport to the hospital generates concerns to the patients and their families. Hence, in order to avoid another trip to the hospital, ambulatory service's nurses could perform a follow-up consultation through the exchange of electronic information in order to monitor and assist the patient, and to conclude if the healing process is running as expected (Sousa, 2014). In cases of side effects, complications or unexpected variations in the cicatrisation process, an appointment with

the surgeon should be scheduled so that the doctor could assess the consequences of his or her intervention and referring the patient for a new surgery or an alternative treatment. In cases that everything is running as expected, the nurse should fill-in a report to the specialty doctor so that medical discharge could be sent to the patient's home, addressing him to the referring doctor.

By using telemedicine and by pushing the patient for the referring doctor, which is usually the family doctor, the follow-up consultation at the hospital can be avoided encompassing benefits at two different levels: a) the patient avoids another visit to the hospital and b) the hospital frees an expensive resource – specialty doctor – whose time could be leveraged on the operating room or attending other patients at the pre-op stage.

Another aspect that might create value to the customer is related to the physical location of External Consultations and Operating Room wards. These two services, both part of the ambulatory surgery service, are provided in different floors of the hospital. The ambulatory surgery service comprehends a pathway that is composed by sequential activities under a push strategy, since the patient goes to the following stage after all previous activities are performed. The process always run in the same hospital, with different services that share the same human resources, as it happens with doctors who go back and forth between the External Consultations and the Operating Room wards. This physical movement of resources represents a waste that can be eliminated, or minimized, by rearranging the layout of both wards, since it is in these wards that the core services of the hospital take place.

Nonetheless, the Operating Room ward has a special environment due to the surgical procedures held there. Therefore, it is not advised that the external consultation is inside the OR ward, otherwise the sterile atmosphere could be compromised. Still, as EC comprises consultations for ambulatory patients and general patients, the ambulatory external consultations should be located next to the ER ward to promote a holistic lean transformation of the ambulatory process. As Poksinska (2010) states, all staff needs to be properly trained and involved, motivated and supported by the managers and embracing a lean culture so that they can take an active role on lean transformation at the ambulatory service level. In order to avoid a mixture of surgery patients and external consultations patients, there should be implemented a coloured floor lines, so that the patients could follow the line and head directly to EC or OR.

Although this rearrangement does not create direct value to the customer, it impacts the patient indirectly. Taking into consideration the scenario where both wards are near each other, though being physically detached some benefits could arise. Firstly, the patient would take another perception of the service, starting from the pre-op stage, which could result in reducing the levels of stress on the day of the surgery due to the fact that the location was already seen before, not creating such a negative impact. Secondly, non-clinical and clinical staff would be more prone to create an ambulatory culture where information would be more easily incorporated. This would allow EC nurses to understand and share the ambulatory vision, hence giving more detailed and accurate information when clearing patient's questions and doubts. Although qualitative these two benefits are supported by Caldwell (1991) and Wetsch *et al.* (2009) who state that the proper access to information helps to reduce the stress and anxiety levels on surgical patients. Thirdly, it would permit the flexibility needed for agile initiatives, as it will be analysed in subchapter 4.6.4.

The improvements presented in this subchapter come from a lean analysis of the types of waste identified, whose features are not independent from each other. Quite to the contrary, those features are interconnected and the elimination of one type of waste would impact other types of waste. Moreover, the suggestions made, on a lean perspective, took also into account the possibility to apply agile initatives in order to complement the improvements already described.

4.6.4. Improving process agility

The application of an agile approach to the process is mainly based on the inefficient management of a resource, namely the anaesthesiologist. As already explained, this type of resource is scarce which implies a high cost of utilization. Hence, the anaesthesiologist should be allocated to services where his skills and expertise are needed the most.

