



UNIVERSIDADE CATÓLICA PORTUGUESA

Value Stream Mapping for Waste
Minimization and Process Improvement
A Case Study in the Storage Process at Hospital
da Luz Coimbra

António João Soares de Albergaria Ramos

Católica Porto Business School
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António João Soares de Albergaria Ramos

Under supervision of
Aydin Teymourifar, PhD

Católica Porto Business School
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Abstract

Healthcare services have garnered considerable attention in the academic world, aimed at process enhancement through the lens of lean methodology. A fundamental aspect of this approach assesses the evaluation of effectiveness and efficiency within the context of healthcare provision. This study seeks to scrutinize the ramifications of such a perspective on the effectiveness and efficiency of hospital services.

This work presents an investigation into the storage process at Hospital da Luz Coimbra, employing a case study methodology. Data collection involved a multi-faceted approach, including direct observations, formal interviews, and informal discussions, all meticulously aligned with predetermined criteria. The analysis utilized Value Stream Mapping and Process Activity Mapping to identify inefficiencies and propose enhancements within the process.

The findings underscore the potential benefits of implementing lean principles to improve the efficiency and effectiveness of the hospital's supply chain. However, achieving these benefits necessitates making the best use of available resources, and facilities management practices to optimize value creation.

This research contributes to the understanding of lean implementation within healthcare settings and offers practical insights for hospital management seeking to streamline their storage supply chain processes.

Keywords: Lean Healthcare; Value Stream Mapping; Process Activity Mapping; Hospital Management; Hospital da Luz Coimbra.

Resumo

Os serviços de saúde têm merecido uma atenção considerável no mundo académico, com o objetivo de melhorar os processos através da metodologia Lean. Um aspeto fundamental desta abordagem é a avaliação da eficácia e eficiência no contexto da prestação de cuidados de saúde. Este estudo procura analisar as ramificações desta perspetiva.

Este trabalho apresenta uma investigação sobre o processo de armazenamento no Hospital da Luz Coimbra, recorrendo a uma metodologia de estudo de caso. A recolha de dados envolveu uma abordagem multifacetada, incluindo observações diretas, entrevistas formais e discussões informais, todas meticulosamente alinhadas com critérios pré-determinados. A análise utilizou o Mapeamento do Fluxo de Valor e o Mapeamento das Atividades do Processo para identificar ineficiências e propor melhorias no processo.

Os resultados sublinham os potenciais benefícios da implementação dos princípios lean para melhorar a eficiência e a eficácia da cadeia de abastecimento do hospital. No entanto, para alcançar estes benefícios, é necessário utilizar da melhor forma os recursos disponíveis e as práticas de gestão das instalações para otimizar a criação de valor.

Esta investigação contribui para a compreensão da implementação do método lean em contextos de cuidados de saúde e oferece perspetivas práticas para a gestão hospitalar que procura otimizar os seus processos da cadeia de abastecimento de armazenamento.

Palavras-chave: Cuidados de Saúde Lean; Mapeamento do Fluxo de Valor; Mapeamento das Atividades do Processo; Gestão Hospitalar; Hospital da Luz Coimbra.

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Introduction

In Portugal, signs of initial improvement toward management innovation in the healthcare sector began in 2002 with the implementation of business management in public hospitals and the introduction of public-private partnerships in the hospital sector. In pursuit of efficiency as a cornerstone of management practices, several steps were taken. This shift resulted in improvements in outcomes for the entire system (Souza, 2021). Barros et al. (2011) highlighted specific measures implemented, including the establishment of a more effective purchaser-provider split, promotion of generic medicines, reduction of medicine prices, reorganization of the public network of healthcare services, and reform of primary care. These reforms involved the creation of Family Health Units and a network for long-term care. However, these innovation processes were far from complete, and further research is needed to analyze the efficiency of Portuguese hospitals (Matos & Nunes, 2016).

Lean appears as a viable and more tested methodology, and, although the main association to Lean thinking is linked historically to manufacturing, there are already studies proving there is more room for continuous improvement in other industries. To prove that the administrative approaches that once seemed to be industry-specific fit nicely into health care, Barnes (1977) in his classic book “Motion and Time Study” has shown that healthcare was one of the sectors in which the principles of scientific management and industrial engineering are well applied. Leading to a new concept named Lean Healthcare.

Lean methodologies offer substantial promise in the healthcare sector for reshaping organizations with a fresh and forward-thinking approach. They empower healthcare professionals and managers to collaborate toward the shared goal of enhancing quality and delivering improved patient outcomes

(Kovacevic et al., 2016). Additionally, Lean practices contribute to error reduction and decreased waiting times (Graban, 2016).

Cardoso (2020) mentions starting the process of cultural change to implement the philosophy of lean Healthcare, must be implemented the Value Stream Mapping (VSM), by mapping and diagnosing the bottlenecks that deserve attention even before the implementation of lean.

The Luz Saúde Group stands as one of Portugal's foremost private healthcare alliances. Since the year 2000, it has been dedicated to delivering top-tier healthcare services. The group has forged an extensive network of integrated care, encompassing 24 establishments, including hospitals, clinics, and senior residential homes, to cater to the diverse needs of its patients. Hospital da Luz Coimbra is established in the centre and litoral region of the country, and has more than 40 clinical areas, which work in an integrated way and bring together all the medical and surgical specialties. It boasts a comprehensive infrastructure, including a surgical block catering to all hospital surgical specialties, in addition to facilities for inpatient care, intermediate care, and intensive care units. The institution further provides urgent care services, ensuring a holistic and interconnected approach to medical services within its purview.

The purpose of this research's structure is to specifically address a clearly stated research issue.

The introductory section gives readers a clear grasp of the background and goals of the research by introducing the topic of examination and summarizing the main research question. To create a solid theoretical foundation and a framework for the next research, the literature review that serves as the thesis's cornerstone is crucial.

The research techniques used in this thesis are thoroughly explained in the methodology section. It also clarifies the justification for the chosen strategies and the rationale for employing the case study methodology.

The examination of the case study is a crucial phase of this thesis, focusing on an extended analysis of the business process within the liability framework. This analysis places a significant emphasis on identifying and discussing any inefficiencies or areas that hold potential for improvement. This part of the research serves to apply theoretical concepts to real-world situations and draw practical insights.

The discussion and conclusion section offers an evaluation of the research results, summarising the key outcomes. Additionally, it provides recommendations for improving the examined business process. It also acknowledges the limitations of the study and suggests potential areas for future research.

Chapter 1

Framework

1. Problem Definition and Research Goals

In the healthcare area, Lean Healthcare is a management philosophy to develop a hospital culture characterized by increased patient, and other stakeholder satisfaction through continuous improvements. All employees such as managers, doctors, nurses, technicians, and assistants actively participate in identifying and reducing non-value-adding activities that are designated as waste. In this context, VSM is an enterprise improvement tool to help in visualizing the entire production process, representing both material and information flow.

The main goal of this paper is to apply VSM as a method to improve processes and minimize waste in the context of Hospital da Luz Coimbra. By conducting a detailed case study, this work aims to identify and eliminate forms of waste within a specific hospital's process operation.

Thus, this research is conducted to analyze a part of the current storage process at Hospital da Luz Coimbra. It will analyze the flow of materials from their arrival at the hospital to their middle storage at the respective warehouses. It is intended to contribute and deliver valuable insights and practical recommendations for healthcare managers and professionals at Hospital da Luz Coimbra to optimize and make the necessary changes and suggestions for

improvement to the current state of the entire process. In this way, Hospital da Luz Coimbra will have access to a model storage process that will effectively adapt according to the hospital unit.

1.2 Research Question

How can VSM be applied to identify and eliminate inefficiencies in the storage process of Hospital da Luz Coimbra?

1.3 Case Study Approach

Yin's (2009) framework suggests that opting for the case study approach is fitting when there is a necessity to thoroughly investigate a current phenomenon referred as the "case". This is particularly relevant when the boundaries between the phenomenon in question and its real-life context are not clearly defined, which enables to focus on the case and retain a real-world perspective. Additionally, the case study method is favoured when it's inappropriate to manipulate actor behaviours, and when various sources of evidence, such as direct observation and interviews with involved agents, are essential for a comprehensive analysis of the events under study.

