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Reducing Inbound Logistics Process Cycle Time Using Lean Six Sigma: An Action Research Project

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Master's in Management of Services and Technology

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Co-Supervisor:
Professor, Dr. Jamison V. Kovach
University of Houston

October 2023

BUSINESS
SCHOOL

Department of Marketing Operations and General Management

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Acknowledgements

Querida família o vosso apoio, confiança, e ajuda são a minha fonte de coragem e inspiração para enfrentar qualquer desafio. Mãe, pai e irmão, estou-vos eternamente grata. Aos meus amigos que compartilharam comigo as alegrias e desafios desta jornada. Obrigado pelas vossas palavras de encorajamento e os momentos de descontração. Um especial obrigado às professoras Dra. Ana Lúcia Martins e Dra. Jamison V. Kovach que me guiaram nesta desafiante jornada académica. O vosso conhecimento, dedicação e apoio foram fundamentais para o desenvolvimento de um trabalho do qual me posso orgulhar. Obrigada por serem exemplos brilhantes de excelência, integridade e humildade. À Santos e Vale, que acreditou na importância deste projeto e forneceu os recursos e oportunidades necessárias para que ele se tornasse realidade, o meu sincero agradecimento. Esta parceria foi essencial para o meu enriquecimento académico, pessoal e profissional. Esta tese é fruto do apoio, paciência e amor de muitos, e todos vocês desempenharam um papel fundamental na minha caminhada. Espero que este trabalho possa ser uma pequena expressão da minha gratidão por tudo que fizeram por mim.

Dear family, your support, trust, and help are my source of courage and inspiration to face any challenge. Mom, dad, and brother, I am eternally grateful to you. To my friends who have shared the joys and challenges of this journey with me. Thank you for your words of encouragement and moments of relaxation. A special thank you to Professors Dr. Ana Lúcia Martins and Dr. Jamison V. Kovach who guided me through this challenging academic journey. Your knowledge, dedication and support were fundamental to the development of a work that I can be proud of. Thank you for being shining examples of excellence, integrity, and humility. My sincere thanks to Santos e Vale that believed in the importance of this project and provided the necessary resources and opportunities to make it a reality. This partnership was essential for my academic, personal, and professional enrichment. This thesis is the fruit of the support, patience, and love of many, and you have all played a fundamental role in my journey. I hope this work can be a small expression of my gratitude for everything you have done for me.

Um enorme obrigado a todos,

Ana Catarina Branco

Resumo

O desenvolvimento de processos eficientes que resultem em tempos de ciclo mais curtos é um mecanismo que as organizações utilizam frequentemente para obter uma vantagem competitiva, lucros mais elevados e/ou melhor satisfação do cliente. Dada a natureza da sua atividade, minimizar o tempo de ciclo dos processos é uma necessidade para os prestadores de serviços logísticos (PSL). Com o objetivo específico de reduzir o tempo de ciclo do processo de logística de entrada, a presente investigação promoveu uma melhoria em quatro armazéns de um PSL português. Esta foi alcançada por meio de um projeto de investigação-ação em que o trabalho desenvolvido lado a lado com os funcionários da empresa levou à criação e implementação de soluções práticas. Foi selecionada a metodologia Lean Six Sigma para orientar os esforços de melhoria do processo. O projeto começou por mapear o processo, analisar os sistemas de medição e recolher dados sobre o tempo de ciclo. Através da análise das medições da situação inicial foram identificados os fatores responsáveis por tempos de ciclo mais longos. Estes aspetos foram depois inspecionados de forma a determinar as causas de ineficiências no processo. De seguida, foram desenvolvidas, selecionadas e apresentadas iniciativas para reduzir/eliminar as causas do desperdício. Por fim, após a implementação, a análise dos dados de controlo mostra uma melhoria em 34% na média do tempo de ciclo do processo logístico de entrada e uma redução do desvio padrão em cerca de 52%.

Palavras-chave: Investigação-ação, Lean Six Sigma, Prestação de Serviços Logísticos a Terceiros, Armazém, Tempo de Ciclo

Classificação JEL: Y40 – Dissertations; M10 – Management

Abstract

Developing process efficiencies resulting in shorter cycle times is one mechanism organizations often use to achieve a competitive advantage, higher profits, and/or better customer satisfaction. Given the nature of their business, minimizing process cycle time is a necessity for third party logistics providers (3PLs). With the specific aim of reducing the inbound logistics process cycle time, the present research promoted an improvement in four warehouses of a Portuguese 3PL. This was achieved through an action research project in which working side by side with the company's employees led to the creation and implementation of practical solutions. The Lean Six Sigma methodology was selected to guide the process improvement efforts. The project began by mapping the process, analyzing the measurement systems, and collecting cycle time data. By examining the initial situation measurements, the factors responsible for longer cycle times were identified. These aspects were then inspected to determine the causes of inefficiencies in the process. Initiatives on how to reduce/eliminate the causes of waste were then developed, selected, and presented. Finally, after the implementation, the analysis of the control data shows a 34% improvement in the average cycle time of the inbound logistics process and a reduction in the standard deviation of around 52%.

Keywords: Action research, Lean Six Sigma, Third party logistics, Warehouse, Cycle time

Classification JEL: Y40 – Dissertations; M10 – Management

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Glossary

3PL – Third Party Logistics Provider

4-D – Define Diagnose Deploy Deliver

5-S – Sort, Set in order, Shine, Standardize, Sustain

AR – Action Research

B2B – Business to Business

BOL – Bill Of Lading

C-K – Concept-Knowledge

DES – Discrete Event Simulation

DMAIC – Define Measure Analyze Improve Control

ERP – Enterprise Resource Planning

FOCUS - Find an improvement area, Organize a team, Clarify current practices, Understand the source of variation/problem, Select a strategy

FTP – File Transfer Protocol

G-D – Goods Dominant

IHIP - Inseparability Heterogeneity Intangibility Perishability

IMS – Inventory Management System

KPI – Key Performance Indicator

LSP – Logistics Service Provider

LSS – Lean Six Sigma

NGT – Nominal Group Technique

PDCA – Plan Do Check Act

PDT – Portable Data Terminals

PFMEA – Process Failure Mode and Effect Analysis

S&V – Santos e Vale, Lda

S-D – Service Dominant

SIPOC – Suppliers Inputs Process Outputs Customers

VOC – Voice Of the Customer

VSM – Value Stream Mapping

1 Introduction

The following sections include a contextualization of the research background (1.1), problem tackled (1.2), the research questions (1.3) and objectives (1.4), the method used in the research (1.5), the scope of the study (1.6), and an overview of the remaining chapters (1.7).

1.1 Background

Cycle time "is the elapsed time between starting and completing a job" (Krajewski et al., 2016, p. 189). Having efficient processes that result in shorter cycle times is claimed to be a method of increasing earnings and product quality (Boggs et al., 1999). Reducing cycle time has been identified as a quality criterion for third party logistics providers (3PLs), and investing in continuous improvement in this parameter is not only a goal but a requirement to achieve a competitive advantage in today's fast moving markets (Barney, 1991; Batarlienė & Jarašūnienė, 2017; Thomas et al., 2017). Despite the demonstrated value of Lean Six Sigma (LSS) in improving customer satisfaction, time efficiency, and process optimization in a variety of industries, its implementation in logistics is noticeably limited (Singh & Rathi, 2018). This discovery highlights a critical research gap — a gap in our understanding of how LSS may be effectively utilized to minimize cycle times and drive process improvements in 3PL operations. This gap in the literature emphasizes the need for further research and the creation of a framework that connects LSS concepts with the particular challenges and dynamics of the 3PL sector.

1.2 Problem and aim

Santos e Vale, Lda. (S&V) is a Portuguese 3PL firm specialized in logistics, distribution, and transportation services. This company is experiencing an average logistics inbound process cycle time that exceeds the strategic target of 11-22 hours, which significantly impacts warehouses' efficiency. Consequently, it was identified an enhancement opportunity for the operations of the logistics department. This research project's core aim is the reduction of cycle time in the logistics inbound process.

1.3 Research questions

The questions this work aims to answer regarding S&V, are:

RQ1. What are the causes of the long inbound process cycle time?

RQ2. What initiatives can be adopted to reduce inbound process cycle time?

RQ3. What is the impact of the adopted initiatives on inbound process cycle time?

1.4 Objectives

The objective of this research was to reduce the inbound process average cycle time at S&V. To achieve the stated objective, the following research activities were needed:

- Map the logistics inbound process;
- Collect and analyze available process data;
- Establish a baseline measurement for the current cycle time;
- Understand and determine the problem root causes;
- Select and evaluate possible improvement initiates;
- Compare post-implementation metrics to baseline measurements to ensure progress.

1.5 Method

This research mixes Action Research (AR) with LSS to develop a comprehensive solution to the identified problem. AR was selected as the primary method because of its practical emphasis and capacity to foster organizational change (Rapoport, 1970; Coughlan & Coghlan, 2016). Based on Coughlan and Coghlan (2016) work, AR cycles are used to give a structured approach to studying, diagnosing, and resolving issues in the inbound process cycle time of the logistics department. To improve efficiency and quality, LSS concepts, instruments and techniques are included in the research process. The study combines the AR cycles within the DMAIC (Define, Measure, Analyze, Improve, Control) phases often associated with LSS (George & George, 2004; Patel & Patel, 2021). This method integration offers an organized and data-driven approach to problem-solving and process improvement, guaranteeing that the solutions created are not only theoretically solid, but also viable and sustainable in the company's context (Näslund et al., 2010; Erro-Garcés & Alfaro-Tanco, 2020). Throughout the study, the emphasis is on employee participation and rigorous control of data quality. Also, all necessary information, documentation and data was exclusively collected from the company's employees, records, and systems. No data was obtained directly from clients or external sources.

1.6 Scope

As previously stated, the focus of this study is on reducing the logistics inbound process cycle time in four warehouses. This research also does not extend its focus to other sub-processes within the S&V logistics department apart from the arrival, unloading, reception into stock and storing of cargo.

1.7 Project Structure

This research is organized in five parts:

1. Introduction: outlines the context of the issue being studied, as well as an overview of the research questions, goals, methodology, and scope.
2. Literature review: explores past literature focused on the company's business sector, namely services and 3PL, the project challenge and investigation methodology.
3. Methodology: describes the path followed in conducting this research.
4. Case study: describes the research efforts conducted to address the research questions and fulfill the objectives of the study.
5. Discussion and conclusion: provides a concise summary of the research and its findings, along with the study’s managerial implications, limitations, and suggestions for future research.

2 Literature Review

This chapter provides a detailed literature review on the studied subject. It begins by assessing the current state of service research followed by the examination of 3PL landscape (2.1). After, the analysis focuses on the challenge, examining previously used methodologies (2.2). Thirdly, a revision of the research methodology is provided (2.3). Finally, based on the concepts and approaches investigated, conclusions are drawn (2.4).

2.1 Service

Edvardsson et al. found that "the concept of "service" is fuzzy" (2005, p. 113) explained by its expanded use in management literature driven by the global economy's shift from manufacturing to services (Johns, 1999; Vargo & Lusch, 2008). Initially, definitions segmented markets into goods and services (Johns, 1999; Edvardsson et al., 2005; Vargo & Lusch, 2008). Services were considered either intangible goods or value-enhancing add-ons according to the leading position, goods-dominant logic (G-D logic) (Vargo & Lusch, 2008). Four key characteristics were appointed to services: IHIP - Inseparability, Heterogeneity, Intangibility, and Perishability (Parasuraman et al., 1985). Edvardsson et al. note that this is an outdated and oversimplified view on service characteristics because it seems to "not capture the process and interactive nature of services" (2005, p. 115). The authors go further saying the idea of inseparability does not apply to services in which the consumer is a passive participant (such as goods transportation or financial services). Standardizing service output can be difficult, and a lack of customization might reduce service value. Intangibility indicates that users cannot directly experience service outcomes, although services might provide tangible outcomes (for example, a useful legal advice). While services cannot be stored, they do leave long-lasting memories that influence consumption patterns.