From a lean perspective, it was suggested that the consultations conducted by an anaesthesiologist would be performed by a trained nurse, freeing the anaesthesiologist to the OR to administer anaesthesia to surgery patients. However, although surgeries are scheduled, there is a high variability associated to it resulting on peak days of surgery, while other days only a few surgeries are scheduled, mostly due to the variability of doctors' agenda that are managed externally by CHTMAD since they are not 100% allocated to ambulatory surgery of Hospital de Lamego. Hence, in order to deal with this variability, an agile strategy is suitable so that the organization could optimise the use of

resources. Agility gives the ability to be flexible and adapt to changes in the environment, thus the process could benefit from an agile approach. This can be achieved by addressing to numerical and functional flexibility as reviewed on subchapter 2.3, hence adapting the number of employees and their skills, consequently promoting the flow of patients in the process, through the use of a decoupling point.

Looking at the process from a value stream point of view, the decoupling point should be located between the anaesthesia consultation and surgery. This decoupling point has a special characteristic associated to it, since it comprises a key resource - the anaesthesiologist – who would be available in both EC and OR wards, depending on the number of consultations and/or surgeries scheduled for the day. This follows the line of study developed by Aronsson (2011), who states that an agile approach works with flexible capacity.

Following the improvement opportunities described in subchapter 4.6.3, a nurse would give anaesthesia consultation enabling the presence of the anaesthesiologist at the OR ward. Since the anaesthesiologist at EC is resident and allocated only to the EC, and taking into account the suggestion of locating EC and OR near to each other, the anaesthesiologist could be flexible between the two wards, following an agile approach. On peak times, with a high number of surgery patients, the anaesthesiologist could be at the OR in order to anaesthetize the patients. In other hand, on off-peak times, the anaesthesiologist could be located at the EC, providing the necessary support to the anaesthesia consultation at the pre-op stage.

This approach, although focused on the internal organisation, could also add value to the patient. During observation it was seen that the hospital has a second surgery room as well as an anaesthesia induction room that have not been used due to the lack of anaesthesiologists. By freeing an anaesthesiologist from EC to OR, in addition to the one that comes from Vila Real to be present at the surgeries, the number of anaesthesiologists at the OR increases from 1 to 2. This presence would then enable the use of the anaesthesia induction room in coordination with both surgery rooms, as illustrated in Figure 13, allowing an increase in the number of surgeries performed, hence reducing the waiting time in the waiting lists, creating value to the patient according to the proposition stated in subchapter 4.3.

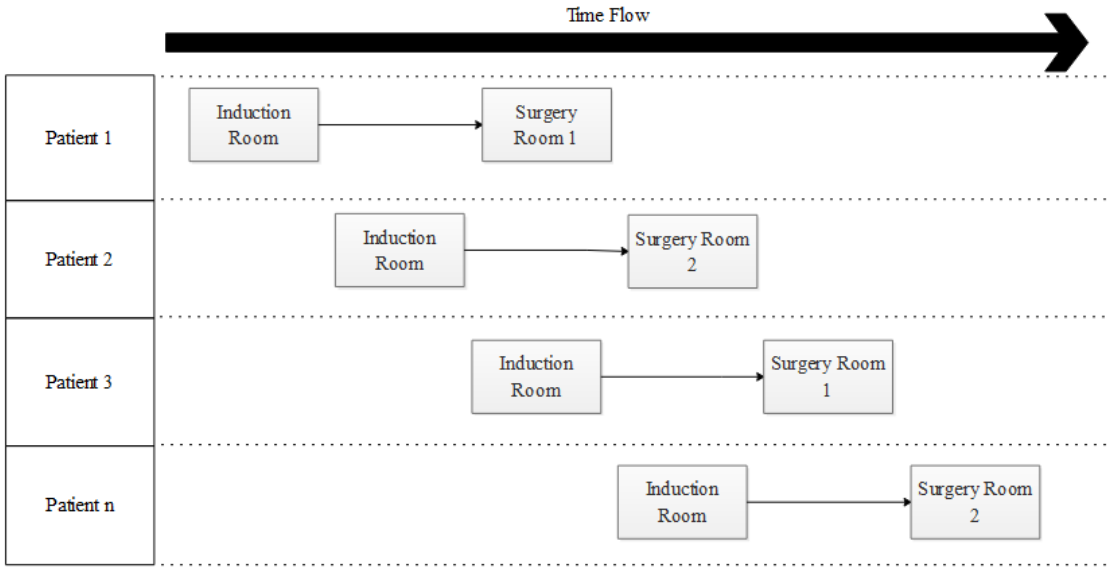


Figure 13 - Induction Room and Surgery Room coordination

The use of an agile would bring benefits to the operation and resource management of the service. The concept of flexibility of a key resource of the process allows an adjustment of the service taking into account the variety in demand and consequently bringing value not only to the patient but also to the hospital.