The adoption of the case study approach in this research is motivated by the method's capacity to systematically investigate, assess, and explicate a specific contemporary context concerning the initial phase of storage processes within a Portuguese hospital, Hospital da Luz Coimbra.

Therefore, the case study methodology was chosen for the progression of this work to offer a comprehensive exploration of the configuration of the hospitals' first phase of the storage process. The objective is to shed light on how the implementation of VSM, as a Lean tool, can contribute to achieving heightened effectiveness and efficiency in the specified storage process.

1.4 Scope of the Study

The case study will engage with Hospital da Luz Coimbra, located in Coimbra, the central region of Portugal.

After careful consideration, in collaboration with the hospital administrator, and considering all areas, sectors, procedures, and relevant management operations within the hospital, it was concluded that the focus of the study should be the storage process for all materials arriving at the facilities. This process is identified as one of the primary sources of waste at the medical center.

The study will focus on the initial phase of the storage process. All the pantries and rooms destined to give shelter to medical supplies in the different specialties divisions are not subject to study, due to its location variability and lack of complaints about its efficiency. Moreover, between the initial storage process and the stockrooms at the specialties, there is an adjacent process linked that consequently would require to be the subject of study, which is the distribution process. This is already well structured with a well-defined platform that reaches the necessities of the stakeholders involved.

The type of procedure in scope for this thesis is the initial storage of the materials, grouped into four categories when arrived at the premises, and the results obtained from such study will be valid exclusively for this area of research.

Chapter 2

Literature Review

This chapter examines the existing literature on the research topic to gain insight into previous studies and the various points of view presented by various authors.

2. Lean Methodology

Rooted in the Toyota Production System, the lean principle is considered a methodology to optimize organisational processes, in both manufacturing and services contexts, emphasizing the elimination of waste, continuous improvement, and the maximization of value for customers (Reddy et al., 2020; Sloan et al., 2014).

2.1 Lean Management

Lean management principles have evolved and an influential work is *The Machine That Changed the World*. Although the book primarily focuses on the Toyota Production System and its impact on manufacturing, it serves as a foundational text that contributed significantly to the development and dissemination of lean principles in management (Womack et al., 1990). According to Womack and Jones (1996), these principles advocate the

streamlining of production, or service delivery, by minimizing unnecessary steps, resources, and time. Grounded in a culture of continuous problem-solving and innovation, emphasizing the streamlining of workflows, reduction of lead times, and enhancement of overall organizational agility, lean management aims to achieve operational excellence by aligning processes with customer needs and cultivating a culture of continuous improvement (Womack et al., 1990).

Diverse definitions of lean thinking abound in the literature; however, they uniformly converge on a fundamental principle: the basic principle of lean thinking is to do more with less, reducing or eliminating waste, and increasing value creation (Womack & Jones, 1996).

Seth and Gupta (2005) explain that lean manufacturing aims to produce high-quality products as economically and efficiently as possible while minimizing waste in human labour, inventory, time to market, and manufacturing space. According to Teich and Faddoul (2013), the concept of lean is inherently multifaceted, demanding concurrent efforts across various organizational dimensions. They believe that a successful implementation is often perceived as the attainment of significant strategic elements within the lean framework, the integration of practices conducive to supporting operational aspects, or the substantiation of sustained improvements over the long term.

2.2 Lean Healthcare

In the healthcare sector, Lean thinking serves as a potent instrument, as a pathway to change to a different mindset in organizations. It facilitates the active engagement of professionals and managers in a shared commitment to ensuring improved outcomes for patients (Kovacevic et al., 2016). Furthermore, it contributes to the mitigation of errors and reductions in waiting times (Graban, 2016).

The main and general goal of lean in any industry is to identify and eliminate waste (Womack et al., 1990). Applied to the healthcare sector, lean methodologies aim to enhance safety, quality, and effectiveness in care delivery. This involves optimizing information and communication flows, innovating to continuously improve service delivery, redesigning patient journeys to enhance access and reduce wait times, managing medical supply chains efficiently, implementing IT solutions, and influencing policies at both organizational and national levels (Sloan et al., 2014).

2.3 Waste

Waste is delineated as any element distinct from the indispensable resources of personnel, machinery, and materials essential for augmenting the value of the product (Mondon, 1994; Prasad et al., 2016). By the principles of lean methodology, a customer-centric approach, any activity that does not explicitly contribute to the enhancement of the product's intrinsic value is identified and targeted for removal as waste (Reddy et al., 2020).

Another definition for waste in lean philosophy is Muda. Ohno (1988) refers to "Muda" as any activity that uses resources but, from the standpoint of the client, does not improve the final product.

2.3.1 Types of waste

Within the framework of the Toyota Production System, Ohno (1988) describes the eight different categories of waste and defines the notion of "Muda" (waste) in the book. The above can be summed up in one sentence: excess inventory, motion, defects, overproduction, waiting, transportation, inappropriate processing, and underutilized Talent.

Even though these types are described by the manufacturing industry, it can be found a description applied to the provision of services in the health industry (Grabau 2016; Pinto, 2010).

2.3.2 Types of waste within the healthcare context

The authors identify eight types of waste within the healthcare context, drawing parallels to defects in the Toyota Production System:

Surgical baskets with insufficient materials are categorized as defects. The unnecessary performance of diagnostic tests is likened to overproduction. Dysfunctional layouts are equated with transportation waste. Employees waiting to work due to uneven labor levels or patients waiting for appointments and examinations represent waiting waste. Expired medicines are considered excess inventory. Excessive movement of hospital staff is analogous to motion waste. The creation of patient forms that remain unused is categorized as inappropriate process waste. Medical professionals and staff experiencing burnout, resignations, or lacking opportunities for continuous improvement are seen as underutilized talent.

2.4. VSM

To understand the concept of value and the purpose of VSM, it is important to be aware of the advocated concept by Michael Porter, which has been prevailing for more than three decades. A value chain represents a series of activities undertaken by an organization to provide a valuable product to the market. According to Porter's perspective, an organization functions as a system comprising inputs, transformation processes, and outputs (Simatupang et al., 2017).

VSM serves as a tool within the value chain framework, allowing for the visualization, analysis, and enhancement of production activities. Is a visual

representation of the steps involved in a process, spanning from the initial request to the final delivery (Dahlgaard et al., 2011). Permits managers to identify the value-added (VA) and non-value-added (NVA) pieces of a process from its beginning to its end, allowing the improvement of flow and identification of opportunities to reduce waste (Shank & Govindarajan, 1993). Within lean healthcare, it represents a key tool for mapping the flow of information and processes in a system, identifying waste sources, and proposing improved future scenarios (Dahlgaard et al., 2011).

To categorize these activities, and to use the VSM tool correctly, managers must respect the two different and divided states of VSM, mapping the current state and future state (Rother & Shook, 2003). Within processes, it allows us to identify the waste created in that process, by mapping the current state, and to suggest a future state where the waste identified is eliminated (Costantino et al., 2010). Mapping The current state of the company involves scrutinizing operational realities to identify and eliminate non-value-adding components, and this process of waste reduction opens the door to start crafting a future state map, that results in a strategic blueprint envisioning optimized processes post-implementation of improvements (Bartnicka, 2018; Vieira et al., 2020). Practical experience has shown that it's important to double-check and confirm the shift from the current way of doing things to the desired future state before making changes (Costantino et al., 2010).

2.4.1 Value Stream mapping in healthcare

On its application to the healthcare contexts, there are case studies able to underscore the potential benefits of applying lean principles to improve healthcare processes. In a Brazilian public healthcare organization, the application of VSM in the sterilized materials unit of the hospital resulted in waste reduction, decreased inventory levels, and shorter production lead times.

The case study contributed to the existing knowledge of lean management by affirming the validity of implementing lean principles in healthcare settings beyond traditional manufacturing (Tortorella et al., 2017). At an Oncology Day Hospital (ODH) in Spain, VSM demonstrated how to improve the delivery of patient care in a specific department of a hospital, addressing the unique challenges of oncology patient management. VSM was used to map the patient flow and to propose improvements such as working at takt time and leveling the workload to enhance patient care and reduce waiting times and length of stay (Vidal-Carreras et al., 2022). The cases presented expose a greater focus on the flow of patients and their planning, acting in several areas of the hospital, whether care or support, using an integrated view of lean tools and techniques. Addressing the main problems encountered, such as high patient waiting rates, an ineffective system, lack of demand, and capacity planning. It became apparent the identification of waste and flows is crucial for effective management and achieving desired objectives.