Vargo and Lusch (2008) remarked that inadequacies of G-D logic, like the IHIP characteristics, sparked new research and concepts in contemporary fields such as service marketing. Service-dominant (S-D) logic arose, characterizing services as "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself" (Vargo & Lusch, 2006, p. 283). The authors note a change in the concept of value, from a production-based attribute - "value-in-exchange" (2006, p. 284) – to one determined during consumption – "value- in-use" (2006, p. 284). Customers are empowered as value co-creators because

of this change, which emphasizes collaboration, partnership, and a new value co-creation attitude. The authors clarify in their concept revision (Vargo & Lusch, 2016) that co-creation implies an active participation of multiple entities, usually unaware of each other, on the creation of the core offering which is a mandatory step in human systems and a fundamental component of markets and marketing. Meanwhile, co-production entails "the creation of the value proposition – essentially, design, definition, production, etc." (Vargo & Lusch, 2016, p. 4) which can be optional depending on various factors.

Service investigation has taken two primary directions. Recent S-D logic research emphasizes the necessity for all entities to actively collaborate in value co-creation through mutually beneficial partnerships. S-D logic is useful for investigating service providers, stressing the importance of fostering collaborative links to produce innovative customer-centric services.

2.1.1 Third Party Logistics

Logistics is commonly defined as "the process of planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods including services, and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. This definition includes inbound, outbound, internal, and external movements" (Council of Supply Chain Management Professionals, 2013). Whereas logistics management "is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements" (Council of Supply Chain Management Professionals, 2013).

Initially emerging in the 1980s as the outsourcing of various logistics activities, 3PL has evolved into a complex concept (Sink et al., 1996; Leuschner et al., 2014; Shi et al., 2016; Batarlienė & Jarašūnienė, 2017). According to numerous authors, companies benefit from engaging in 3PL services by improving the provided service, reducing costs, and by focusing on core competencies (Maloni & Carter, 2006; Batarlienė & Jarašūnienė, 2017).

As said by Leuschner et al. (2014), customer service is a major focus in 3PL literature since it can lead to high performance results and sustainable competitive advantage from a resource-based view. Barney (1991) defines resources as attributes of physical, human,

and organizational capital that enable enterprises to improve efficiency and effectiveness in order to gain a competitive advantage. These resources must be valuable, rare, difficult to imitate, and non-substitutable to provide a sustainable competitive edge. Given this definition, Leuschner et al. (2014) demonstrated that customer service excellence meets these characteristics since it is valued, rare to achieve all goals, difficult to imitate interpersonal relationships, and non-substitutable in the logistics business.

2.1.2 Quality in 3PL

Kilibarda et al. (2020) stress the importance of logistics service quality in the fiercely competitive 3PL industry (Shi et al., 2016). Key assessment criteria identified by Batarlienė and Jarašūnienė (2017) include service quality, service execution time and cost. Among these, time-related aspects, like timeliness and order processing, stand out as crucial for customer satisfaction (Kilibarda et al., 2020). In broad terms, in the competitive 3PL sector, customer service excellence is strongly reliant on the quality of logistics services, with a special emphasis on timeliness and service execution time. To effectively satisfy consumer expectations, businesses and logistics providers must prioritize these criteria.

2.2 Cycle Time Reduction

Cycle time, defined as “the elapsed time between starting and completing a job” (Krajewski et al., 2016, p. 189), was identified as a profitability and service quality driver (Boggs et al., 1999). This notion also applies to 3PL, where timely fulfillment of client needs is critical. As previously stated, the 3PL sector places a high value on time-related parameters and as a result, satisfying customers' time-sensitive requirements is crucial for offering a prime service. Therefore, reducing cycle time within the framework of 3PL is a path to efficiency and effectiveness and a significant predictor of customer satisfaction and overall service quality.

Even though this is a decisive topic, literature addressing this issue from the perspective of a Logistics Service Provider (LSP) or a 3PL appears to be scarce. The sections that follow will explore previous approaches, methods, and tools from relevant literature, laying the groundwork for the methodology used in this project.

2.2.1 Big data analysis

In the case presented by Chan (2016), a big data analysis solution was applied for cycle time improvement in a wafer fab manufacturing. The project was implemented in three phases: 1) defining key performance indicators (KPIs), 2) optimizing KPIs, focusing on work-in-progress inventory level, and finally 3) implementing forecasting tools for planning. As a result, cycle time was reduced by 17%. The case study is not applied to a 3PL company, but it centers on inventory management which is one of its' the main activities (Batarlienė & Jarašūnienė, 2017). This methodology requires a high level of collaboration with clients, availability of real-time data, and investment in software. Baruffaldi et al. (2020, p. 1636) noted that in the case of outsourced logistics services "information is neither stored with nor sent to the service provider, who is often unaware of the whole process he is called to manage". As a result, in a 3PL instance, the high need for data availability might pose a challenge for improvement using this method.

2.2.2 Alternative decision-support framework

Baruffaldi et al. (2020) proposed a decision-support framework for 3PL warehousing process improvement consisting of: "(1) the general comprehension of the observed system (e.g., storage layout, storage processes, material flow), (2) the formulation of a tailored panel of performance metrics and (3) the design and the implementation of the most effective improvement scenario that addresses the target of the KPIs" (Baruffaldi et al., 2020, p. 1620). The application results present a reduction in travelling time for picking of 10%. The examples presented focused only on specialized warehouses with minimal variation in product categories and retrieval policies which are limited examples in 3PL context. Moreover, this framework is highly time and resource-intensive and requires strong collaboration between the subject and its clients which can be challenging in other 3PL case applications.

2.2.3 Speeding development cycles five principles

Boggs et al. (1999) present in their study the implementation of five principals for reduction of clinical research cycle time: 1) understanding the process through "is" and "should be" process mapping; 2) setting stretch goals to be implemented in two separate phases; 3) implementation and measurement by having a clear and comprehensive implementation plan and an effective measurement system; 4) having a continual

improvement culture in the organization; 5) management commitment in all phases. The given approach resulted in an 80% reduction on a 3-year project. The basic principles followed are clearly expressed, whereas the means for achieving the kind of results presented are limited. Some tools are referenced - “large rolls of paper on tables, with “sticky notes” to identify single work activities against time” (Boggs et al., 1999, p. 34) - but lacks detail on application to other scenarios. Furthermore, given interpersonal dynamics, the method's dependence on worker memory may not adequately capture the "as-is" process. Despite acknowledging the importance of culture and managerial commitment, no concrete preventative techniques are presented.

2.2.4 Design for Logistics

Keil et al. (2013) implemented the Design for Logistics methodology in a mature multiproduct semiconductor fabrication facility to tackle both workflow and logistics by focusing “on reduction of non-value adding times” (Keil et al., 2013, p. 27). It was implemented following a four-step sequence: 1) Preparation, which includes the definition of objectives, team and area of investigation; 2) Analyze the whole, where researchers identify processes and technologies variations, relationships between process steps, sampling strategy and process classification; 3) Evaluate key ratios such as the ratio between value adding process time and total cycle time; 4) Design of standard process flows in order to reduce variability. After the implementation of three initiatives – elimination of unnecessary cleaning steps, redesign of measurement steps and homogenization of technological process steps – cycle time was reduced by 26%, benefiting manufacturing logistics processes. The report, however, lacks information on how to apply the used ratios, identify root causes of non-value adding times, and generate potential implementations to other scenarios outside the manufacturing realm.

2.2.5 Value Stream Mapping and Discrete Event Simulation

In the case study by Lin et al. (2017) two methods were combined to reduce cash-to-cash cycle time, directly linked to the operating cycle (Schilling, 1996). Initially, Value Stream Mapping (VSM) revealed bottlenecks and opportunities for improvement. Following, a solution prioritization table was implemented and the solutions “of purchase materials without inner core, and purchase materials with stringent dimensions” (Lin et al., 2017, p. 2065) were chosen. After, a simulation of the current and post-implementation states

was created revealing the possibility of reducing changeover time. This scenario, however, had no real-world repercussions.

As demonstrated by the authors, VSM is a valuable business process language that provides insights into numerous process components such as cycle time, inventory, machine uptime, manpower, and information flows. In the one hand, it has various advantages such as the provision of a comprehensive picture to identify potential improvements, on the other hand, it has limitations. It is based on static data and is unsuitable for simulating the effects of variation. To fill some of the VSM gaps, Discrete Event Simulation (DES) was used. DES is a comprehensive analytical tool for in-depth system study, but it is time-consuming and necessitates specific computer programming skills (Lin et al., 2017). Due to manufacturing layout, material flows, order sequencing, flexibility, and human variables, forecasting inventory flows can be difficult (Pepper & Spedding, 2010; Dinis-Carvalho et al., 2015). In this case, the effect on implementation of implicit simulation elements such as aversion to change and a lack of training is not clear. Furthermore, simulating a complex process can take a long time and at the end the "momentum can be lost, or the system has changed, making the model invalid" (Pepper & Spedding, 2010, p. 139).

2.2.6 PDCA and PDCA variants

Isniah et al. (2020) found increased interest in the PDCA (Plan, Do, Check, and Act) method in manufacturing and services since it is "future-oriented, flexible, logical, and reasonable to do and contains a description of all elements of the plan drawn up" (Isniah et al., 2020, p. 73). It has been used to reduce lead time, idle time, and quality concerns. The approach consists of a four-stage problem-solving cycle: "1. Plan - Plan consists of setting goals and processes to achieve specific results. 2. Do - This step was previously created. 3. Check - The inspection process stages have been monitored and evaluated according to specifications 4. Action - In the fourth step, actions are taken to improve results and meet or exceed specifications" (Isniah et al., 2020, p. 73). The authors underline that problem-solving is based on the identification of root causes and taking both temporary and permanent corrective action on them.

Mitreva et al. (2019) effectively used PDCA in a Macedonian 3PL to determine the root causes of slow pace and erroneous service citing the lack of technology, space, and strategic storage as the key factors. The improvements provided by the implemented

warehouse and transportation optimization software were not quantifiable, but they include increased control, less mistakes, quicker procedures, higher morale, and simplified decision-making. Abu-Shaheen et al. (2020) using the PDCA variant FOCUS (Find an improvement area, Organize a team, Clarify current practices, Understand the source of variation/problem, Select a strategy**)** was able to reduce clinical trial cycle time by 45.6%. Through these two examples, PDCA demonstrates a viable future adoption in the service sector. However, none of the instances simultaneously addressed both cycle time and 3PL application, raising concerns about failure/success factors in such scenarios.

2.2.7 Concept-Knowledge Theory and Six Sigma

The authors addressed one of Six Sigma's disadvantages – "negative effect on organizational innovation" (Sony & Naik, 2019, p. 2106) – with Concept- Knowledge (C-K) theory, a cognitive theory noted for encouraging creativity. In the case presented, C-K tools were integrated into the Six Sigma methodology, DMAIC (Define, Measure, Analyze, Improve, and Control), specifically in the improve phase to "bifurcate the design requirements of the process into concepts and knowledge" (Sony & Naik, 2019, p. 2113). This method not only lowered loader cycle time but also maximized resource consumption, resulting in substantial cost savings. While it significantly improves Six Sigma innovation, it may not solve other issues identified in section 2.2.11.

2.2.8 Lean Additives

Sunder and Ganesh (2021) applied Lean, along with Six Sigma and Agile, in a Design Science approach to address capacity, responsiveness, and variation issues. In the global bank case presented, a total of 20 initiatives in a 3-year period were implemented, five of them focused on cycle time improvement. The authors drawn these opportunities of improvement and consequent solutions through a 4-D methodology (Define, Diagnose, Deploy, Deliver). The study concludes that this approach not only reached its' initial goals but also generated strategic medium/long-run outcomes beyond operational efficiency and effectiveness. Although, several interventions are related to cycle time in a service context they are not applied to a logistics context. Also, the model used is developed to work under standard conditions, where processes and work volumes are standardized which can be limiting when implemented to a 3PL case.

2.2.9 Lean

Lean principles are acknowledged for enhancing performance and competitive advantage (Dankbaar, 1997; Shah & Ward, 2007) offering various benefits such as quality improvement, higher labor productivity, reduction of both lead time and cycle time, and reduction of manufacturing costs (Shah & Ward, 2003). The origin of Lean production can be traced back to the Toyota Production System but General Motors' formal adoption cemented its significance (Rinehart et al., 2018). Since then, Lean's multifaceted strategy increased in importance, being considered as the future manufacturing standard for the 21st century (Rinehart et al., 2018).