4.6.5. "To be" mapping

With the suggestion of some improvement initiatives an assessment has to be run in order to understand to which extend the initiatives create value to the patient. Hence, the process has to be redesigned, reflecting the changes on a future state mapping.

This assessment will be made at two distinct levels. Firstly, on a macro level, the VSM is redesigned to graphically represent the value stream of the process comprising the improvements presented in subchapter 4.6.3. This macro image of the process illustrates how information and transformed resources would flow, on a scenario where the application of lean would be implemented, as shown by Figure 14.

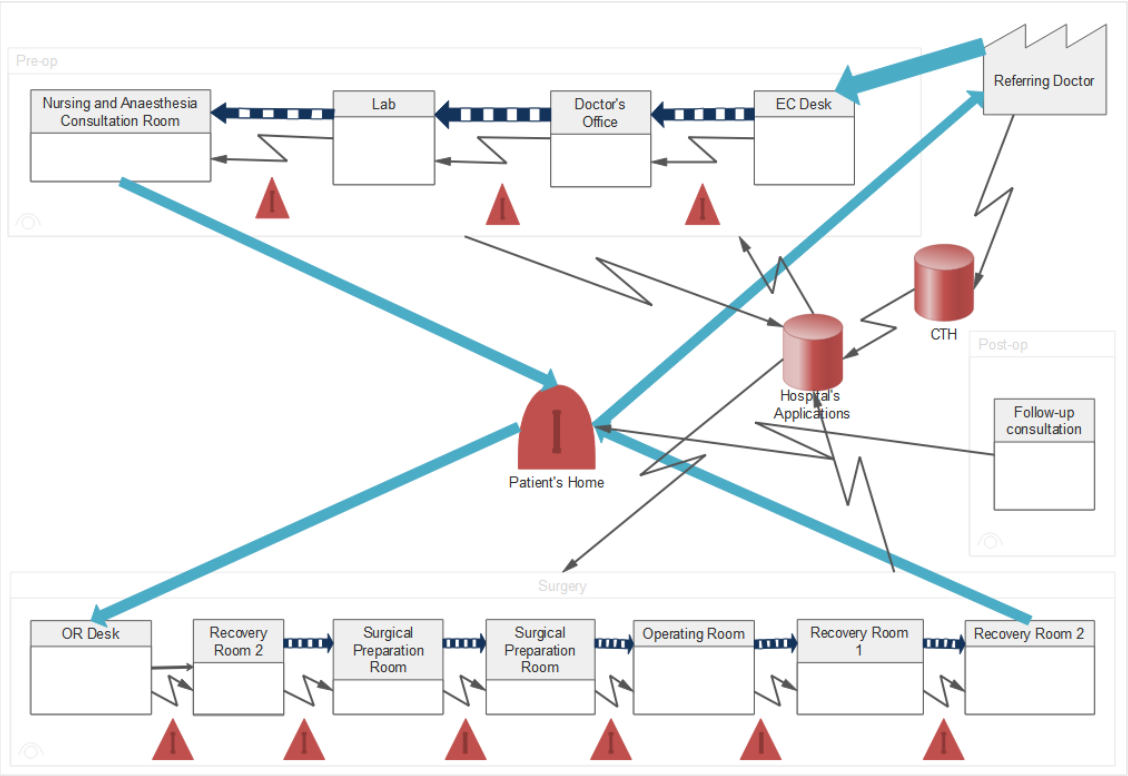


Figure 14 – Redesigned Value Stream Mapping

Looking at Figure 14, the re-arrangement of the post-op stage as well as the merging of the Nursing and the Anaesthesia consultations reduced the number of patient visits to the hospital. Moreover, after the surgery, the patient is pushed to the referring doctor, enabling freeing Hospital's medical resources as described in subchapter 4.6.3.