2.5 Lean Tools

2.5.1 Layout Types

In the realm of healthcare facilities, renowned for their intricate nature, the constant evolution of healthcare processes and the integration of novel technologies necessitate corresponding adjustments in internal layouts and building performance. This dynamic environment involves various stakeholders, each with distinct and occasionally conflicting requirements, ranging from medical staff and patients to visitors, as well as cleaning and maintenance teams (Junior et al., 2018).

In certain instances, the intricacy of healthcare demands subjective considerations, hinging on human interpretation, creativity, or the application of

artificial intelligence techniques for comprehensive inclusion in the design. Consequently, the evaluation of healthcare designs against client requirements necessitates a degree of subjectivity but concurrently allows for the integration of automation to a certain extent (Junior et al., 2018).

2.5.2 Visual Management Tools

Visual Management, as a lean Tool, serves to make crucial information accessible to all stakeholders by presenting it through visual cues rather than relying solely on textual information. Aiming to elevate efficiency, value, and overall clarity, the design of visual management should be prominently displayed, facilitating understanding and effective communication among stakeholders (Singh & Kumar, 2021).

2.6 Importance of Lean in warehouse hospital and storage management

Through case studies on manufacturing companies in the oil and energy sector seeking to enhance warehouse operational efficiency, Ikatrinasari and Nurjaman (2023) highlight the importance of lean warehouse methodology, by incorporating VSM and utilizing the 5S approach with waste analysis. An improvement is a significant reduction in operating time activities, including a decrease in loading-unloading activities and, a reduction in receiving, and storage.

Conducted in the logistics operations of a Northern Portuguese hospital, Rocha et al. (2023) present findings from an exploratory case study specifically examining the delivery plans for essential products between the central warehouse and the internal medicine ward. The study utilized PDCA improvement cycles and various lean tools to analyze the existing delivery system, identify inefficiencies, and propose solutions. The objective was to

mitigate different forms of waste, such as the time spent by the ward head nurse on initiating orders and managing product reception/arrangement and addressing surplus products leaving the central warehouse.

On the importance of warehouse and storage management, Bocquet et al. (2022), in a view to rationalization of logistic warehousing processes, affirms that to maintain profit growth in a free market environment, logistics plays an important role for companies, through a wide range of tools and methods, reduce costs and eliminate waste. Based on his testimony, and top of the logistic activities, warehousing and inventory management are the keys to ensuring an optime business by being optimally sourced.

A Lean warehouse necessitates continual, systematic, sustainable, and measurable improvement by all involved collaborators. Given its position within the logistics domain, where numerous sources of waste can readily be identified, there exists significant potential for enhancement, ultimately contributing value to the customer (Dehdari, 2014).

2.6.1 Inventory Management

When a company maintains an excessive inventory beyond its consumption capacity, it incurs superfluous expenditures for storage management. On the other hand, low inventory levels increase the possibility of revenue loss due to orders that are not filled, which may result in lost business. Maintaining profitability and customer happiness while maximizing resource allocation in inventory management depends on finding the ideal balance (Kučera & Suk, 2019).

2.6.2 ABC Analysis

For inventory management to be as important as it can be in ensuring that the business is efficiently procured, several methods and tools are used. A vital one

is the ABC analysis (Bocquet et al., 2022) as a tool employed in logistics, particularly in warehousing, the ABC analysis effectively strikes a balance between minimizing inventory holding costs and maintaining a satisfactory level of customer service (Kučera & Suk, 2019). Rooted in the Pareto principle, it classifies stock items into three categories based on significance. By focusing on the top 20% of critical items, ABC analysis aims to exert control over 80% of the overall volume of stored items (Kučera & Suk, 2019).

2.6.3 Storage and warehouse in healthcare

At the beginning of the eighties, Kowalski (1981) strongly reasoned that a solid hospital warehousing/storage is established through key elements, including a proficient item numbering system, a meticulously planned location system, strategic layout principles, an optimized storage system, a well-structured rotation system, and a dependable approach for measuring productivity and outcomes.

Warehouses constitute integral components of any logistical system. Their function aims to deliver a desired level of customer service at the lowest possible cost. Within a warehouse, an effective layout holds the potential to enhance outputs, optimize product flow, decrease costs, elevate customer service, and foster improved working conditions for employees (Grant et al., 2006).

2.6.4 Kanban

Kanban, as a pull method approach, facilitates employee productivity by enabling production at a required rate and allowing control over product inventories in alignment with customer forecasts (Cheng et al., 2015). The primary advantages of Kanban include the reduction of inventory holding, improvement in material flow, elimination of overproduction, minimization of

obsolete inventory, and enhancement of supply chain management (Papalexi et al., 2015).

Lin et al. (2012), which corroborate their research by illustrating the creation of a knowledge kanban system through the integration of kanban management principles, affirm the primary advantage of Kanban as a guide for the employees to understand the knowledge necessary for creation, sharing, and revision, facilitating a more informed and efficient workflow.

2.7 Educational culture on continuous improvement

Lean thinking refers to individuals who operate with thoughtful reflection on organizational issues, are committed to continuous improvement efforts, and demonstrate the willingness to lead change (Mazur et al., 2019).

In both healthcare provision and manufacturing operations, achieving successful change shares common key factors, thus including a clear commitment from senior management, active involvement of practitioners, and acknowledgment of the expertise found on the shop floor. Despite the inherent distinctions between the two sectors, such as the geographical protection of healthcare delivery, the diverse nature of customer presentations, and the significant influence of healthcare specialists, these differences only contribute to a more important and effective role of educational culture required when implementing lean techniques in healthcare organizations (Kučera & Suk, 2019).

Tucker et al. (2008) proposed that individuals are more inclined to participate in reporting errors and contributing to improvement initiatives when they are afforded the necessary time and support, aligning with the core tenets of lean philosophy. Research on organizations with a robust history of enhancing quality and safety through lean methodologies has demonstrated the crucial role of granting employees dedicated time and a sense of autonomy in engaging with

improvement endeavours (Drotz & Poksinska, 2014; Graban, 2009; Stelson et al., 2017).

Despite positive reports in the academic literature, books, and lay press, it is still difficult to determine if employees have transformed into effective “lean thinkers” within healthcare organizations (Mazur et al., 2019).

2.7.1 KPIs used in inventory healthcare

Previous applications of lean in healthcare have primarily aimed to enhance the safety, quality, and efficiency of healthcare delivery. This includes improving information and communication flow, driving continuous service delivery improvement through innovation, redesigning patient journeys to enhance access and reduce waiting times, managing medical supply chains, implementing IT solutions, and influencing policy at both organizational and national levels (Sloan et al., 2014).

For further information on the literature review, please find Appendix 1.

Chapter 3

Methodology

3. Qualitative Research

This study adopts a predominantly qualitative research design to delve into the intricacies of the storage process at Hospital da Luz Coimbra, employing VSM as a tool for waste minimization and process improvement. The qualitative approach is chosen to capture the nuanced perspectives, experiences, and insights of key stakeholders within the hospital's pharmaceutical unit, which is responsible for the process under research.

3.1 Case Study Approach

Hence, the case study approach was chosen as the focal methodology for this work to provide a comprehensive understanding of the hospitals' first phase of the storage process. The aim is to delve into the configuration of this specific pathway and explore how the application of VSM, as a Lean tool, can contribute to achieving enhanced effectiveness and efficiency in the scope of this thesis.

3.2 Data Collection

This research began with a formal letter between the thesis author and the director of the Hospital, asking for the opportunity to have the hospital as the

subject of research. At an initial meeting, the director gave the consent needed for the study to move forward and, after the selection of the hospital area at study, quickly introduced the author to the manager of the pharmaceutical supply department, which manage the process of research.