Lean production is defined as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability" (Shah & Ward, 2007, p. 791). Shah and Ward (2007) highlight the significant lessons from Toyota's strategy of delivering what's needed when needed, with a constant focus on cost reduction through quality control, quality assurance, and respect for humanity. To achieve a true level of improvement, Lean should be seen as a philosophy and a synergetic system of practices that addresses customers, suppliers, and employee's concerns (Shah & Ward, 2003; Pepper & Spedding, 2010). It's by simultaneously addressing all three underlying constructs - supplier, customer, and internal – that organizations may optimize the advantages of Lean (Shah & Ward, 2007). A comprehensive focus on these variables not only creates significant growth but also ensures sustainable competitive advantage.

Waste, central to Lean theory, manifests in various forms. Initially, seven types of waste were defined: transportation, inventory, unnecessary motion, waiting, over-processing, over-production, and defects (Shingo, 1989). Later, skills was introduced, to account for the missed opportunity of using employees' creativity or talent to further improve the process (Liker & Morgan, 2006). Thürer et al. (2017, p. 252) defined waste as "Any system input (transformed resources, transforming resources) that is not transformed into a system output that is valued by customers (fulfilled customer demand, this is neither unfulfilled nor exceeded) just-in-time". The authors also proposed the classification of waste not only in categories – operational and process related – but also by type – "obvious waste" and "buffer". Buffers refer to "any waste that cannot be reduced without creating another" (Thürer et al., 2017, p. 252) underlining the need of eliminating process variability rather than controlling the waste it produces

Lean provides a toolset for finding areas for improvement and attaining quality and costs goals (Prakash, 2018). VSM, 5-Why, Poka-Yoke, 5-S (Sort, Set in order, Shine, Standardize, Sustain), Kanban, and Total Productive Maintenance are tools that can help facilitate this challenging task (Prakash, 2018; Zhang et al., 2016). Kaizen events, quick week-long process improvement activities, are used when waste causes are evident, with low-risk, and elimination delivers rapid results. These are conducted by full-time devoted professionals from different areas seeking rapid, cost-effective improvements (George & George, 2004).

Various authors stress the evident link between waste, variability, and process improvement in the Lean method. Numerous instances of successful cycle time reduction through Lean implementation are found in manufacturing (Yudhatama & Hakim, 2020; Bolanos Valencia et al., 2022) and in the service sector (Chukukere et al., 2014; Siva et al., 2017). The common factor in all these cases is the reduction of waste in its many forms and the enhanced competitive advantage.

2.2.10 Six Sigma

As to de Mast (2007), Motorola introduced Six Sigma in 1987, followed by several successful deployments such as General Electric in 1995. According to the author it first aimed to reduce defects, but it has evolved to a "methodology for managing and executing quality improvement" (de Mast, 2007, p. 353) boosting profitability, reducing quality costs, and enhancing efficiency and effectiveness in quality goals (de Mast, 2007; Sony & Naik, 2019). Six Sigma is labelled as a structure functioning outside normal operations, but closely connected to management, with a clear team organization as in Schroeder et al. (2008, p. 540) definition: "Six Sigma is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives"..

Six Sigma follows the DMAIC methodology – Define, Measure, Analyze, Improve, and Control – for problem-solving and process improvement, similar to PDCA (Schroeder et al., 2008). It begins by defining the problem, then measures the current situation, identifies the root causes of the current performance level, implements tailored improvements, and evaluates changes (de Mast, 2007). Six Sigma incorporates a variety of concepts, methods, and performance metrics into a logical framework based on existing knowledge. According to Schroeder et al. (2008) performance measurements are

divided into two types: customer-oriented metrics that represent client requirements, and financial metrics that indicate demonstrable financial and strategic gains from the project. A central metric of this methodology is the sigma (σ) level, indicating standard deviation (Lemke et al., 2021). According to Wei and Yi-zhong (2013) the sigma level, when compared to upper and lower customer specifications, assesses the current state of an organizational process, with the ultimate goal being six sigma performance. Achieving a nearly perfect sigma level, 6σ, corresponds to an exceptional performance likelihood of 0.9999966 (in a normal distribution), which is commonly stated as a defect rate of 3.4 parts per million opportunities (Schroeder et al., 2008; Wei & Yi-zhong, 2013).

Schroeder et al. (2008) note that, Six Sigma presents a new organizational structure that differs from previous methods to quality management. It provides a framework for generating improvement ideas and establishing an internal routine for their implementation (de Mast, 2007; Schroeder et al., 2008). It also distinguishes itself by emphasizing training and support through a belt system (Schroeder et al., 2008).

Six Sigma has been successful in both manufacturing (Does et al., 2002; Wei & Yi-zhong, 2013; Sánchez-Rebull et al., 2020) and services (Does et al., 2002; Kumar et al., 2008; Ozcelik, 2010; De La Lama et al., 2013; Shokri et al., 2014; Lemke et al., 2021) to address time-related problems. The application of this methodology is rare in the LSP, as noted by Zhang et al. (2016), due to a lack of knowledge and comprehension of the technique, which leads to widespread implementation issues, as well as higher reluctance to change. Furthermore, the sector often misjudges Six Sigma given its primary focus on minimizing variation and errors since logistics acts mostly in transportation and storage without direct product modifications. Does et al. (2002) highlight differences in implementation problems between manufacturing and nonmanufacturing environments. However, the authors claim that this technique is still a good match for making logistics services and operations in general less unpredictable and more trustworthy.

2.2.11 Lean Six Sigma

"Lean Six Sigma is an organized strategy from a business perspective that enables industries to effectively recognize the customer desires, eliminates the variability within the production, and reduces all non-value-added activities" (Singh & Rathi, 2018, p. 625). Authors state that this combination of two valuable methodologies is now a widely used

business optimization tool that has been successfully applied in a variety of industries (Thomas et al., 2017; Patel & Patel, 2021).

2.2.11.1 Purpose of joint efforts

As referred by Cudney and Elrod (2011), while Lean enables enterprises to effectively minimize all types of waste, standardize procedures, and continually improve, Six Sigma assists in the efficient removal of bottlenecks, the enhancement of resource allocation, and the reduction of variance and error in processes. As affirmed by various authors, Six Sigma alone cannot eliminate all sorts of waste from a process, whereas Lean philosophy alone cannot manage the process statistically and eliminate variance. Antony (2011) states that Lean lacks clear guidance and sometimes the training which Six Sigma solves with the use of DMAIC and the belts training logic, nevertheless Six Sigma can be perceived as a too analytical tool that requires high investments and years of training in such tools. The two methods complement each other, allowing for a degree of performance enhancement not feasible with either alone (Pojasek, 2003; Antony, 2011; Corbett, 2011; Trakulsunti et al., 2022).

2.2.11.2 Route of application

DMAIC is adopted by LSS as a problem-solving and process improvement methodology. These five phases can "lead a team logically from defining a problem through implementing solutions linked to underlying causes, and establishing best practices to make sure the solutions stay in place" (George & George, 2004, p. 1)

The Define phase establishes the project's foundations, assuring clarity and alignment. Its objective is to establish an understanding of the needs of customers, identify possibilities for improvement, and launch the improvement project with a problem description, business impact, goals, scope, timetable, and defined team. Several tools can be used in this stage. Interviews, surveys, and focus groups are the primary methods for gathering data on customers' needs and desires – "Voice of the Customer" (George & George, 2004, p. 65). The Project Charter, containing essential project details, is instrumental for project definition, including the project title, team, problem, and mission statements (Tague, 2005). George and George (2004) highlight the importance of clearly defining all project details with all stakeholders as it will impact moving forward to the next stages.

In the Measure phase, data from the current state of the process is collected to identify influential factors and causes of waste and variability. The goal is not only to gather data, but also to ensure its validity and reliability in order to construct a credible baseline that is consistent with reality (George & George, 2004). This caution is required to avoid introducing uncertainty into the project by presuming data accuracy without validation. Ensuring both data and data collection reliability is crucial to prevent wasting resources on false issues caused by measurement-generated variability (Kovach, 2019). To map the process in various levels of detail the tools proposed by LSS theory include VSM, SIPOC (Suppliers, Inputs, Processes Outputs, Customers) Diagrams, Flowcharts and Swim-lane Diagrams (George & George, 2004; Tague, 2005). After, data is collected and measurement system analysis is performed recurring to, for example, Gauge R&R studies, Percent Agreement Analysis or alternatively, expert review, Repeated Measurements, Reconciliation or Mystery Shopper (George & George, 2004; Kovach, 2019). Descriptive statistics and graphical methods like Bar Charts and Run Charts aid in better illustrating the current process state. Finally, with the gathered data, further analysis of potential causes for waste and failure points is carried out.

As pointed by George and George (2004), the purpose of the Analyze phase is to narrow down and prioritize the research to the root causes. Commonly, tools such as VSM, PFMEA (Process Failure Mode and Effect Analysis), Work Flow Diagram, or Critical-To-Quality Tree are used in conjunction with other data analysis methods, for example, Correlation and Regression Analysis to identify failure points in the previously mapped process (Tague, 2005). Following that, the identification of potential causes is typically done through Brainstorming, Cause-and-Effect Diagrams, or others (George & George, 2004; Tague, 2005). Finally, to narrow down to the root causes Brainstorming and other selection and prioritizing tools such as Nominal Group Technique (NGT), Multivoting, and Decision Matrixes are used (George & George, 2004; Tague, 2005).

Is in the Improve phase that possible solutions to the root causes identified are generated, selected, prioritized and implemented (George & George, 2004). The approach differs depending on the sort of causes found. Lean tools such as 5-S, Pull System, Four Step Rapid Set Up, or similar are used for waste-related issues, generally through Kaizen events (George & George, 2004). Solutions for other causes are customized to the case context. For the development of potential solutions tools such as Brainstorming, Benchmarking, Brainwriting, or others are appointed by Tague (2005) as useful to LSS

researchers. Similar techniques to those used in the Measure phase can be utilized for selection and prioritizing. George and George (2004) highlight the need of having explicit and within the project scope implementation in order to generate an enhanced process that is reliable, predictable, and that fulfills customer's objectives.

The Control phase is dedicated to project completion which includes the development of methods and documentation to support continuous improvement and process standardization, monitorization of implementations, and auditing of results deriving project's performance and financial outcomes, verifying them, and comparing them to the initial planned objectives (George & George, 2004). The major tool used is Process Control Plans/Charts (George & George, 2004; Tague, 2005) where a detailed description of the new improved process, including the revision and updating of early flowcharts, is provided. They specify the necessary monitoring and action efforts to seamlessly integrate the new procedures into everyday routines. For the evaluation of the project, quantitative data can be used in Statistical Process Control Charts such as Individual Moving Range Charts, XBar and R Chats, C and U Charts, etc.

2.2.11.3 Critical factors

Albliwi et al. (2014) found 34 critical failure factors amongst several LSS implementation programs analysis. According to the study, the most common are the lack of resources, the lack of management involvement and commitment, and the lack of training. Specifically in services, the poor data availability, collection, and analysis are emphasized as a failure factor alongside resistance to change and a weak improvement strategy.

2.2.11.4 Previous applications

LSS application is prevalent to practically all market sectors. In manufacturing, successful LSS application examples are many (Andersson et al., 2014; Dora & Gellynck, 2015; Cabrita et al., 2016; Bhat et al., 2020). In services, healthcare stands out, but applications are multiple exploring mainly time issues (Ray & John, 2011; Ashok Sarkar et al., 2013; Gutierrez-Gutierrez et al., 2016; Kovach & Ingle, 2019; Tay & Loh, 2021; Vermaelen & Kovach, 2021). Taking as an example of LSS applied to logistics services, Gutierrez-Gutierrez et al. (2016) emphasize the applicability of the methodology in the sector for improving service quality by reducing order and payment process cycle

time. The authors underline the importance of the DMAIC approach and its associated tools in this scenario since they allowed for the necessary flexibility and customization to the company's circumstance while giving a structured framework of application.