At a micro-level, the use of lean tools also improved the management of resources and facilities. The flexibility incorporated into the Anaesthesiologist that was previously located at the EC enabled the use of the induction room, hence maximising the utilization of the surgery rooms that can now have a higher utilization rate than before.

Spaghetti diagram and process activity mapping tools were not selected on the 'to be' mapping, since there no significant improvements reflected by these tools. The suggestions made enabled the reduction of visits to the hospital that demonstrated by the VSM tool. Therefore, as VSM enables a better overview of value creation, this was the only tool considered on a 'to be' scenario.

4.6.6. Discussion

An analysis to the process in scope of this thesis has demonstrated that there are some inefficiencies associated to it, resulting in waste, which by nature does not add any value

to the service offered. Some improvements have been suggested under a lean perspective, but the process can also benefit from the application of a parallel agile approach.

Nonetheless a leagile approach cannot be adopted as a hybrid strategy since lean was applied to the whole process and agile initiatives was applied only to a specific part. Hence, although it was not possible to observe leagility in the process, it is possible to state that a lean approach with agile characteristics can bring benefits to both patients and hospital, increasing the efficiency and effectiveness of the process.

Taking into account the value proposition identified on subchapter 4.3 it is possible to perceive that the proposed version of the process allows the patient to reduce the number of visits to the Hospital. Furthermore, with the readjustment in how the anaesthesiologist is managed, not only the patient would benefit from the improvements made, but also the hospital. From the hospital perspective, clinical resources would be maximised on peak and off-peak days, as well as facilities that could have a higher utilization rate (the surgery rooms). From the patients' perspective, as facilities are now being used more extensively, the surgical waiting lists could face a reduction in average waiting time, meaning that patients are treated faster than in the current state.

Therefore, the application of leagility was not feasible, but the application of a lean approach with agile characteristics on the ambulatory surgery process of Hospital de Lamego has responded to the value propositions identified in subchapter 4.3, resulting in a more effective and efficient process to the patients and Hospital.

5. Conclusions

The primary objective of this thesis was to analyse if the application of lean tools and principles allied to the leagility concept create effectiveness and efficiency gains for an hospital pathway of ambulatory surgery and analyse the impact on the human resources and facilities management.

Accordingly, the process in scope of this research was selected taking into account three distinct criteria. Customer's perception of value was identified highlighting two value propositions. An overview of the process was presented enabling a macro view of the process, funnelling the analysis to a micro level with the use of lean tools. Waste was identified and improvement measures were suggested by using lean and agile initiatives. The process was then assessed, on a future state basis, to perceive the process' efficiency and effectiveness gains, thus meeting the goals of the research.

5.1. Research questions and goals analysis

In Chapter 1 it was presented the main purpose of this thesis. Along with this purpose, six partial goals were also defined, which were considered throughout the thesis:

1. Select the criteria that underlie the choice of the pathway – based on the literature review three criteria were defined to select the process namely a) relevance of the process, b) presence of human resources and c) presence of waste;
2. Identify the customer throughout the whole pathway – the customer of the process is the patient, which is the transformed resource of the pathway;
3. Map, design and analyse the process of the pathway – the process was mapped, designed and analysed using BPM and lean tools, namely Value Stream Mapping and Process Activity Mapping;
4. Identify activities, resources and agents that are integral part of the process – the use of tools referred in the previous goal allowed identifying the activities, resources and agents that participate in the various stages of the process;
5. Identify and classify the types of waste observed – three different types of waste were identified and classified as a) movement, b) resource inefficiencies and c) process inefficiencies;
6. Develop and suggest improvements to the process mapped – improvement opportunities were identified and improvement measures were suggested,

namely a) re-arrange the pre-op stage by condensing nursing and anaesthesia consultation in one consultation given by a nurse appropriately trained, b) the anaesthesiologist present at EC could be present at both EC and OR, depending on the number of surgeries scheduled, c) rearranging the EC and OR wards by locating both near to each other in the same floor, and d) re-arrangement of the post-op stage allowing the use of telemedicine and pushing the patient to the family doctor.