The primary data collection method employed in this study is in-depth interviews, recognized as a robust approach for exploring complex organizational processes. Additionally, an essential facet of the investigation involved an informal meeting with Dr. Ricardo, the esteemed manager of the hospital's pharmaceutical unit.

Dr. Ricardo plays a crucial role as a key decision-maker, providing valuable information into the strategic aspects that shape the storage process, part of the hospital area, previously chosen between the author and the hospital director. It is important to mention that the meeting was in the initial phase of the case study, and it took place at the hospital premises, contributing to the process chosen and giving the first insights of it.

The interview, along with a Gemba walk, served to delineate the intricacies of process selection within the broader spectrum of storage procedures. Crafted for core data collection, the interview, available on Appendix 2, was then meticulously tailored by the author to target the interviewee's team and the staff under their purview. This phase emerged as the pivotal and indispensable component of the overall research, laying the foundation for a thorough exploration of the selected process under research.

The exploration of the storage process at Hospital da Luz Coimbra is corroborated by eight key staff members from the pharmaceutical unit. These individuals were chosen according to their job function, years of experience, gender, and age. This range offers a diverse array of perspectives within the organizational context.

The sampling strategy adheres to qualitative research principles, emphasizing the selection of participants with rich and varied experiences in the context of the study (Patton, 2002). This purposive sampling approach aims to capture nuanced insights from individuals closely involved in the pharmaceutical unit, contributing to a holistic understanding of waste minimization and process improvement within the storage process at Hospital da Luz Coimbra.

Thematic analysis is applied to the qualitative data collected through interviews. This approach allows for the identification, analysis, and reporting of patterns or themes within the dataset (Braun & Clarke, 2006). Through this systematic process, emergent themes related to waste minimization and process improvement in the storage process are identified and rigorously analyzed.

Ethical approval for this research was obtained from the relevant institutional review board, ensuring the protection of participants' confidentiality, informed consent, and the overall ethical integrity of the study.

3.3 Process Selection

This research focuses on examining a healthcare sector process, particularly within a private hospital setting. To ensure the case study's relevance, the chosen process must hold significant importance for Hospital da Luz de Coimbra, the major collaborator for this thesis. The selected process may play a pivotal role in the overall operations of the hospital, thereby enabling the proposed solutions to have a substantial impact on a broader scale. Also, considering lean methodology's foundation in waste reduction, it is essential for the selected process to inherently contain elements of waste.

3.4 VSM

The decision to adopt VSM stems from a thorough review of existing literature, which highlights its effectiveness in streamlining complex workflows

and eliminating NVA activities. As mentioned in chapter two, numerous studies within the healthcare domain have underscored the utility of VSM as a visual and systematic approach to identifying, analysing, and optimising processes. Building upon this scholarly foundation, the research aims to apply VSM to the initial phase of the storage process of Hospital da Luz Coimbra, systematically assessing the current state, identifying inefficiencies, and proposing a refined future state.

Chapter 4

Case Study

The information presented thus far provides a foundational context for the subsequent chapter. In this ensuing section, the chosen lean methodology, VSM, will be applied to the specified case study within the scope of this research.

The investigation begins with insights into the rationale behind the selection of this particular methodology and process selection overview. A detailed examination of the current state of the process, known as the "AS IS" phase, where each activity is meticulously mapped out with VSM serves as a mark for a thorough description and explanation of the activities based on findings derived from the conducted interview.

Subsequently, the process delves into Process Activity Mapping which will structure a Waste Identification analysis. Supported by the conducted interview, field analysis, and informal discussions, will uncover inefficiencies and redundancies within the current system. This phase is crucial for identifying areas of improvement and potential optimization. The identified waste and shortcomings then pave the way for the exploration of improvement opportunities, laying the groundwork for enhancing the overall process efficiency.

The third coming stage involves the envisioning of an optimized future state, encapsulated in the "TO BE" phase of the Future VSM. This phase outlines the

proposed improvements and serves as a roadmap for steering the process towards enhanced effectiveness and efficiency.

4. Process Selected

Understanding the selection of the process at the hospital for this case study is of paramount significance, particularly in light of the hospital's established proficiency in Lean methodologies and continuous improvement initiatives.

4.1 First visit

At the beginning of the case study, a primary visit was made to the hospital together with the hospital administrator, to discuss his concerns regarding the most deficient sectors and areas of his hospital as well as be able to understand the lean culture applied in the hospital's foundations. Beforehand, it was known that the hospital currently represents a highly differentiated health project, having created an innovative and dynamic clinical model that brings together all the clinical valences, reference professionals, and proven experience. However, most of the director's concerns were related to the storage process. He began to explain that, within the hospital's organizational culture linked to continuous improvement, this was the sector that had more resistance to these principles by being the most operational and farthest from the patient, at the value chain. He added that, in terms of operational management, the storage process has a key role in the entrance of materials and has a significant impact on the daily operations of the hospital.

4.2 Gemba Walk

The second visit to the hospital, together with the manager of the hospital's pharmaceutical unit, Dr. Ricardo, a Gemba walk was made of the entire storage process, to understand the procedures, their importance and relevance, their visual flaws, and constrained points. The author found a computerized inventory management system super advanced at an inventory management level that only a more in-depth analysis could identify possible improvements to be made. However, found that there were some bottlenecks in the integration/entry of materials into the information system.

Other deficiencies visualised during the visit relate to space management and the location of warehouses, that difficult the flow of materials and information.

4.3 Meeting with the manager

After the walk, an informal discussion with Dr. Ricardo was made with the aim of draw general conclusions about the whole process managed by him. The conclusions drawn were quite objective.

He considers that within the area of supervision, the entire supply chain for pharmaceutical products is very well-regulated. Inventory management of the pantries and rooms destined to give shelter to medical supplies in the different specialties divisions at the hospital are well managed and the distribution process to the respective sites is an efficient process. What worries him most is the phase of intermediate warehousing of the materials that enter the hospital. Their storage and procedures in common with pharmaceuticals, suffer some deficits due to the prioritization of medicine implemented.

Other highlighted topic mentioned is the quality management system imposed by the government in the health sector for medicine, which are highly demanding, and often slows down the process due to its delicacy.

About the support system for inventory management, purchasing management, and operational support, he made positive comments about the information system, which is well equipped with alerts for stock management, which allows them to control and minimize the risk of stock-outs. On the other hand, he made some criticisms, such as the slowness of the system at the computer level.

After this, and together with the literature review on the subject, it was decided for the research to focus on the first phase of the storage process, considering the flow of material from the start of the supply chain to the first storage locations, excluding other hospital units and specialties that serve as a final material destination.

The subject of study is the streamline of all types of materials, its storage pathway, and all the VA by those involved in the process. This strategic choice is motivated by the pivotal role that efficient warehouse and storage operations play within the healthcare supply chain, ensuring the timely availability and distribution of critical medical resources and materials.

4.4 Process Overview

First of all, it is important to generally describe the process carried out in the pharmaceutical inspection department, to objectively validate the process selected for research. This information is based on the questions made by the author during the Gemba walk and the additional information provided by Dr. Ricardo.

All the items that enter the hospital and pass through the main warehouses at the premises are classified into four major groups of material. Medicines, clinical devices, consumables supply office, and hospitality supplies.

The mapping of the route travelled by these materials involves the unloading dock, areas used for validation, a support room equipped with a fridge and two

computers, the pharmacy for storing medicines and three warehouses. It should be emphasised that the location of what is described is spread over three different floors and a considerable distance apart.

It's important to bear in mind that INFARMED, the Autoridade Nacional do Medicamento e Produtos de Saúde, I.P., demands extra care when it comes to the medication receiving process. With the goal of ensure the quality and safety of pharmaceuticals and medicine, and clinical devices, all of the materials must come with an associated number, which must be validate upon entering the hospital.

As already mentioned, the process within the scope of study at Hospital da Luz Coimbra involves the handling of incoming at its initial phase, where the materials that came into the hospital go to the warehouses before they are supplied to other points at the hospital. The process is managed by a team composed of two types of positions, pharmacist technicians and pharmacist assistants, who design different functions but contribute to the overall process. Both roles actively participate in maintaining an accurate inventory and ensures seamless integration with the hospital's broader supply chain. It is with this premise that the case study and its respective application of the VSM will initially be divided into two applications detailing the different roles of the two types of positions that will fuse into a global VSM of the current state of the process.