In conclusion, Lean Six Sigma is an efficient business optimization solution that integrates Lean concepts and Six Sigma methodology to handle a wide range of process improvement challenges across sectors. By complementing each other, Lean and Six Sigma can achieve performance levels that neither method alone can accomplish. Furthermore, while implementing LSS has barriers in terms of resource allocation, managerial commitment, training, and resistance to change, the rewards are significant. It still is a powerful tool for firms aiming to improve their operations since it increases process quality, reduces cycle times, reduces costs, and allows the researcher to tailor solutions to individual conditions through the assistance of the DMAIC's structured methodology.

2.3 Action Research

AR is said to be a rapidly emerging methodology in which theory and practice coexist (Coughlan & Coghlan, 2016). It initially gained prominence in health and psychology, followed by the operations and social science, as noted by Rapoport (1970). Erro-Garcés & Alfaro-Tanco (2020) noted its rising importance in recent service research, mainly in business and management studies.

2.3.1 Purpose and goals

As defined by Rapoport (1970, p. 499) "Action research aims to contribute to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework". Coughlan & Coghlan (2016) underline that AR focuses on real organizational challenges with a "dual agenda, practical and scientific" (Rapoport, 1970, p. 506) aiming to provide robust, reliable, and practical research-based knowledge.

2.3.2 Distinctive characteristics

The authors claim that AR differs from traditional science in that it is founded on practical knowledge and practice-based theory, as well as the embrace the complexity of organizations and social-systems (Coughlan & Coghlan, 2016). Its collaborative nature

emphasizes that co-creation of knowledge enables the delivery of accurate evidence regarding the process's reality (Näslund et al., 2010). Only by engaging with the change the researcher can completely comprehend the system. Rapoport expands on this concept by illustrating how, with a certain level of attachment and sympathy, the researcher may even acquire access to far more detailed data. This practical, collaborative, and flexible approach functions as a meta-methodology, combining numerous methods and tools to provide a holistic understanding of the context-specific circumstances (Erro-Garcés & Alfaro-Tanco, 2020). According to Coughlan and Coghlan (2016) it provides valuable insights by integrating different types of data-gathering methods both quantitative and qualitative.

2.3.3 Method dynamics

Persistence, resourcefulness, and persuasiveness are required for AR projects success (Rapoport, 1970, p. 507) since the researcher takes an active role in the process of change and improvement, frequently as an external collaborator with internal personnel from various organizational levels (Coughlan & Coghlan, 2016). Both researcher and subject engagement are drivers of a higher level of authenticity and reliability in the results, given AR's collaborative nature (Erro-Garcés & Alfaro-Tanco, 2020).

AR's practical approach, usually in the form of projects – core and academic – operates through cycles of action and reflection. These cycles include four key steps detailed in Coughlan and Coughlan (2016) work as: constructing, planning, acting, and evaluating. According to the authors, during the construction phase current issues are determined through collaborative and participatory data gathering in conjunction with continuous reflection on actions taken. Data gathering occurs through the researcher's active participation (for example, observation) and early interventions followed by thorough assessment. Coughlan and Coghlan (2016) go on to say that since the method integrates into live social systems, it is required from action researchers to be attentive to/during initiatives implementation. What can be seen as simply data collection in traditional methodologies, in AR cases the format of data collection can affect other important moving parts of the system which the researcher should be aware - "a survey or interview may generate feelings of anxiety, suspicion, apathy and hostility or create expectations among staff" (Coughlan & Coghlan, 2016, p. 238). The planning phase sets action steps and addresses both project-related questions, such as "What needs to change?

In what parts of the organization?" (Coughlan & Coghlan, 2016, p. 249), and academic project related – "What kinds of data? How might the data emerge and be captured? What access will be required to whom, when and on what terms?" (Coughlan & Coghlan, 2016, p. 250). During the action phase, the team executes changes, collects data, and interacts with stakeholders. Due to context specificity, data gathering issues are identified by the authors (Coughlan & Coghlan, 2016). Researchers must remain vigilant and exercise caution in data collection, analysis, and interpretation to ensure result validity and accuracy. The last step comprises reflection and assessment, which allows for learning and progress.

2.3.4 Challenges and critiques

This method faces critiques in terms of its ability to create meaningful and rigorous findings, a primary goal for all researchers (Näslund et al., 2010). Authors suggest that AR case studies can offer useful knowledge about an organizational issue, despite challenges in generalization and causality, requiring evaluation based on different criteria (Näslund et al., 2010; Coughlan & Coghlan, 2016). Researchers must prioritize the implementation of quality control methods to provide actionable knowledge. The authors also underline that it should be the researcher's purpose to reflect on and implement quality control standards that will ensure the production of relevant actionable knowledge to the best of his abilities. Näslund et al. (2010) advocate handling these issues by specifying project scope, the researcher's role, quality criteria, and encouraging in-company engagement.

2.3.5 Previous applications

AR, with its interdisciplinary approach, collaboration, and practical knowledge development, has addressed real-world challenges and expanded knowledge in various fields. Erro-Garcés and Alfaro-Tanco (2020) and Elg et al. (2020) highlight the growing use of AR in services across business and public sectors, including logistics, healthcare, marketing, and more. In the review past projects to reduce operational expenses, enhance quality, location optimization, and capacity decision-making, improve supply chain coordination, maximize technology uptake, and boost operational time efficiency (Hendry et al., 2012; Farooq & O'Brien, 2015; Gylling et al., 2015). Erro-Garcés and Alfaro-Tanco (2020) add that different methodologies such as Six Sigma, Lean and LSS

have been conjugated with AR using both quantitative and qualitative specially interviews, workshops or meetings (Nair et al., 2011; Kregel & Coners, 2018).

2.4 Conclusions

When considering service as a capability offering, special consideration should be given to collaboration in value creation to achieve high service quality, particularly in 3PL, a highly competitive industry. Customer satisfaction is a crucial goal in this business area, given the immense competitive advantages it may bring. Therefore, time-related factors such as cycle time are a priority, according to how quality has been evaluated in the sector. From the provided investigation, LSS emerges as a well-defined, adaptive approach with substantial literature insights on various problem-solving situations, although less frequent in logistics areas. AR is a flexible, collaborative methodology capable of being effectively integrated with other methods for in-depth exploration of real-life challenges generating significant insights for both academia and practical applications. As a result, one can infer that combining AR and LSS can be an effective strategy to enhance service quality in dynamic 3PL operations by providing actionable insights and industry benefits through the application of context-specific tools.

3 Methodology

In this chapter serves as a description of the methodology used. It starts with an analysis and description of the research design and the chosen methods (3.1), followed by further insights into the research application plan (3.2).

3.1 Research design

3.1.1 Action Research

Logistics and logistics management pose complex challenges, especially in the 3PL sector, where improving cycle time efficiency is vital for enhancing service quality, cost-effectiveness, and competitiveness (Nilsson, 2019). To address the problem of reducing logistics inbound process cycle time in a 3PL company, AR was selected as the primary methodology motivated by a recognition of its substantial benefits in social science studies due to its emphasis on real-life applicability, shorter programs, customizability, experimentation, and project-based techniques (Zuber-Skerritt & Perry, 2002). The authors emphasize that, while both methods of research - action and traditional - are useful, the use of AR cycles is considerably more helpful for all stakeholders in situations of systems in constant change with complex challenges such as the given situation, by providing the needed real-life adaptation. Additionally, given its collaborative nature, AR bridges theory and practice by fostering collaboration between industry and academia, promoting knowledge exchange for more reliable insights (Erro-Garcés & Alfaro-Tanco, 2020).

In conclusion, given to its adaptability and past success in similar complex scenarios, AR is an adequate method to reduce inbound logistics process cycle time in a 3PL setup. The company's eagerness to collaborate and learn signals positively for the development of an AR project that will provide the needed flexibility while also adding to academic knowledge through shared learning.

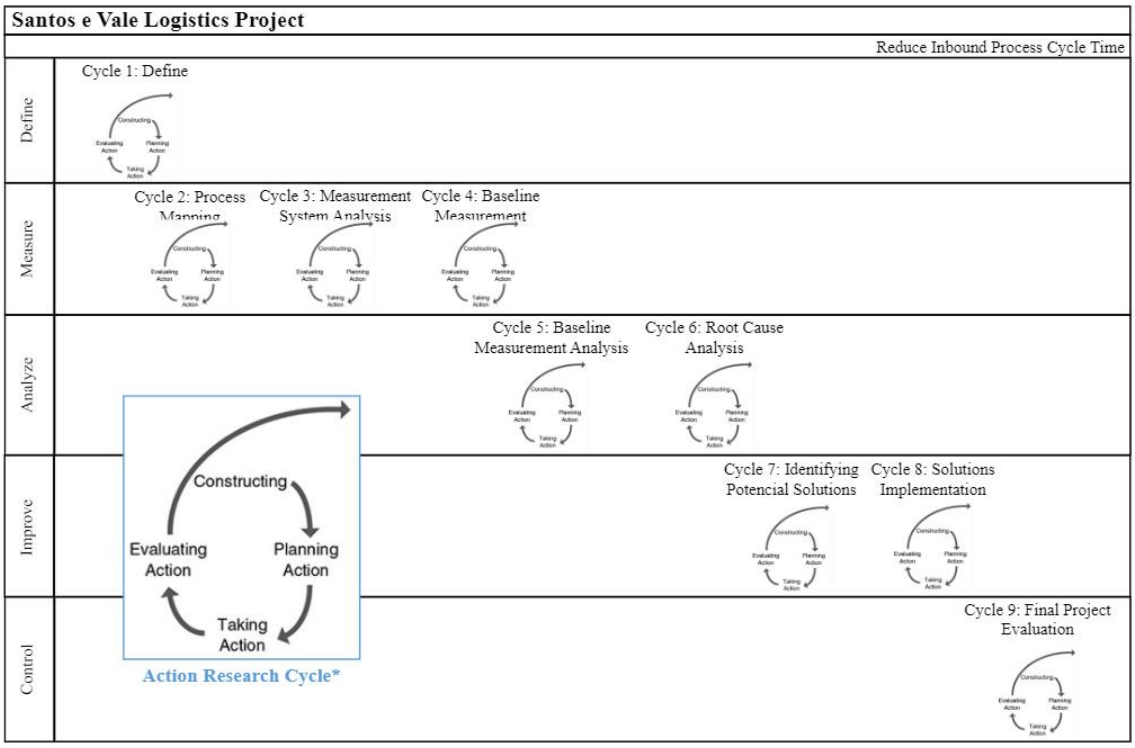
3.1.2 Methodology within Action Research

In their study, Erro-Garcés and Alfaro-Tanco advocate using AR as a "umbrella methodology" (2020, p. 2), indicating that combining it with other methods leads to a more comprehensive knowledge of the problem. LSS is a method that has demonstrated effectiveness in the service sector due to its structured approach to problem solving based

on data-driven decision-making tools. LSS stands out by its capacity to tailor solutions for continuous process improvement and cost, error, waste and variability reduction (Pepper & Spedding, 2010). It distinguishes itself by emphasizing a customer-centric strategy, which is extremely important in the 3PL industry (Patel & Patel, 2021). Hence, the incorporation of this technique with AR was selected as it aligns more effectively with the objectives and complexities of this research. This mixed-methodology approach is predicted to excel in challenging and complex settings, providing a clear guide for an effective and efficient customized tool application that acts as the foundation for technical and practical knowledge development.

3.2 Application Path

This study provides a pragmatic approach to a longitudinal study on cycle time reduction via the use of AR and LSS techniques as part of a mixed-methods strategy. For this research the path of application chosen was to combine AR cycles with the DMAIC phases.



*Souce: Coughlan & Coghlan, 2016, p. 252

Figure 3.1 Project Action Research Cycles

3.2.1 Action Research Cycles

As illustrated in Figure 3.1, this project implemented a total of nine construction-planning-action-evaluation cycles. They followed closely the DMAIC method application, coinciding with the major tasks from each phase.

3.2.2 DMAIC

The following sections describe how the DMAIC methodology is applied to the case, explaining each step's purpose and the tools used, primarily referencing the works of George and George (2004) and Tague (2005).