In addition to the partial goals, a research question was formulated, entailing a guideline during the development of this thesis. Recapping what was written in subchapter 1.2, the Research Question was:

RQ 1: How can the effectiveness and efficiency of an hospital pathway of ambulatory surgery be affected by the application of leagility concept?

Despite the improvement measures suggested were not yet implemented, there are clear benefits on the efficiency and effectiveness of the ambulatory surgery pathway. Although no times were measured, this research still demonstrates the impacts such measures would have on human resource and facilities management, responding to the value propositions defined. However, these benefits do not come from a leagile approach. These benefits are generated by the application of lean to the whole process adapting one part of the process with an agile approach.

Effectiveness of the process might have a subjective perspective since it is supported on the patient's perception. It was, then, crucial to identify the patient's perception of value to elaborate guidelines on how the process analysis was conducted. Value identification resulted in two levels of patient's value: reduced the number of visits to the hospital and reduce waiting time for surgery.

Accordingly, the effects of subjectivity on the process could be minimized by addressing the analysis of the process and the improvement suggestions to the patient itself as a transformed resource of the service.

Efficiency, on the other hand, has a more objective nature that could be measured since it has a more quantitative enhancement rather than qualitative. In the present study, efficiency of the process could be measured through the management of human resources

and hospital facilities, resulting in an increase in the number of consultations and surgeries performed.

Another important aspect to emphasise regards to the lean culture that could be implemented in the service by rearranging the layout of the EC and the OR wards. This rearrangement, although possibly expensive, would enhance the potentiality of a shared mind-set through all the staff, focusing on the patient and aligned to the principles of an ambulatory service. A lean sustainable model as reviewed on subchapter 2.2.3 is then advised so that this mindset would not only bring more benefits to the hospital since information would be shared and accessed more easily since all staff is located at the same place, but also to the patient whose stress levels could be reduced.

From the process analysis it was possible to see that a leagile approach is not best suited to the process in study. Instead, there should be applied an overall lean strategy to the process, with some agile characteristics. This approach would bring gains on the efficiency and effectiveness of the process, by optimising a specific human resource, giving proper training to others which could, consequently, maximize the utilization of surgical and anaesthesia induction rooms and thus contribute to the addition of value to the process, as well as leaning the process by reducing the number of patient visits to the hospital, hence creating value to the patient.

5.2. Results validation

This thesis was supported on the literature review presented in Chapter 2 regarding both lean and agile management philosophies as well as a hybrid approach of the two, namely leagility.

Despite the scarce literature around the topic, it is possible to conclude that this study follows the same overall approach as Aronsson *et al.* (2011), as the healthcare process under analysis cannot be fully lean before the decoupling point and fully agile after the decoupling point.

Value was identified due to its importance in healthcare processes under a lean perspective as Jones & Mitchell (2006). Adopting a lean thinking approach to the ambulatory service, both patient and hospital might expect promising results (D'Andreamatteo *et al.*, 2015) on the reduction of waiting times and visits to the Hospital.

However it is not possible to combine lean and agility on a hybrid approach – leagility – as Rahimnia & Moghadasian (2010) as Hospital de Lamego is not a specialized hospital. Nonetheless, the results have shown that both concepts could be used simultaneously along the process, resulting in a lean process with agile characteristics

Accordingly, in this thesis it was concluded that the process became even more efficient at an operational level, by directly reducing the number of visits to the hospital and indirectly reducing surgical waiting times, while increasing the flexibility of the process by rearranging the allocation of a medical resource, namely the anaesthesiologist, whom would be located in the decoupling point.

The decoupling point location has taken into account the characteristics of the service so that the anaesthesiologist could have some flexibility to give anaesthesia at the OR on peak surgery days or support the nurse at EC on off-peak surgery days, as enlightened by Aronsson *et al*. (2011) that have stated that the decoupling point location should be based on the characteristics of the service.

Similarly to the findings of Aronsson *et al.* (2011), and as the customer is part of every stage of the process, there the decoupling point does not differentiate lean from agile. The decoupling point represents the characteristic of the service where an agile approach can be considered in a lean process as a whole.