Chapter 5

VSM

5. Storage Process

The preliminary overview of the storage process in the subchapter “Process Overview” served to establish foundational understanding, while this subchapter delves deeper into its intricacies. By employing identified tools, it presents a nuanced analysis of the process and its constituent activities. Furthermore, a comprehensive examination identifies various types of waste embedded within the process, aiming to formulate targeted solutions for their elimination and enhance operational efficiency.

5.1 Current State

VSM is a methodological approach that graphically delineates the intricacies of a process's value stream. It employs visual representations, utilizing icons to elucidate the diverse trajectories of both materials and information. The thin black arrows represent the flow of information, and the thick green arrows characterise the flow of materials, from one process to another. The rectangles represent the process flow icon, which symbolizes fixed and continuous internal material flow through a department, procedure, operation or machine. The primary objective is to optimize the delivery of value to the end customer through a depiction of the entire operational continuum.

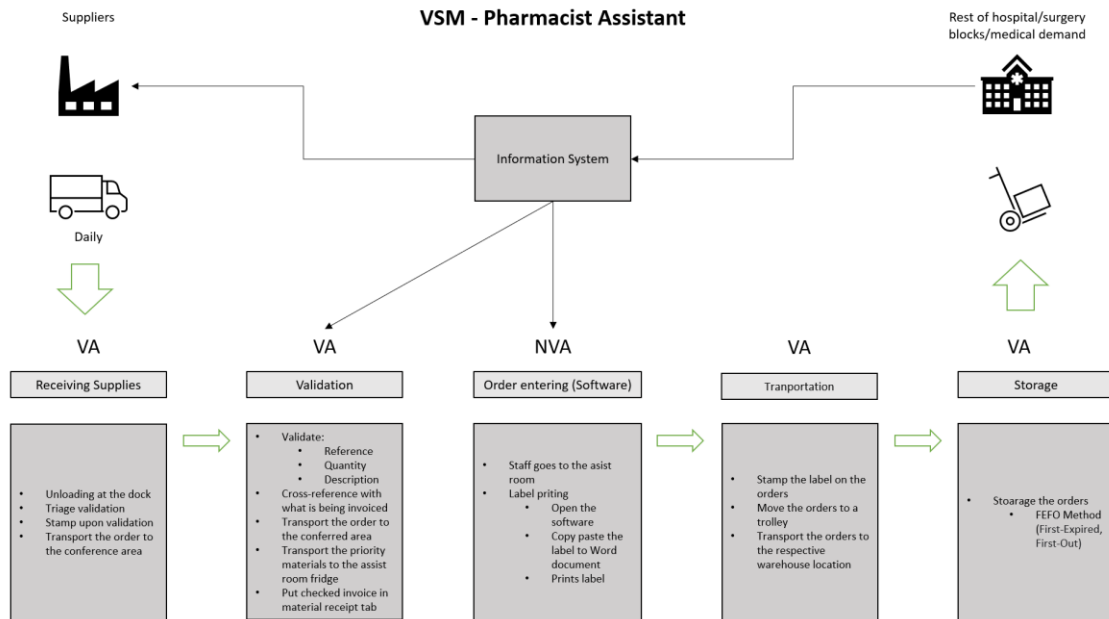


Figure 1. VSM – Pharmacist Assistant | Current State

The VSM represented in Figure 1 is relative to the current state of the materials pathway where the main agent is the pharmaceutical assistant.

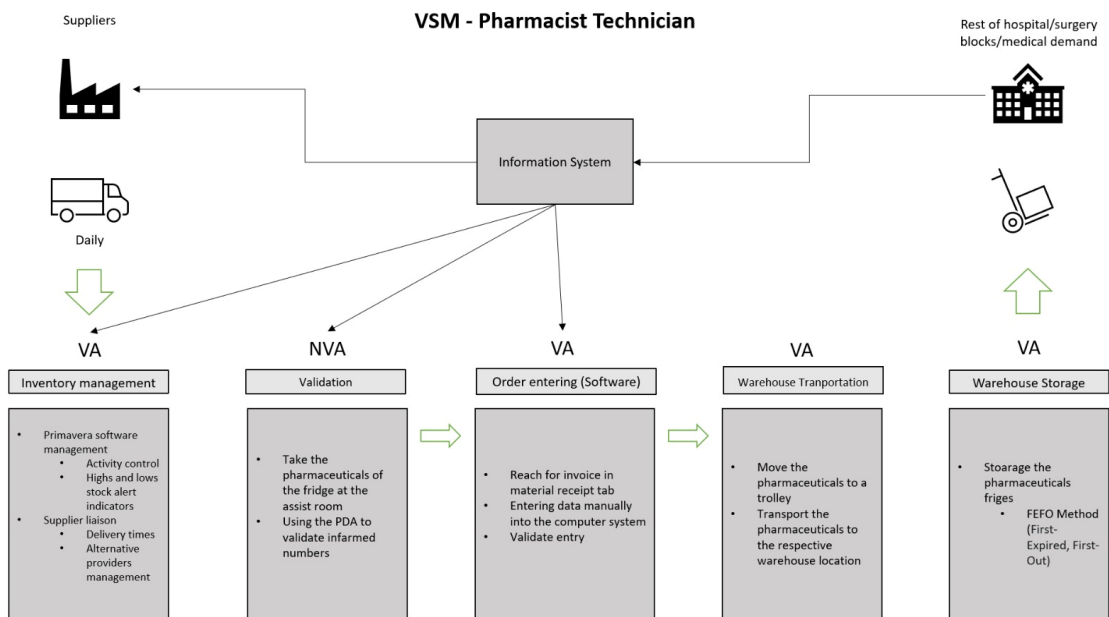


Figure 2. VSM – Pharmacist Technician | Current State

VSM represented in Figure 2 is relative to the current state of the materials pathway where the main agent is the pharmaceutical technician.

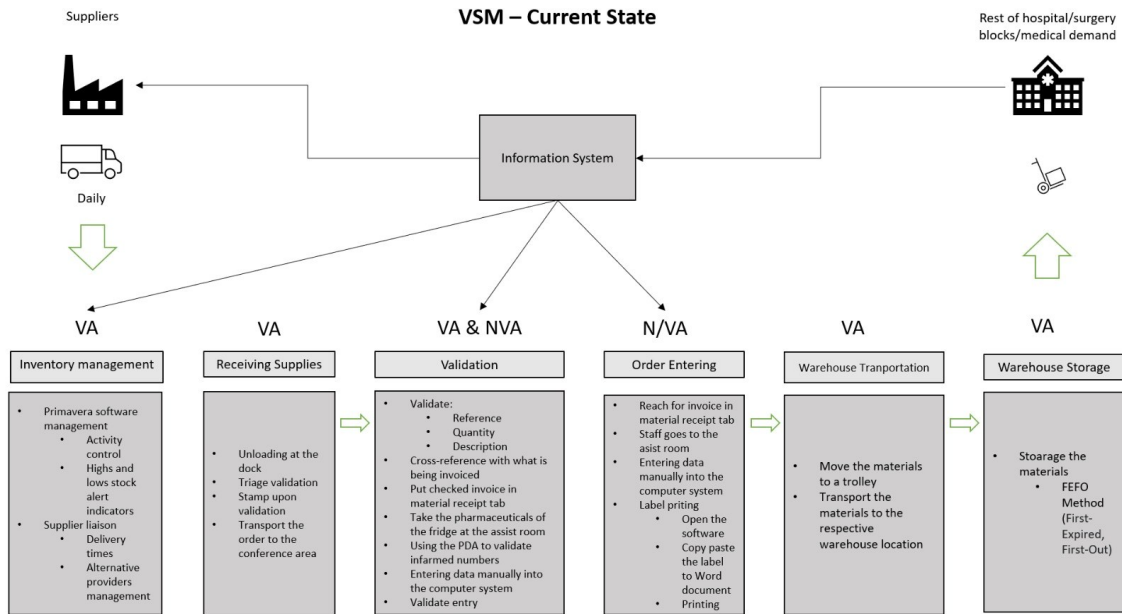


Figure 3. VSM | Current State

The VSM represented in Figure 3 is relative to the current state of the materials pathway combining the functions of the pharmaceutical technician and pharmaceutical assistant.