3.2.2.1 Define

In this study, considering the characteristics of the context, VOC was collected prior to the beginning of the project by the company. After, the project charter was tailored to correspond to both the study and the company needs, taking into consideration the inputs received from the gathered VOC. Due to the lack of knowledge about the current process and cycle time, the initial charter included a broader definition of problem and mission statement. This gap was field after the conclusion of the Measure phase, which provided the needed detail for a complete and clear project charter. Returning to the Project Charter was considered essential as giving a well-defined problem and objectives and detailed project description would better define the following project's stages. This transparency is key for bringing together company stakeholders and encouraging collaboration.

3.2.2.2 Measure

Firstly, the aim was to understand the process at a higher-level, and the tool used for process mapping was a SIPOC Diagram. Following that, a Swim-Lane Diagram was created to capture all the inbound process details for a thorough examination. Both diagrams were constructed based on process observation and semi-structured interviews. After, a quantitative approach was taken for the analysis of cycle time. Data was provided by the Inventory Management System (IMS), in-person observations, and a new measurement system implemented to solve a significant data gap. Measurement system analysis was conducted on both IMS and new measurement system to validate and ensure data reliability, involving extensive quality assurance efforts like Reconciliation and Repeated Measures. Finally, SPSS and JMP software’s were used for baseline cycle time

measurements, focusing on descriptive statistics and graphical representation of the initial situation.

3.2.2.3 Analyze

Initially, the challenging task of data interpretation to determine potential impacting factors was tackled through deeper statistics and graphical analysis limited by substantial data constraints, minimal information exchange between teams and management, and unstandardized and erroneous processes. For the identification of root causes, the techniques utilized in this research were chosen based on the context. Cause-and-Effect diagrams were created using information gathered in face-to-face, semi-structured interviews to help identify likely causes. Because of a vast number of alternatives, a two-stage process of Multivoting followed by NGT was used to establish the most significant causes. This allowed for a detailed analysis of the root causes of process waste, informed by those who perform it.

3.2.2.4 Improve

For the identification of potential solutions Brainstorming sessions were conducted with the logistics employees and complemented by Mind Mapping. To find viable solutions, Brainstorming sessions were held with logistics staff, although in unusual circumstances due to context constraints (four distinct warehouses and continuous operations). Because the breadth of the first Brainstorming ideas was limited, Mind Mapping was used to broaden the range of options. For the selection of most impactful solutions NGT was employed, gathering logistics management input. Solutions were prioritized first using a Prioritization Matrix with evaluation criteria informed by management feedback and complemented by an Effective-Achievable Matrix. Management and personal input were the base for benefits analysis performed on high-priority implementations and the creation of custom tools and documentation for the selected initiatives.

3.2.2.5 Control

To conclude the project, data from the 2 months following final implementations was collected, examined using descriptive statistics, and improvements were estimated by comparison to baseline measurements.

3.3 Conclusion

The study strategy was to combine AR with LSS to face the challenge of reducing inbound process cycle time in four warehouses of a 3PL. These two methods were selected given their individual and joint benefits. They served as a base for the development of a structured and data-driven approach to the issue.

Throughout the project development, several tools and methods were used always focusing the specificities of the context and the goals of each task. High emphasis was given to gathering input from management and employees across all stages. Also, given the importance of having accurate and reliable data, several strategies were devoted to overcoming large data gaps and limitations.

4 Case Study

The implementation of DMAIC and AR cycles takes center stage in this chapter as it addresses the crucial task of reducing inbound process cycle time within a 3PL setting. The systematic use of these approaches demonstrates a dedication to rigorous process improvement via deliberate cycles of action and reflection.

4.1 Company characterization

The project was conducted at Santos e Vale, Lda. (S&V), a Portuguese 3PL founded in 1982 that through consistent, continuous development and innovation has been able to provide a prime logistical solution to consumers where the emphasis on speed and reliability as well as proximity has garnered them several awards for customer satisfaction over the years (Santos e Vale, 2023).

S&V provides three types of services – logistics, distribution, and transportation – in the Iberian market. They operate through a network of 22 hubs in Portugal, with 16 for distribution, 4 for logistics, and 2 for mixed services. Additionally, they have a strategic partnership in Spain. From B2B to door-to-door, distribution makes deliveries for a wide range of clients. Transport activities are focused on the outsourcing of transportation with dedicated vehicles and trained drivers. The company's most recent department, logistics, handles tasks including unloading, receiving items into warehouse involving specific handling and classification, storing, picking, packing, promotional logistics, and reverse logistics.

4.2 Define

4.2.1 First cycle – Defining the problem

Despite their performance over the years, management recognized room for improvement in the logistics department. Logistics' tasks are subdivided into inbound process - the tasks from when the cargo is agreed to be sent to a warehouse until it is stored - and outbound process - the fulfilment of orders, shipment, and delivery. Characteristics in all S&V logistics warehouses such as area, number of employees, activity volume, type of products, type of clients, etc. vary substantially. Also, despite significant advancements in barcoding technology, Enterprise Resource Planning (ERP) and IMS software, processes are still mostly manual.

Due to the complexity of the processes, the limited data, and the fact that this is the department's first cycle time reduction initiative, the project focuses solely on the inbound process for more insightful action and reflection cycles. The goal is to reduce the inbound process cycle time in four warehouses: one of mixed services (Carregado) and three of logistics (A-de-Mourão, Benavente and Castanheira). These warehouses were selected since they handle the highest volume of inbounds, implying that any future changes will have a greater impact. Furthermore, they have been in operation for a longer period, indicating that their practices are likely well-established. In the Project Charter's (Figure 4.1) constructed, the details for the project are summarized - project scope, team, problem, and mission statements. Currently, cycle time is not quantified, limiting a precise measurement of the starting point and problem magnitude, however the trajectory for progress is made evident.

PROJECT CHARTER	
Date	01/07/2022
Project Title	Inbound Process Cycle Time Reduction
Project Leader	João Rocha
Company/Department Description	Santos e Vale logistics department operates the longest in four locations that vary in type of products (food, chemicals, appliances, etc.), procedures, area, teams, and work volume. Currently, it is challenging to fully address customers' logistics needs/requirements (communication, documentation, etc.). Much of this is tacit knowledge held by current employees that is not documented in standard operating procedures. There are no key performance indicators (KPIs) to describe the performance of the logistics operations.
Team Members	Ana Catarina Branco; Nuno Jacinto; José João; Filipe Trindade
Problem Statement	Average logistics inbound process cycle time is greater than strategic goal (11-22 hr.), which limits warehouse throughput.
Mission Statement	Reduce process cycle time to provide opportunity to increase warehouse throughput.
Stakeholder	Joaquim Vale, Administrator

Figure 4.1 Initial Project Charter

4.3 Measure

4.3.1 Second Cycle – Process mapping

4.3.1.1 High-level process mapping

The research began with face-to-face semi-structured interviews with the department's warehouse employees and managers to discover the key elements of the operations, as

well as the major distinctions between warehouses, clients, and products. With the initial information gathered it was possible to determine who are the suppliers and customers and what are the inputs and outputs of the inbound process to construct the SIPOC Diagram (Tague, 2005).

As illustrated in Figure 4.2, the process starts by receiving the inbound list from the client – list of all items that will be sent to storage with details such as number of units, weight, dimensions, product reference, etc. Then, a truck or container (internal or outsourced) arrives at the warehouse bringing the products detailed in the inbound list and accompanied by the documents required for transportation. After, the items are unloaded followed by reception into inventory. Finally, they are stored in storage locations (in rack or in bulk depending on the warehouse) and information is updated automatically in the IMS through barcode scanning. The inputs for this process include documentation such as the inbound list and Bill Of Lading (BOL), the drivers and company employees, trucks, forklifts, and Portable Data Terminals (PDTs), the IMS and the ERP. This process results in stored items and updated records in the IMS. The customers are S&V clients, the warehouse team, and the logistics clerks.

Suppliers	Inputs	Process	Outputs	Customers
Client 3rd party transportation companies Santos e Vale Vendors	Inbound list Bill of lading Truck drivers Trucks/containers Employees Forklifts PDTs IMS	Receive Inbound List Truck/Container Arrives* Unload Receive Items into Inventory Store Items*	Stored items Updated records in IMS	Clients Warehouse team Logistics clerks

*Cycle time start/end; PDT – Portable Data Terminal (used to scan item barcodes); IMS – Inventory Management System

Figure 4.2 SIPOC Diagram

4.3.1.2 Detailed process mapping

Several job shadowing sessions and informal interviews with various personnel, including management, warehouse managers, clerks, and warehouse workers were conducted. The aim was to understand the process by consulting those involved, to construct the step-by-step process representation using a the Swim-Lane Diagram (Tague, 2005).

As illustrated in Annex A, the process starts with the client creating the list of items that will be sent and stored. These items can be picked up and delivered using S&V services or other third party companies. In the latter case, the client informs the clerk who schedules the arrival date. In the case of S&V doing the transport, a collection request is created or by the client if he uses the client's web portal or by the clerk according to the information provided by the client. Depending on the characteristics of the cargo the collection request is sent to the collections team (less than a full truck load) or to the transports team (a full truck load). In both cases the pick-up and delivery are assigned to a driver.

In all cases (both departments and outsourced company) the drivers, after arriving at the warehouse and parking temporarily, checks-in with the clerks by delivering all transportation documents. The clerks then confirm if it is scheduled and if it matches the clients' information provided, otherwise the client is contacted. If all aligns, an available dock is communicated and assigned by a warehouse worker. The warehouse staff begin the unloading process by photographing the seal (generally for containers) and opening the car. The procedure varies depending on the client, particularly if a delivery report is requested. If so, pictures are taken throughout the unloading process and if there is any damage in the cargo; otherwise, pictures are only taken if there is any damage. If damage is found, the clerks are informed and share this information with the client directly or through the report. Another distinction between clients is found at this stage with the damage grading. Warehouse workers, after identifying damage, classifies it according to the clients' guidelines if there are any. After the cargo is classified and placed in the reception zone, warehouse workers confirm if the quantities and references correspond to the documents and if not, this information is also shared with clerks who pass it along to clients. Transportation documents are finalized and given to the driver who leaves the dock.

Then, the clerks have the task of making the inbound list available for reception (this step can be done in advance depending on the early availability of the inbound list). The inbound list can be made available either through File Transfer Protocol (FTP) - automatic communication between the clients' ERP and S&V's IMS - which, in the event of an error, must be corrected by the logistics manager or by the clerks. With the inbound available on the PDTs, warehouse staff begin the receiving procedure, which includes scanning and entering the cargo characteristics into the IMS. When the warehouse

workers complete the PTD task, the clerks check if it matches the initial list. If there are fewer than two errors, reception is redone only for the items that were incorrectly scanned; if there are more than two errors, the scanning process is redone completely. Finally, after all is confirmed to be correct, the cargo is stored by the warehouse workers who assign, using the PDTs, a warehouse storage location to each support (internal barcode identification for tracking the items characteristics and location).

To ensure the accuracy of both diagrams, multiple individuals in various positions were consulted at different stages of the construction process to verify all aspects and details. The finalization of the diagrams was confirmed and checked by top management. This cycle enabled a deeper awareness of not only the organization, but also of the clients, teams, and their differences. This was advantageous in the later stages of the project, although it took longer to fully translate the four distinct location's methods into unique representations since the process is not standardized. One of the lessons learned was that employees are not always aware of the overall scale and detail of the operations.

4.3.2 Third Cycle – Measurement system analysis

4.3.2.1 Process roadmap construction

With the assistance of management, a roadmap, illustrated in Annex B, of all process related data was created, which served the aim of identifying possible process data, whether they are accessible, and where they can be accessed. At this stage, four main conclusions were drawn: 1) the start of the process should be when the trucks/containers arrive at the warehouse since it coincides with the beginning of the operational process and eliminates taking into consideration clients' variability in timing of sending inbound lists; 2) data for truck/container arrival time are not collected/does not exist; 3) unloading sub-process has no associated IMS data (since PDTs are not used to support this sub-process); 4) both reception and storing sub-processes have associated IMS (but the quality is suspect). The end point of the process was identified as the date/time of the last item being stored.

4.3.2.2 Data collection

A new measurement system was developed and implemented to document truck/container arrivals, the start of the process (Annex C). The new procedure was for

clerks to log into a shared Excel spreadsheet the date and time of car arrival - determined as the time when clerks receive the transportation documents from the drivers as they check-in - specifying the client and inbound number for IMS trackability. The implementation of said system was done not only by email communication from management with information about the new practice but also through regular visits to the warehouses in the following weeks. For the end of the process, IMS data was collected of inbound reception approval made by the clerks on the computers and support migration to a final location given by scanning using the PDTs done by the warehouse employees.