5.3. Research limitations

The presents study regards to a specific service of a specialized hospital, thus, the validation of results is limited to the scope of the thesis and may not be generalized into other contexts outside the scope of the thesis. A sample cannot be gathered from a case study, hence, case studies are just “generalizable to theoretical propositions and not to populations or universes” (Yin, 2009, p. 15).

This thesis may also be limited by the data gathering period which were not collected in different moments in time. In fact, data was collected during five working days of the same week. However, this was the only way to develop this thesis since the referred week was the only opportunity to gather all the data through the application of interviews, informal conversations and *in loco* observations.

During the data gathering period times were not measured, which might represent a limitation to the outcomes of the study. However, as the partial focus of the study was to

study the impacts of the leagility application on the management of human resources and hospital facilities, the frequency of use of such resources was preferred to be studied rather than the time each resource was used.

Only two persons were interviewed, whose interviews were held in spaced days of the week. In between those days, data was gathered by the use of other methods, namely direct observations and informal conversations. By the time the last interview took place the point of theoretical saturation (Strauss, 1987) was achieved, meaning that no more value adding information was provided regarding the process.

5.4. Future research topics

This research has followed an exploratory and descriptive methodology approach which encompass the need of further investigations regarding the subject in scope.

Due to the scarcity of literature review, this study contributes to the findings concerning the application of leagility, lean and agility in the healthcare sector. However, it is suggested that more studies should be conducted in order to support the results of this thesis.

As future research, it could be assessed the application of lean and agile strategies in other hospital units that have an ambulatory surgery pathway defined, so that it can be assessed the impacts of the application of a leagile approach on the effectiveness and efficiency of the process, over a lean approach with agile characteristics.

Moreover, the impacts can also be studied by measuring times throughout the process and quantifying the results in terms of improvements in the process efficiency and effectiveness.

The application of leagility is not restricted to the healthcare sector. Accordingly, the application of such approach might be extended to other categories of services.

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Annex 1 - Hospital Ethics Committee approval letter

Centro Hospitalar de
Trás-os-Montes e Alto Douro, E.P.E.
COMISSÃO DE ÉTICA

Exmº(ª) Senhor(a)
Luís Filipe Martins Órfão
Rua Elias Garcia, 307 R/C Dtº
2700-322 Amadora

ASSUNTO: Pedido de autorização para a realização de projeto de investigação

Após parecer emitido pela Comissão de Ética de 15/01/2016, o Conselho de Administração em 21/01/2016, autorizou a realização do projeto de investigação na Unidade de Lamego sobre identificação de medidas a implementar nos processos globais do circuito do doente em cirurgia do ambulatório através da aplicação Lean, Agilidade e Leagility.

Com os melhores cumprimentos,

Vila Real, 28 de Janeiro de 2016

O Presidente do Conselho de Administração

Carlos José Cadavez (Dr.)
Presidente do Conselho
de Administração

CHTMAD

Annex 2 – Informed consent for participation in the research written according to Declaration of Helsinki and Oviedo Convention

CONSENTIMENTO INFORMADO, LIVRE E ESCLARECIDO PARA PARTICIPAÇÃO EM INVESTIGAÇÃO

de acordo com a Declaração de Helsínquia[1] e a Convenção de Oviedo[2]

Por favor, leia com atenção a seguinte informação. Se achar que algo está incorreto ou que não está claro, não hesite em solicitar mais informações. Se concorda com a proposta que lhe foi feita, queira assinar este documento.

Título do estudo: Aplicação do conceito de *Leagility* no circuito de pacientes em cirurgia de ambulatório

Enquadramento: O estudo será feito na Unidade Hospitalar de Lamego, no âmbito de realização de tese de Mestrado em Gestão de Empresas, no Instituto Superior de Ciências do Trabalho e da Empresa, com a supervisão da Professora Doutora Ana Lúcia Henriques Martins e com a colaboração da Drª Lúcia Marinho, Directora do serviço de Cirurgia Ambulatória.