5.1.1 Understanding the Current State: Analyzing Process through “AS IS” Mapping

In VSM, 'AS IS' refers to the current state of a process or workflow. It involves thoroughly documenting and visually representing all steps, activities, and flows involved in the existing process. “As Is” representation aims to portray the current steps involved in a process, relying not solely on information obtained during interviews but predominantly on first-hand observation in the field, capturing the practical execution of tasks.

As previously mentioned, the storage process is a sequential pathway that materials must follow. This pathway serves as a macro process, incorporating numerous activities conducted across all stages of storage. Its overarching goal is to ensure meticulous monitoring of the flow of materials. For the scope of this

thesis, as mentioned before, the research only goes until the stage of whare-house storage.

5.1.2 Process Activity Mapping

The elucidation of the process intricacies necessitates a comprehension of the discrete actions transpiring at each juncture. Consequently, the integration of an additional tool emerged as imperative.

Process mapping aims to provide a comprehensive presentation for enhanced understanding of a particular process, converging toward the overarching objective of describing the process and identifying opportunities for improvement. The mapping process places a primary focus on the material, considering it as an integral part of the pathway. Consequently, the mapping procedure involves tracing the material's journey throughout the process, ensuring that the pathway is centered around its efficiency.

The utilization of process activity mapping was instrumental in disassembling the overarching process into discernible subunits, encompassing both activities and tasks. This facilitated a more lucid understanding of the process dynamics, concurrently enabling the identification of inefficiencies, VA activities, and the stakeholders involved.

From a macro viewpoint, the storage process is a continuous and recurring process that takes place daily, several times a day in all its stages. This process, since it mirrors the need and demand for material goods for the medical and health purposes of the hospital's patients, is elastic. In other words, it requires enormous adaptability, predictability, and management due to this elasticity of demand.

5.1.2.1 Inventory Management

The storage phase studied is initiated by the purchase order for all types of materials. As described by the interviewees, this generated demand is parameterized beforehand in the Primavera system so that there are minimum and maximum stocks, established by various key interlocutors who know the hospital's levels of effort. In the purchasing process, the pharmacy technicians play a fundamental role in this initial phase, as they are the ones who monitor and validate stock levels daily.

Once the purchase order for the materials has been placed, the technicians have the task of controlling delivery dates, being in frequent contact with suppliers, and coordinating and alerting staff and pharmaceutical assistants to the arrival and collection of orders on the dock. In the event of any unforeseen circumstances on the part of the supplier in the delivery of materials, they are responsible for defining alternatives and contacting other suppliers to provide the same service and be able to supply the orders on time with the desired conditions.

5.1.2.2 Receiving Supplies and Validation

When the delivery arrives at the hospital dock, the pharmaceutical assistant is in charge of validating its condition. With the help of the lifts from the supplier's vans, he unloads the materials onto a pallet. At this stage, he will only validate its condition, whether the pallets and packaging appear to be in good condition and without signs of damage. He will also check if the order is really for the hospital, since in the sector, due to the high volume of goods produced, it is common for suppliers to mistakenly deliver material ordered by another hospital or clinic in the wrong location.

Once the first validation has been carried out, the assistant stamps the packages and transports them to the first checking point, which is located next to

the support room on the same floor as the unloading bay. This first location is referred to by the staff as the conference area. There, he carries out the rest of the order validation, checking if what the supplier has billed on the invoice corresponds to what has been delivered. At this stage, the employee prioritizes any pharmaceutical medication that comes in the order received, going to the support room and placing the product in the support fridge in the room.

5.1.2.3 Generating Label

Once the validation is complete, the assistant goes to the support room where he goes to the computer to generate a label. The employee checks the information on each material in the system, indicating its storage location, and opens a Word file where he pastes in the information to print the label. After generating the necessary labels, they go back to the conference area where the materials are to stick them on. In this step, it should be noted that some of the employees take the orders into the room when they go to enter them into the system, to minimise possible mistakes in the label pasting procedure.

Afterward, the assistant transfers the checked material to a zone two meters to the side referred to as the conferred zone. Along with it, he places the corresponding invoices in the appropriate tab, located in the same place. It is at this stage of the process, and due to the complexity of the materials entering the hospital, that the storage path is divided according to the type of material. Pharmaceuticals, i.e., medicines, follow a path that requires further validation and special care in their handling. They are also the type of material that is most allocated to the duties of pharmacy technicians.

5.1.2.4 Warehouse Transportation/ Storage

As the final steps, the pharmaceutical assistant places the orders on trolleys and, depending on the label, goes to the respective warehouses to store the materials, applying a strict FEFO (First-Expire, First-Out) model when storing.

Also, as part of the process analyzed, the pharmacy technician is responsible for entering into the system all types of materials that arrive at the hospital. Therefore, the technician who goes to the support room to enter the material into the system picks up the invoice left by the assistant at the designated location.

After validation by the assistant and storage in the support fridge at the dock's support room, pharmaceutical materials are transported by technicians to the pharmacy on the upper floor. The pharmacy is equipped with two large fridges for storing medicines and three sizable shelves for storing clinical devices that do not require refrigeration. It is in this room and again by the pharmaceutical technicians that, with the help of a PDA (personal digital assistant) device, the QR code contained on the packaging of each medicine is scanned to validate the Infarmed number so that the quality and veracity of the medicine can be checked. This step is required by law in Portugal.

The reading is that the PDA cannot integrate the medicine into the system, which means that the technician enters the data manually into the system into the Primavera system. The material in question is then stored in the places described above. Bear in mind that the assistants also apply a strict FEFO (First-Expire, First-Out) model when storing the medicine. Once this stage has been completed for pharmaceutical materials, they are only moved again at the request of the doctors and clinical managers of each of the hospital's medical specialties. Other hospital teams manage this phase.

Nº	Activities	VA vs. NVA
1	The technician receives a low stock alert.	VA
2	The technician generates the purchase order.	VA
3	A technician places the order.	VA
4	Technician awaits order confirmation from supplier.	NVA
5	The technician validates estimated delivery date.	VA
6	Waiting for the arrival of materials.	NVA
7	The assistant unpacks the order.	VA
8	The assistant checks physical condition of the order.	VA
9	Assistant validates address and tax number.	VA
10	The assistant validates the number of volumes.	VA
11	Assistant stamps the order checked.	VA
12	The assistant downloads the order from the shopping cart.	NVA
13	The assistant goes to the support room with priority material.	NVA
14	The assistant places the prior material in the support fridge.	VA
15	Assistant transports the order to the conference area.	NVA
16	Assistant validates the material number.	VA
17	Assistant validates quantities.	VA
18	Assistant validates label description.	VA
19	The assistant cross-checks the information validated with the invoice.	VA
20	The assistant enters the system.	VA
21	Assistant transfers information to a Word file.	NVA
22	Assistant prints label.	VA
23	The assistant goes to the conferred area.	NVA
24	Assistant labels orders.	VA
25	The assistant transfers the orders to the conferred area.	NVA
26	Assistant places invoice in tab.	VA
27	The assistant adds the orders to the trolley.	NVA
28	The assistant goes to the warehouse.	NVA
29	Assistant stores the order.	VA
30	Assistant applies FEFO.	VA
31	The assistant goes back to another warehouse to store another order.	NVA
32	Technicians pick up the invoices left in the tab.	VA
33	Technicians transfer the orders at the support fridge to the pharmacy.	NVA
34	The technician uses a PDA to validate the QR code/ Infarmed number.	NVA
35	The technician gives entry of all the materials, in the system.	VA
36	Technicians storages the pharmaceutical orders at the fridges of the pharmacy.	VA
37	Technician applies FEFO.	VA

Table 1. Process Activity Mapping

5.2 Waste Identification

The gathered data from observations and interviews indicates that the storage process streamline is currently relatively efficient. However, in line with lean principles advocating continuous improvement, there's always room for enhancements. Through Waste identification, this study aims to pinpoint specific areas for incremental improvements, seeking to further optimize the effectiveness and efficiency of the pathway.