4.3.2.2.1 New measurement system analysis

For truck/container arrival data obtained from the new measurement system, the analysis tried to answer two questions: a) Are all arrivals being logged? b) Are the date/times logged for each arrival accurate? Question (a) was tackled though the implementation of a Reconciliation analysis (Kovach, 2019), where total logged arrivals were compared to reality given by total arrivals available in the IMS. The goal was to have at least 90% of weekly warehouse arrivals logged. Question (b) was answered using the Repeated Measures method (Kovach, 2019). In this scenario, samples of 30-40 random arrivals in each warehouse were analyzed by comparing date and time observed with those entered in the new measurement system. If the difference was within five minutes, the time logged was considered accurate. The goal was to have at least 80% of analyzed arrivals matching the time logged in by clerks.

After evaluating data for both questions for several weeks it was clear that the engagement from warehouses teams was low since, although times logged were accurate (Repeated Measures analysis achieved the goal right from the begging in almost all warehouses – Figure 4.4) the total number of arrivals logged was far from the goal in almost all warehouses (Reconciliation analysis did not achieve the goal in the first months - Figure 4.3). The first solution implemented in alignment with management was to reinforce the procedure by email and visitations. Secondly, a thorough investigation in all warehouses was made to pinpoint the reasons for the lack of engagement. It was learned that Castanheira's warehouse had an impactful difference in its process – in one client's case, most drivers delivered transportation documents directly to warehouse workers and only after unloading the warehouse workers would deliver them to the clerks. Adaptations to the new measurement system procedure were made to accommodate this difference

(warehouse workers took note of the arrival date/time and clerks logged it accordingly). Lastly, regular feedback to management was also implemented during bi-weekly operational meetings. By the beginning of March 2023, positive improvements are noticeable in total arrivals logged and in date/time of arrival accuracy. To maintain the favorable outcomes, it was agreed with management that frequent analysis and reporting to warehouse managers would continue. By the end of April 2023 all warehouses had reached the two intended goals set and it was concluded that with the measures taken through the new measurement system provide reliable and accurate data for future cycle time calculation.

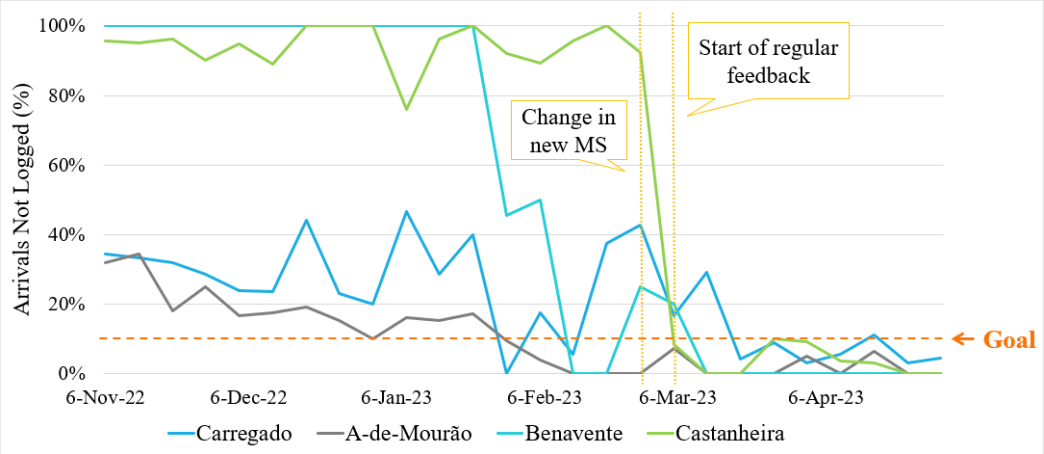


Figure 4.3 Evolution of Unlogged Arrival: Percentage of Total Warehouse Arrivals

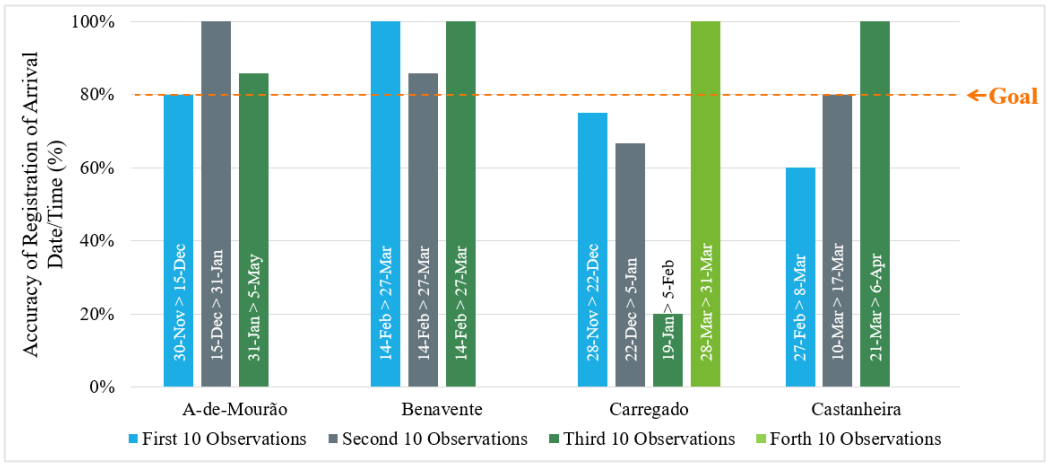


Figure 4.4 Logged Arrivals Date/Time Accuracy: Percent Match Between Observed and Registered

4.3.2.2.2 IMS data measurement system analysis

The system data for the end of process data was also examined for its rigor and correctness using Repeated Measures (Kovach, 2019) to compare the time recorded by the IMS for

(a) inbound reception approval i.e., the date/time inbounds were 'release' for storing by clerks and (b) the time of storage location scanned by warehouse employees using the PDTs. For analysis (a) a total of 15 inbounds were compared and in (b) 15 inbounds were observed recording three support storage scans using the PDT for each inbound observed. Observations that differed by more than 2 minutes from system data were deemed to be mismatched. The goal was to have at least 95% match. At the end of the analysis, it was determined that there was 100% match of all observations vs. data stored in the IMS for all warehouses.

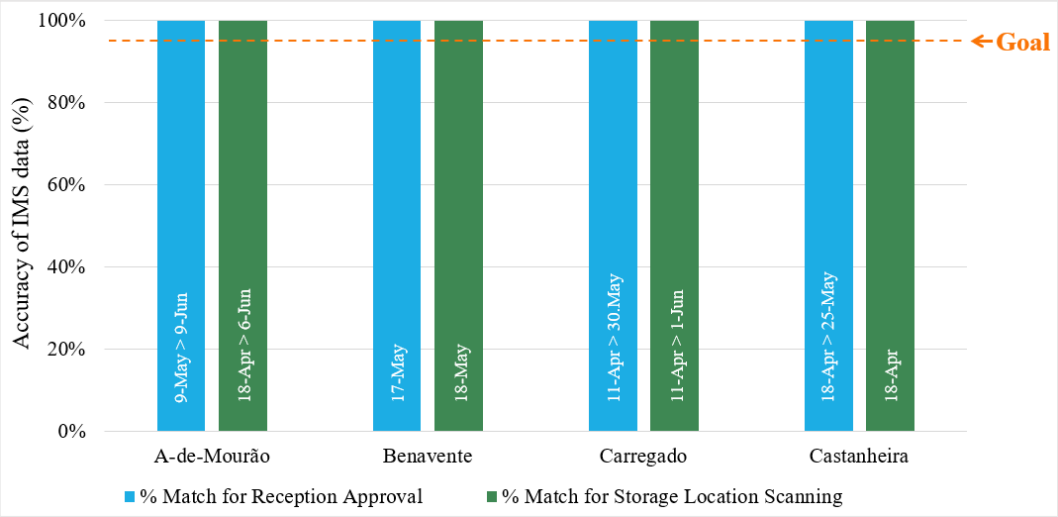


Figure 4.5 IMS Stored Date/Time Data Accuracy: Percent Match Between Observed and Stored

The time dedicated to gathering and analyzing both stages data was more than anticipated since not only there was a gap in the process data but also data available was not investigated internally at the time, which implied a higher investment in understanding the values and how they are collected. Analyzing this cycle, increased clerk involvement based on Lean, particularly Kaizen concepts, could have positively impacted implementation time and engagement. Furthermore, the new measurement system implementation initially overlooked client procedure differences but later addressed them, leading to goal achievement. Nevertheless, this task has led to fruitful learnings such as: a) providing constant feedback has very positive results when a new procedure is in mind; b) management engagement is important to transmit benefits from tasks that may be asked for; c) the creation of a sense of healthy competition was praised by employees and managers as it was a good motivation factor to improve performance.

4.3.3 Fourth Cycle – Baseline measurement

This cycle's purpose was to compute and assess the baseline cycle time. Initially, observations of the unloading sub-process were undertaken to supplement the new measurement system and IMS data due to data unavailability. Following that, a database was created to collect accessible data for baseline computation. Finally, the Project Charter was updated to include the new data and research findings.

4.3.3.1 Unloading observations

With no existing unloading sub-process data, management agreed that the first step in calculating baseline cycle time would be on-field observations. Observations would include not only information about timings – arrival of the truck/container, start/end of the physical unloading, etc. – but also about cargo specificities, resources used and other notes - type and number of machines used, type and number of employees involved, type of car and cargo, etc. Then, observations were made and analyzed using SPPS software. A total of 100 observations were made (94 valid) in a 4-month period (25-Jan to 16-May 2023) across the four warehouses. No clear distinctions can be made between types, nonetheless it can be concluded that containers, manual unloading, and bulk cargo not only take more time to unload but are also more variable, as illustrated in Figure 4.6.

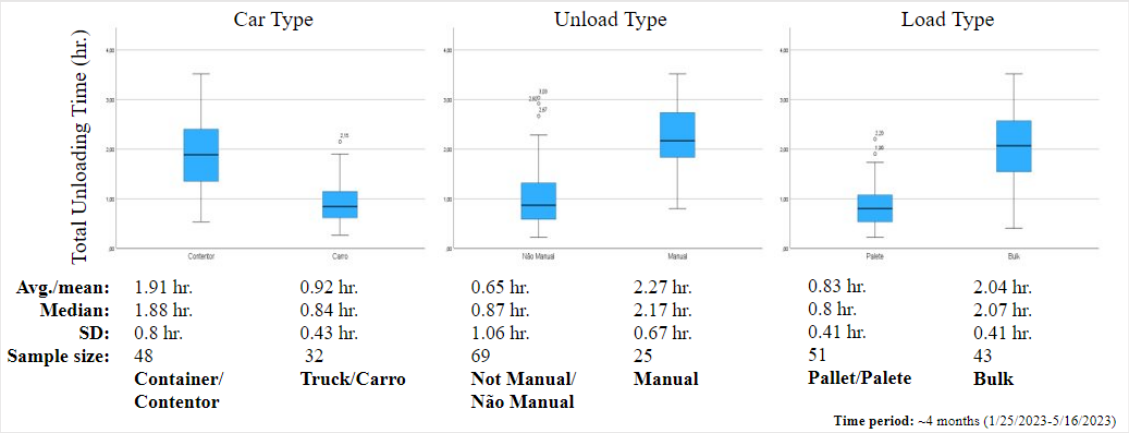


Figure 4.6 Total Unloading Time (hr.) by Types

The unpredictable unloading schedule across four distinct warehouses demanded an extensive dependence on management for visitation scheduling. Furthermore, with only one person handling the observations, the procedure took longer than intended. However, this effort offered critical insights that would shape the project's subsequent phases. The company now has a data-driven understanding of the true time of the unloading sub-process, moving beyond relying on experience alone.

4.3.3.2 Database construction

The second stage was to develop a database using all the available data to establish a baseline measurement of the complete inbound process cycle time. This was also an opportunity to develop a resource support tool that would allow management to understand how time is spent on different sub-processes in greater detail. Using SQL and Power Query, an Excel tool was created to combine the records of each sub-process, beginning with the new measurement system data (truck/container arrival) and integrating the available IMS data. This customized tool aligned with the company's context and management's needs, considering factors like non-working hours, client inbound list acceptance protocols, and more. After several tests and adaptations, this new database was confirmed and approved by management and shown to second line logistics management.