Explicação do estudo: Este estudo tem como propósito identificar medidas de longo, médio e curto prazo a implementar nos processos globais do circuito de doente em cirurgia de ambulatório, de modo a melhorar a gestão do fluxo de pacientes e dos recursos envolvidos, através da aplicação dos conceitos de *Lean,* Agilidade e *Leagility* ao conjunto de actividades e tarefas realizadas ao longo desse processo.
A metodologia de investigação envolve três fases. Numa primeira fase serão realizadas entrevistas a médicos e alguns enfermeiros, directamente relacionados com o processo da patologia em estudo, não sendo descuradas algumas possíveis observações para uma melhor compreensão de todas as actividades e tarefas.
Posteriormente, seguir-se-á uma análise de conteúdo por forma a esquematizar a actividade no seu todo e aferir onde os conceitos de *Lean* e *Agility* poderão ser aplicados, com o intuito de encontrar uma solução para melhorar ainda mais este serviço, a curto, médio e longo prazos.
Por último será feita uma nova ronda de entrevistas a médicos e enfermeiros onde se irão expor as soluções encontradas de forma a serem validadas pelos profissionais que delas poderão vir a usufruir.

Condições e financiamento: O presente projecto de investigação é feito no âmbito de uma tese de mestrado, não tendo qualquer tipo de financiamento, seja público ou privado, sendo o mesmo realizado com um carácter puramente voluntário.-

Confidencialidade e anonimato: Os dados recolhidos serão obtidos em ambiente de privacidade e usados única e exclusivamente para o presente projecto de investigação, garantido-se a confidencialidade dos mesmos e anonimato de todos os colaboradores envolvidos, não sendo tornada pública a identificação de nenhum participante envolvido.

Assinatura/s: Luís Ofra ……

-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-

Declaro ter lido e compreendido este documento, bem como as informações verbais que me foram fornecidas pela/s pessoa/s que acima assina/m. Foi-me garantida a possibilidade de, em qualquer altura, recusar participar neste estudo sem qualquer tipo de consequências. Desta forma, aceito participar neste estudo e permito a utilização dos dados que de forma voluntária forneço, confiando em que apenas serão utilizados para esta investigação e nas garantias de confidencialidade e anonimato que me são dadas pelo/a investigador/a.

Nome: … João Miguel Cardoso de Sousa ……
Assinatura: …… ……
Data: .07 /.03. /.2016

SE NÃO FOR O PRÓPRIO A ASSINAR POR IDADE OU INCAPACIDADE (se o menor tiver discernimento deve também assinar em cima. se consentir)
NOME: ……
BI/CD Nº: ..... DATA OU VALIDADE ..../..../.....
GRAU DE PARENTESCO OU TIPO DE REPRESENTAÇÃO: .....
ASSINATURA ……

ESTE DOCUMENTO É COMPOSTO DE 1 PÁGINA E FEITO EM DUPLICADO:
UMA VIA PARA O/A INVESTIGADOR/A, OUTRA PARA A PESSOA QUE CONSENTE

CONSENTIMENTO INFORMADO, LIVRE E ESCLARECIDO PARA PARTICIPAÇÃO EM INVESTIGAÇÃO

de acordo com a Declaração de Helsínquia[1] e a Convenção de Oviedo[2]

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Assinatura/s: ……

……

-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-o-

Declaro ter lido e compreendido este documento, bem como as informações verbais que me foram fornecidas pela/s pessoa/s que acima assina/m. Foi-me garantida a possibilidade de, em qualquer altura, recusar participar neste estudo sem qualquer tipo de consequências. Desta forma, aceito participar neste estudo e permito a utilização dos dados que de forma voluntária forneço, confiando em que apenas serão utilizados para esta investigação e nas garantias de confidencialidade e anonimato que me são dadas pelo/a investigador/a.

Nome: ……

Assinatura: ……

Data: 10 /03 /2016

SE NÃO FOR O PRÓPRIO A ASSINAR POR IDADE OU INCAPACIDADE
(se o menor tiver discernimento deve também assinar em cima, se consentir)

NOME: ……

BI/CD Nº: ……. DATA OU VALIDADE ……/……/……..

GRAU DE PARENTESCO OU TIPO DE REPRESENTAÇÃO: ……

ASSINATURA ……

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