The Process activity mapping allows to computing good metrics related to the VA and NVA activities. According to this lean tool and Table 1, there is a relative amount of waste.

5.2.1 Movement

Since the procedural area described includes three warehouses located on three different floors, the pharmacy, a support room, a dock, a conference area and a conferred area, movement is, by the interviews, identified as the main type of waste at the storage process. This spatial dispersion results in prolonged travel distances for materials and staff.

Each material entry to the hospital represents a source of a large amount of time spent by the staff on moving the materials and moving over the process. For the same trolley of materials, they often have to go to all three floors to store them in a warehouse. Moreover, technicians, who are integral resources within the process, endure extended walks between the assistance room and the pharmacy.

This type of waste can be identified in the activities 15, 25, 31 and 33 on Table 1.

5.2.2 Overprocessing

Analyzing the procedure for entering materials into the system and processing the data, it is clear that there are wastes. Since the process is entirely manual, it

costs technicians time. When printing the label that gives access to the location information, the assistant needs to take the input from the Primavera system and paste it into a Word file before printing it.

This type of waste can be identified in the activity 21 on Table 1.

5.2.3 Display Inefficiencies

At the warehouses, many of the items, especially the consumables supply office, and hospitality supplies materials, which have a long validity life or no validity life at all, occupy a large part of the flow of materials entering the hospital. Often, these types of materials have the largest dimensions and require a more standardized shelf display for their size. This leads to display inefficiencies since the other smaller materials leave unused space between shelves.

At the dock, even though the conference area and the conferred area are quite close to each other and close to the support room, it is clear that there is an unnecessary occupation of space.

5.2.4 Inventory

From the data collected, it is clear that there is an excess of inventory in some storage areas, specifically the warehouses. The consumables supply office materials clearly had old labels and dust.

5.3. Improvement Opportunities

Having identified various types of waste within the process, the focus now shifts towards seizing improvement opportunities. The overarching goal is to eliminate or, at the very least, minimize the impact of waste on the process.

5.3.1 Movement

When building the hospital, the intention was for the pathway be less interrupted and the materials would be transported to the final rooms. With growth, these rooms were allocated to the needs of the patients. The only way to combat and reduce this type of waste is to tackle the more intermediate phases of the process relating to staff movement.

5.3.2 PDA Usage

Identified as a major opportunity for improvement is the use of the PDA to allow integrated entry of materials into the system remotely from a picking procedure already used for validation of the Infarmed number. Its use would not represent an increase in material resources, since the PDAs already available would be used and it would allow the elimination of some steps in the process, both in terms of time and transport and movement. In addition, the picking system could be applied in the initial phase of the process, after all the parameters have been validated, to eliminate the unnecessary transport of materials into the support room.

Its usage would lead to a transfer of functions from the technician, who until then was the only one with the know-how and responsibility to enter the material into the system, to the assistant. In turn, the breakdown in the flow of material and information, which a priori existed in the placement of the invoice in the tab near the support room as a means of passing on information, would no longer occur.

5.3.3 Inventory

To eliminate excess inventory waste, the hospital should use ABC analysis to prioritize items based on their value and demand frequency, enabling efficient stock management and reduction of unnecessary storage. As demonstrated in the

chapter two, a regular adjust inventory levels according to ABC classifications, will ensure optimal stock levels and minimize excess inventory accumulation.

5.4 Envisioning the Future: Designing Process Improvement with “TO BE” Mapping

In VSM, 'TO BE' refers to the desired or ideal future state of a process or workflow. It involves envisioning and designing improvements to the current state ('AS IS') to achieve specific goals such as increased efficiency, reduced waste, improved quality, and enhanced overall performance. Evaluate the value created by proposed improvement initiatives, a redesign of the process is essential. This involves reflecting suggested changes in a future state mapping. This visual representation enables stakeholders to understand how the proposed improvements will impact process efficiency.

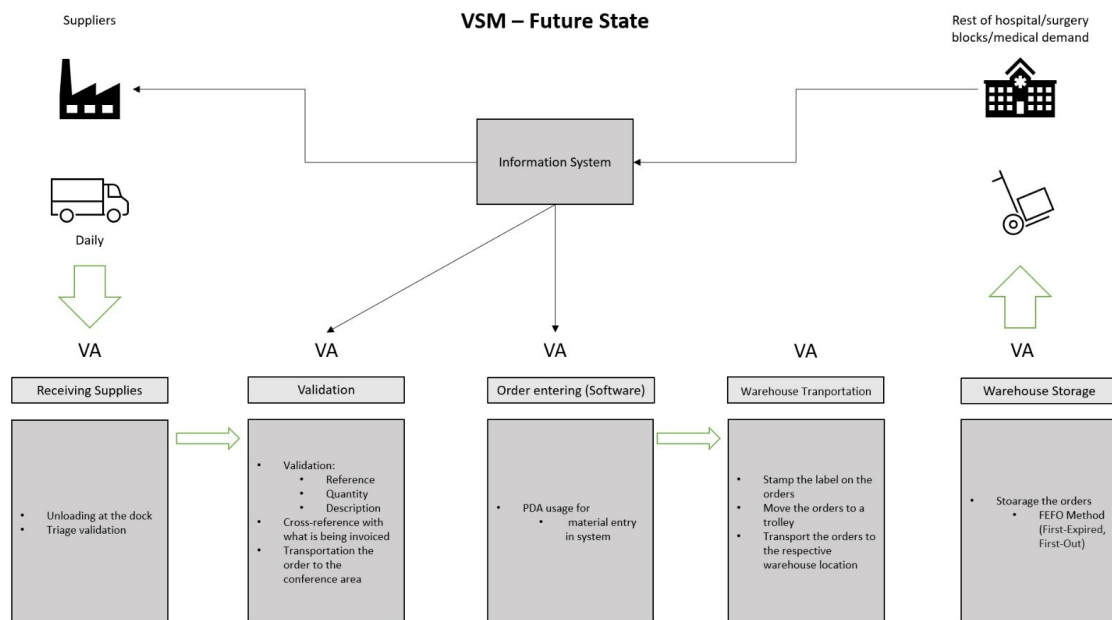


Figure 4. VSM | Future State

The VSM represented in Figure 4 is relative to the Future State of the materials pathway combining functions of the pharmaceutical technician and pharmaceutical assistant.

As notes in Figure 4, there is a reduction in the number of steps compared to AS IS and the elimination of intermediate processes within those steps. Also, the flow of materials is reduced, which reflects a decrease in staff movement.

Chapter 6

Discussion

6. Discussion

The information presented thus far provides a foundational context for the subsequent chapter.

The discussion elucidates the potential gains and implications of implementing suggested improvements in the hospital's storage system. The VSM analysis for Hospital da Luz Coimbra's storage process revealed how waste elimination can be eliminated by its critical insights and improvement proposals.

By identifying VA and NVA activities, this analysis highlighted on critical areas where time and resources are squandered. The VSM analysis showed significant wastes such as unnecessary movement, overprocessing, and inventory issues. This identification is the first step toward streamlining operations.

It suggests improvements such as remodelling of the technology usage on PDAs for inventory management. Its digital integration capabilities for entering material into the system appear to be a huge opportunity to cut out several steps identified as wasteful. Indirectly, it would positively affect the biggest waste considered by the agents studied, movement, since, as the PDA is a mobile device, entry could be carried out when validating the order, removing the need

to go to the assist room and conferred area. In addition, the need for storage layout optimisation also emerges as a suggested improvement for the agents.

Proposes changes like reallocating responsibilities and enhancing workflows, which require staff adaptation and training, would optimize resource utilization, and minimize redundancies.

Central to the discussion is the indirect impact of streamlined storage processes on patient care. By ensuring the timely availability of necessary supplies, the hospital can enhance the quality and efficiency of healthcare delivery. Patients benefit from expedited treatment processes and reduced wait times, thereby bolstering overall satisfaction and outcomes.

The chapter underscores the importance of ongoing re-evaluation and refinement of the storage process to sustain efficiency gains. In a dynamic healthcare landscape, where needs and technologies evolve rapidly, continuous improvement is indispensable.

By addressing these points, the hospital can move towards a more efficient, cost-effective, and patient-centric storage system.