4.3.3.3 Baseline cycle time

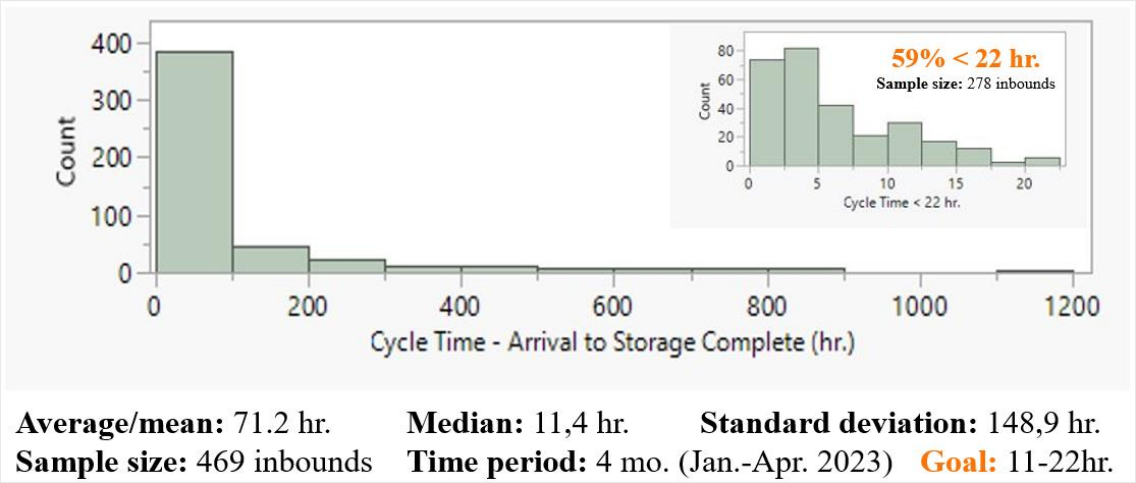


Figure 4.7 Inbound Process Baseline Cycle Time

The data gathered from the new database was analyzed using JMP software. The sample of 469 inbounds corresponded to all inbounds from January to April 2023 (4 months) in the four warehouses that followed the complete process – from truck/container arrival to last item stored – and inbounds that went through "cross-docking" process – inbounds that had a fully complete reception sub-process, but at least part of the items were expedited before storing was complete. The total cycle time averaged 71.2 hours per inbound with a standard deviation of 148.9 hours (Figure 4.7). After further analysis it became apparent that some extreme values are the cause of the distribution to be skewed to the left. The median cycle time is 11.4 hours, which is within the managerial goal of

11 to 22 hours. About 59% of the sample inbounds (278) have a cycle time below 22 hours which shows that the other 41% of inbounds are the issue in terms of having extreme values for cycle time.

4.3.3.4 Update project charter

Given the new knowledge gathered on the current situation of the inbound process, the project's problem statement was revised: "Average logistics inbound process cycle time (Jan-Apr 2023) is 71.2 hr. and 59% of inbounds are within the strategic goal (11-22 hr.), which limits warehouse throughput" (Annex D).

The tool developed met the two objectives initially established: to provide baseline data for the project and to serve as a starting point for future time productivity analyses in the department. In this cycle, there was more pushback from management at all levels than in prior ones. The new database was first viewed as an instrument to evaluate the department's present undesirable performance, and considerable convincing was required to demonstrate the necessity of measuring to understand where we are so we can know what we need to do to get where we want to go.

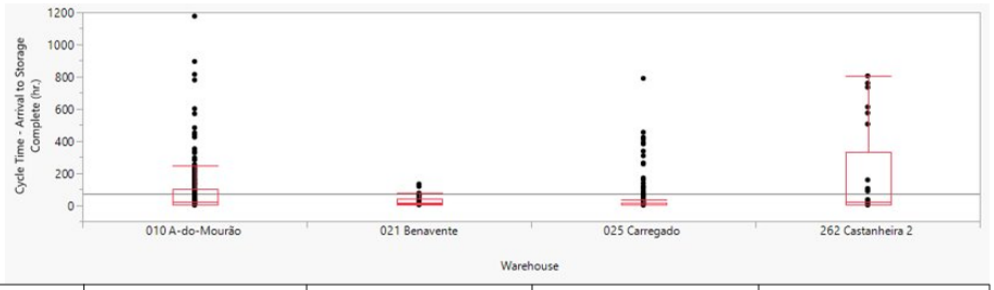
4.4 Analyze

The purpose of the Analyze phase was to discover the causes of extended inbound process cycle times. It starts with an in-depth cycle time analysis, then moves on to tools that collect information from process performers to discover the root causes.

4.4.1 Fifth Cycle – Analyzing process cycle time data

4.4.1.1 How does process cycle time vary by platform?

Examining the four warehouses independently (Figure 4.8), it is obvious that differences in sample sizes in the 4-month period show disparities in activity. When comparing cycle times, it's advisable to look at the medians given the existence of extreme values, which are the highest for A-de-Mourão and Castanheira. In addition, these two locations have the lowest percentage of inbounds arriving in less than 22 hours. Castanheira's warehouse requires examination because of the small sample size and stated medians. However, given their influence on overall activity, A-de-Mourão and Carregado may be of higher priority.



< 22 hr. (%)	45.7%	63.9%	75.7%	52%
< 22 hr. (sample size)	102	23	140	13
Average/mean (hr.)	90.0	28.7	41.6	183.4
Median (hr.)	**24.2**	**14.8**	**5.7**	**20.3**
SD (hr.)	162.6	34.1	101.8	284.1
Sample size (inbounds)	223	36	185	25

Figure 4.8 Inbound Process Cycle Time by Warehouse

4.4.1.2 How does process cycle time vary by client?

When evaluating cycle time by clients (Figure 4.9), which are unique to each warehouse, A-de-Mourão not only has the most cases with extreme values but also has the client with the longest cycle time. Higher volume can be associated with greater variability given A-de-Mourão and Carregado's scenarios.

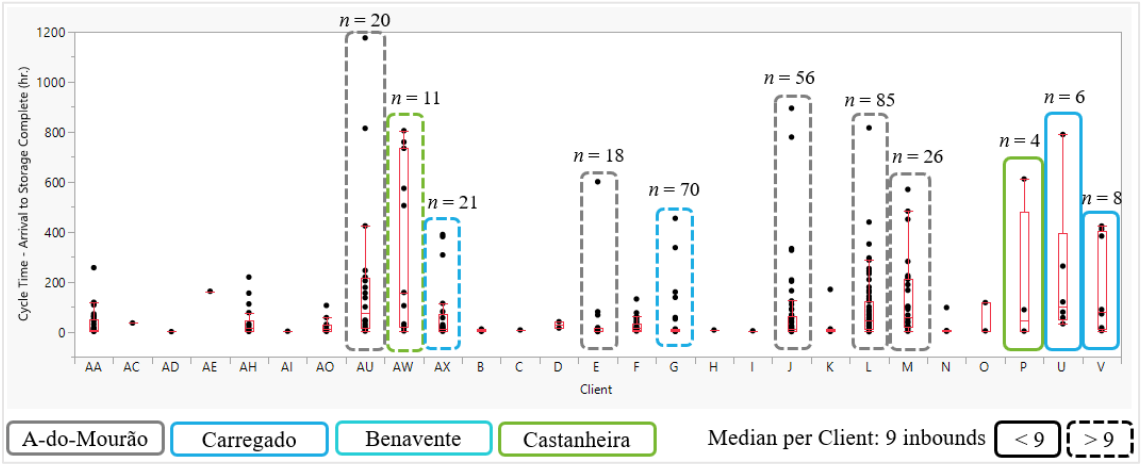
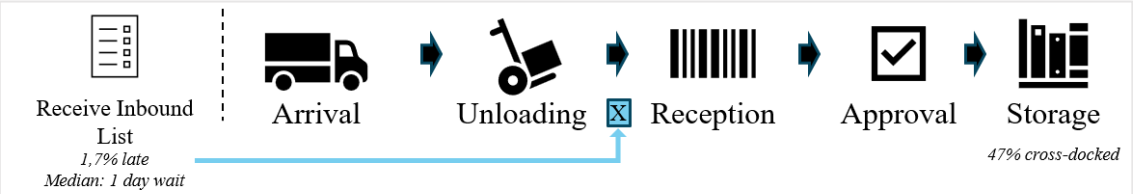


Figure 4.9 Inbound Process Cycle Time by Client

4.4.1.3 How does process cycle time vary by sub-process?

The first process task (from truck/container arrival until the start of reception, as illustrated in Figure 4.10) is rather broad, encompassing unloading time (based on observations), waiting for the inbound list (required for reception), and any incorrect receptions, as only the last/approved reception is recorded in the IMS. Reception time refers to the time spent completing the approved reception, which is a value-added task. The approval of reception (the period between the last item scanned and the final approval

by clerks) contributes less than 2% to the overall cycle time, although it may involve some waiting time, as mentioned in the analysis. The delay between approval and storage start is a significant waste source, accounting for 5.6-7.2% of total cycle time. Preliminary research links it to communication gaps between clerk teams, multitasking (prioritizing other tasks), space seeking, and other issues yet to be established. Despite data restrictions, the analysis suggests that sub-processes, particularly storage, induce longer cycle times and require further examination.



Subprocess	Arrival-Begin Reception* (hr.)	Unloading (hr.)**	Reception* (hr.)	Approve Reception* (hr.)	App. Reception-Begin Storage (hr.)	**Storage (hr.)**	Est. Total
Average (hr.)	2.8	0.8	0.7	0.5	5.1	62.1	71.2
Median (hr.)	1.5	0.6	0.3	0.09	0.3	3,2	5,4
Range (min.-max.)	0.02-26.6	0.2-2.2	0.01-42	0.01-14.3	0-334.4	0-1,164	0-1,581
SD (hr.)	3.7	0.5	2.4	1.3	23.3	146	---
Sample size	469	86	469	469	469	469	---
~Percentage	4-28%	---	1-6%	0.7-1.7%	5.6-7.2%	**59-87%**	

*Last reception, if done multiple times; **Manually collected (observation) data; Includes all receptions, except last (waste); Waiting (waste)

Figure 4.10 Inbound Process Cycle Time by Sub-process

4.4.2 Sixth Cycle – Root cause analysis

4.4.2.1 Identifying potential causes

The path followed was to first identify all potential causes, summarized using Cause-and-Effect Diagrams (Tague, 2005) built on previous knowledge gathered and semi-structured interviews. Due to the intricacy of the process under consideration, three comprehensive diagrams, as shown in Figure 4.11, were constructed for each sub-process (Annex E). Process, people, resources/equipment, cargo, and client were the topics covered in all diagrams. A total of 128 sub-causes were discovered under these categories.

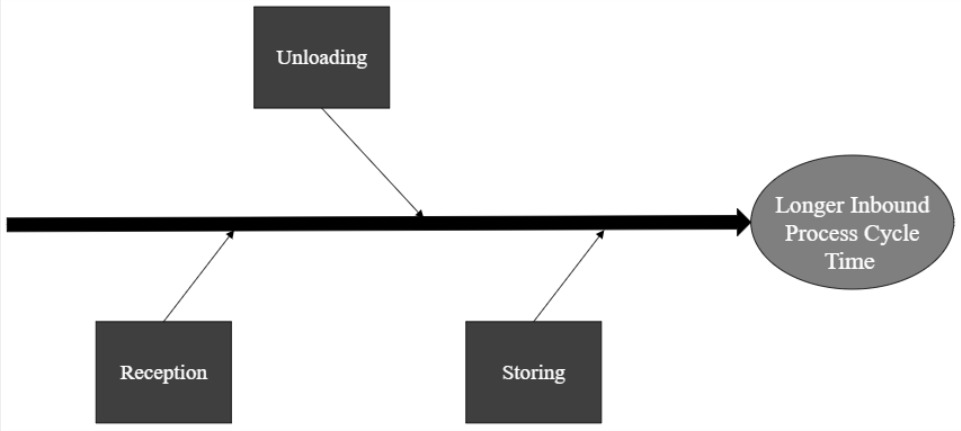


Figure 4.11 General Cause-and-Effect Diagram

4.4.2.2 Narrowing potential causes

Multivoting technic (Tague, 2005) was used to narrow down the initial list of causes for longer cycle times. It was performed in all warehouses within a representative sample of approximately 80% of the total logistics staff from all hierarchical levels (further detail in Annex F). The participants were asked to select a maximum of 10 most influential sub-causes (identified as the white boxes) in each of the sub-processes according to their opinion and experience. The votes were cast by individual voting instead of group voting because of disparities in staff counts across warehouses, the fact that it was a vacation period, and the inability of gathering personnel due to ongoing operations. After all votes were tallied, a list of the most voted sub-causes was created (Annex G). The list included 20 sub-causes, comprising the most highly voted in each category across the three diagrams, along with the second most voted when the difference was less than 2 votes and total voting exceeded 25% of the sample (over 10 votes). There were no apparent disparities in votes across positions or warehouses and there was a high level of agreement among the most voted sub-causes across all categories.