Chapter 7

Conclusion

7. Findings

This study employs VSM analysis to evaluate and enhance the storage process at Hospital da Luz Coimbra. Important conclusions can be drawn from the research findings.

7.1 Identification of VA and NVA Activities

The document outlines a detailed breakdown of activities involved in the storage process, classifying them into VA and NVA activities. This classification is crucial for understanding which steps in the process contribute directly to the end service or product and which could be minimized or eliminated to improve efficiency.

7.2 Waste Identification

The VSM analysis has identified several types of waste within the storage process, including excessive movement, overprocessing, display inefficiencies, and inventory issues. These waste types are common in many processes and can lead to significant inefficiencies and increased costs. By identifying these wastes,

the hospital can focus on targeted interventions to improve the overall efficiency and effectiveness of the storage process.

7.3 Improvement Opportunities

The document suggests various improvement opportunities based on the waste identified. The main recommendations are to make more efficient use of the PDA system already existing in the process, in order to digitally integrate the materials that arrive the hospital into its information system via a picking procedure.

7.4 Technological and Process Innovations

The adoption of PDAs for direct system entry, represent an opportunity to leverage technology to streamline the storage process. These innovations could lead to more accurate inventory management, reduced time spent on manual data entry, and overall improved efficiency. It would also indirectly contribute to the elimination of some steps and the reduction of wasted movement.

7.5 Cultural and Behavioral Changes

Implementing changes based on VSM findings often requires cultural and behavioral adjustments within the organization. For instance, transitioning responsibilities from technicians to assistants, as suggested in the document, would require training, communication, and changes in workflow. The success of such changes depends significantly on staff buy-in and the hospital's lean culture.

7.6 Patient-Centric Approach

While the document focuses on the storage process, it's important to consider the ultimate goal of improving patient care and outcomes. Efficiency improvements in the storage process can lead to better availability of medical supplies, which can directly impact patient care quality.

7.7 Continuous Improvement

The VSM analysis is not a one-time activity but part of a continuous improvement cycle. The document indicates that lean principles advocate for ongoing improvements. After implementing the identified improvements, the process should be re-evaluated to identify further enhancement opportunities.

7.8 Strategic Impact

Finally, the VSM exercise, underscores the strategic impact of efficient storage processes on hospital operations.

In conclusion, the outputs of VSM highlight significant areas for improvement in the hospital's storage process and present a roadmap for enhancing efficiency and effectiveness. By addressing the identified waste and implementing the suggested improvements, the hospital can advance toward a more streamlined, efficient, and patient-centric storage process.

7.9 Research Limitations

The current study focuses on a specific service within a specialized hospital, and therefore, the validation of findings is confined to the context of the thesis. Due to the nature of a case study, it is important to note that samples cannot be collected in a manner typical of other research designs. As emphasized by Yin (2009), case studies can only be applied to theoretical propositions and cannot be

generalized to entire populations or universes. The study on applying VSM to the hospital storage process faced limitations. A key constraint was the limited number of staff interviewed due to time and resource constraints. The team under study has 12 employees and 8 were interviewed. Broader input from the rest of the staff could have enriched insights into the storage intricacies. Moreover, the study focused on only three types of stakeholders, overlooking the opportunity to engage with a diverse set of stakeholders within the hospital. Exploring the viewpoints of additional stakeholders, such as administrative staff, clinicians, or even patients, could have enriched the analysis by incorporating different perspectives on demand and storage requirements. Another notable limitation was the lack of access to the hospital information system. The absence of direct interaction with the information system restricted the depth of data analysis and hindered the ability to incorporate real-time metrics into the VSM process. Access to the information system could have facilitated a more detailed examination of key performance indicators, workflow patterns, and other relevant data, ultimately enhancing the accuracy and reliability of the findings.

7.10 Future Research Topics

The research has employed an exploratory and descriptive methodology approach, addressing the necessity for additional investigations within the scope of the subject.

Due to the complexity and size of the process of storing and supplying hospital materials, which is divided into three major phases:

Backoffice management - The entire back-office process of purchasing and inventory management at the computerized information system level.

Initial storage - The storage, logistics, and space management of the different types of materials that enter the hospital.

In-house shipping and supply- Hospital and medical demand which dictates all types of internal travel, their demand, and their final destination within the hospital.

The research focuses on the initial storage process and complements its thesis on the back-office process but leaves room for the further intrinsic study of the subject matter in computerized information systems and the entire in-house shipping process from the outside.

For future research, there is an opportunity to evaluate the implementation of VSM in the supply and storage in various hospital units.

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Appendices

1. Appendix 1. - Completion of literature review

1.1 5S

The 5S methodology, originating in Japan, is a powerful Lean tool consisting of five sequential steps: Sort, Set in Place, Shine, Standardize, and Sustain. These steps, starting with the removal of unnecessary materials (Seiri) and organizing for efficiency (Seiton), emphasize collective cleanliness (Seiso), standardized cleanliness (Seiketsu), and ongoing discipline (Shitsuke). Fundamentally, 5S aims to establish and maintain an organized and efficient work environment (Seth & Gupta, 2005).

Using a correlation analysis, Balinado and Prasetyo (2020) describe the impact of 5S on the service operation of Toyota dealers. The authors implied that the implementation of the 5S culture significantly enhances the quality of work, and through effective 5S practices, employees are better equipped to organize files, tools, and equipment in their daily tasks. It is concluded that this kind of organizational efficiency leads to heightened productivity and systematic workflows, resulting in waste reduction, cost reduction, improved safety standards, and optimized quality of work performance.

1.2 A3 Culture at Toyota

The A3 method, initially deployed by Toyota Motor Corporation and now a cornerstone of contemporary lean management practices, provides a visualized management framework applicable to healthcare delivery systems. Implemented on an 11 × 17-inch sheet of paper, this methodology facilitates interdisciplinary

dialogue, fostering objective-driven process changes with measurable metrics (Simons et al., 2014).

The sequential stages of the A3 process entail problem identification, a comprehensive portrayal of the current state, root cause analysis, formulation of countermeasures, specification of the target state, development of an implementation plan, creation of a follow-up plan with predicted outcomes, and the mobilization of collective commitment for successful execution. This approach not only establishes a systematic problem-solving framework but also cultivates collaborative endeavours to achieve measurable and sustainable improvements in healthcare delivery systems (Simons et al., 2014).

2. Appendix 2. - Interview

Bear in mind that the interview carried out was structured taking into consideration the data collected from Dr Ricardo and field analysis about the process overview.

Welcome to our Value Stream Mapping Interview. Your insights are crucial in helping us improve our storage and supply processes. All responses will be kept confidential.

Professional Information

- Department:
- Role and Responsibilities:
- Years of Experience in Current Role:

Process Steps and Involvements

“Please describe the overall process and your respective functions and try to describe the flow of materials between stages without letting out the flow of information between steps.”

For each of the following process steps, please indicate your involvement.

- **Inventory Management**
- **Receiving Supplies**
 - Reception phase
 - Verification phase
 - Pending verification

- Product under verification
 - Verified product.
- **Storage - Warehouse management**
- **Retrieval**
 - Requisition of materials (Demand decision)
 - Order Processing
 - Local identification
 - Picking
 - Transportation
 - Delivery Confirmation
 - Updating Inventory
- **Restocking - Inventory management at the platform system**

Waste Identification

“In general, in which steps (between, during, or after) do you think that there are wastes? Can you Identify critical decision points and any bottlenecks in the stages?”

Proposed Solutions and Improvements

“What specific changes would you suggest to improve process efficiency?”

- Training staff effectively
- Improving capacity
- Enhancing material flow.

- Enhancing information flow.
- Improving communication among staff.
- Implementing the 5S methodology for workplace organisations.
- Optimising storage layout for efficient space utilisation.
- Root-cause analysis for problem prevention.
- Cultivating a culture of continuous improvement (Kaizen).
- Conducting regular audits for waste reduction.
- Standardising inspection checklists.
- Automating reporting processes.
- Streamlining documentation requirements.
- Encouraging staff feedback and suggestions.

Any Additional Comments or Suggestions

“Thank you for participating in this interview. Your feedback is invaluable in our continuous effort to improve our hospital's efficiency and service quality.”