4.4.2.3 Selecting root causes

Following the results obtained, the NGT method (Tague, 2005) was applied within the same sample to determine the true root causes. Employees were asked to select the 5 causes with the greatest influence on inbound cycle time from the Multivoting summary table and rate them in order of importance. Once again, the method was carried out individually due to the same causes listed previously. With all votes added, six causes stand out as the most impactful: 1) Lack of client storage space; 2) Difficulty in

distinguishing the items small differences; 3) Necessity for rebuilding mixed-product pallets; 4) Lack of space planning for reception; 5) Cars loaded with stacked items; 6) Lack of space planning for unloading (Annex H). Lack of space and planning is the most common problem for storage, unloading, and reception, which frequently occurs in shared areas. Causes 2 and 3 are associated with the type of incoming products, the sorting time, and the possibility of errors. The fifth most voted cause relates to how trucks are loaded, which affects unloading efficiency but is a question of lowering transportation and environmental costs.

During the execution of this cycle, it became evident that the lessons learned up to this point, as well as the relationships formed, are vital. The activities completed earlier in this project, such as process mapping and unloading observations, served as the foundation for the diagram's construction and the analysis of causes. Employee participation drove root cause determination, embodying AR and LSS ideals of collaboration. Careful adjustments to tool accessibility, language, and presentations helped active engagement from employees, enhancing communication and idea exchange. While there was initial apprehension, gathering participation became easier in the second stage. Employees were eager to share and excited to be heard, enriching the project.

4.5 Improve

4.5.1 Seventh Cycle – Identifying potential solutions

4.5.1.1 Identifying potential solutions

Improvements ideation was made through two main tools - Brainstorming and Mind Mapping (Tague, 2005). The Brainstorming sessions were held individually due to the same factors listed in the previous cycle. From these sessions a total of 17 possible initiatives were generated. Because there were limited solutions with regard to space planning, Mind Mapping was picked as a suitable mean for generating ideas on this crucial topic (Annex I) and three new ideas were created using this tool. Additionally, during the project development, four potential solutions were recognized as possibly useful to the issues raised.

To organize and categorize the solutions generated, a session with management was held to construct an Affinity Diagram (Tague, 2005), illustrated in Figure 4.12. The categories in the diagram included solutions related to the development of internal documentation of the processes, technological development of mainly with the IMS and PDTs, investments, changes in procedures. Client-specific/client-dependent solutions and initiatives already carried out by the company during project development were also included in the brainstorming sessions.

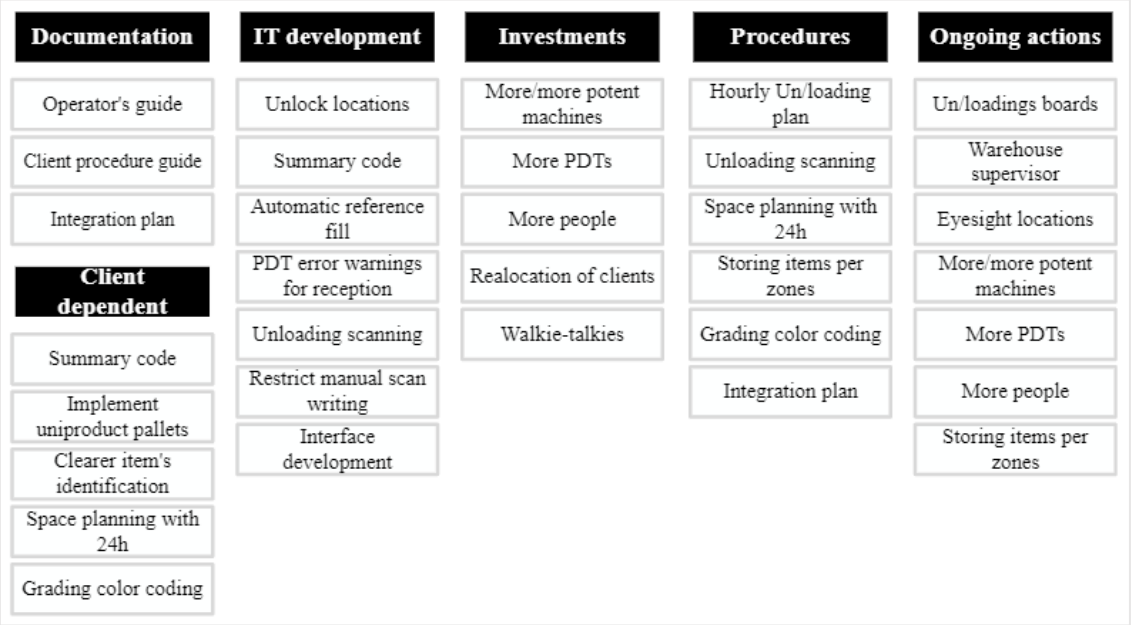


Figure 4.12 Improvement Initiatives Affinity Diagram

4.5.1.2 Narrowing potential solutions

Following the construction of the diagram with 24 solutions, the following stage was to pick the most significant yet feasible options. Initially, department managers utilized NGT to choose and rank the seven most significant solutions based on previously discovered causes. Their responses influenced the subsequent Prioritization Matrix (Tague, 2005), illustrated in Annex J which took into account factors for both the project (such as resource availability and implementation time) and the company (such as management and employee importance, possibility to standardize for all warehouses and future ones, and third-party dependencies). It also evaluated how well each solution corresponded with project goals in terms of time, space efficiency, and error reduction. From the application of a ranking scale of 1,3 and 9 points, it was concluded that seven solutions stand out: 1) official implementation of a warehouse supervisor, 2) eye-level location labels, 3) investment in more PDTs, 4) investment in more and/or more potent

machines, 5) implementation of (un)loading planning boards, 6) implementation of (un)loading hourly schedules, and 7) the creation of an operator's guide.

4.5.2 Eighth Cycle – Solutions implementation

This cycle aims to delve deeper into selected solutions to provide a better understanding of their potential benefits. It forms the basis for aligning project and management expectations.

4.5.2.1 Benefits analysis

Given the context of the department, the type of solutions selected, and the limited data available, the evaluation of benefits relies heavily on workers and management input, as well as brief studies. The formal deployment of a warehouse supervisor was greatly mentioned by warehouse staff at the larger warehouses during the brainstorming sessions. Employees emphasized the necessity of having an on-site position to manage everyday activities quickly and efficiently. This role would have the power to deal with small issues, advancing to higher levels only when required. It was considered essential to assist warehouse managers in problem resolution, allowing them to focus on strategic goals rather than day-to-day concerns.

The warehouses that employ rack systems for storage (A-de-Mourão, Castanheira, and Carregado) use barcodes to identify storage locations (example in Figure 4.13 - Image 1) and scan them in tasks such as ascribe an item to said location. In the newer sites (Castanheira and Carregado) a different solution is already in place. It involves consolidating higher-level barcodes on a magnetic band, as seen in Figure 4.13 - Image 2. This innovation was developed in response to the initial practice of placing location barcodes directly on rack structures, which made scanning with regular PDTs at higher levels impossible. As a result, personnel were frequently required to manually record location codes. There is an exception in A-de-Mourão regarding the use of a unique type of label in conjunction with long-range PDTs. Yet, due to the limited number of available labels and PDTs (just three for an 8-person team) and the difficulty of scanning higher levels, which is often done from within forklifts, warehouse workers find manual code entry required in most circumstances. The new approach has received positive feedback from workers due to its flexibility (allowing for location adjustments), quick and easy scanning from forklifts, reduced need to exit the machines (which can be physically

tiring), elimination of manual entry, and decreased error likelihood, resulting in an overall reduction in storing time. The proposed solution aims to extend the practice of eye-level location barcodes to the A-de-Mourão warehouse, standardizing procedures across all sites.



Figure 4.13 Photographs of Location Barcode Label (Image 1) and Eye-level Location Barcodes Magnetic System (Image 2)

A study was conducted at A-de-Mourão's warehouse to assess the expected time savings from this implementation (Annex K). Observations of location barcode scanning and writing were made for four employees, two with more experience (5 and 20 years) and two with less (4 and 6 months). On average, writing took an extra 3 seconds. To estimate high-level location usage in the inbound process, the study considered the average number of inbounds per client, the average number of lines per client's inbound, and the weight of second-level locations in the overall warehouse setup. The findings suggested an average annual loss of approximately 14 hours due to writing location codes instead of scanning. It's worth noting that the actual savings may exceed the projected time, as the study did not account for error reduction and the impact on other tasks requiring these codes, such as expedition.

The third and fourth solutions were deemed necessary investments by the teams for their everyday responsibilities. The number of available PDTs and machinery (forklifts and carton clamps) has a major influence on both inbound and outbound processes. Table 4.1 displays the initial number of PDTs and machines for each team. This solution seeks to decrease waiting times, errors, and machine-related damage, all of which were frequently referred to by employees.

Table 4.1 Initial Number of Workers, PDTs and Machines per Warehouse

Warehouse	Warehouse Employees	PDTs before implementation	Machines* before implementation
A-de-Mourão	8	8	8
Benavente	3	2	4
Castanheira	2	3	2
Carregado	10	6	5

*Includes forklifts and carton clamps

The fifth and sixth solutions involve improving communication among managers, clerks, and the warehouse team, along with implementing proactive workspace planning. Employees have pointed out that the lack of information flow hampers their ability to organize work and set priorities. Planning heavily relies on client information, and in some cases, long-standing partnerships may have led to an absence of clear information flows. However, for these implementations, establishing such flows is essential. Initially, these systems would be implemented in warehouses with strong existing communication links with clients, facilitating advanced planning and sharing of scheduled unloadings, ideally with specified time slots. Subsequently, they will be expanded to other warehouses as communication with clients improves.

The final solution selected aims to: 1) document the processes; 2) enhance the visualization of the present process to identify potential improvements; 3) gather the know-how from experienced workers; 3) assist newly recruited staff and serve as a guide for newcomers to rapidly integrate into the regular workflow; 4) reduce errors. This document will offer step-by-step instructions to the warehouse workers both on the floor and using the PDTs. The information will be provided in simple flowcharts alongside photos and images.

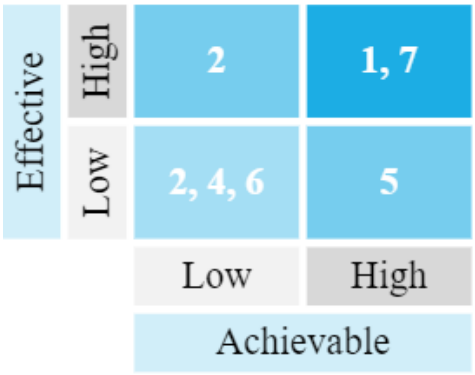


Figure 4.14 Improvement Initiatives Effective-Achievable Matrix

To prioritize the seven solutions, it was used an Effective-Achievable Matrix (Tague, 2005), as illustrated in Figure 4.14. Based on benefits shown, implementing a warehouse supervisor and creating an operator's guide emerged as the top choices, warranting

prioritization in subsequent stages. Placing location barcodes at eye level, though effective, requires investment in materials and time, as does implementing PDTs and machines, which have less obvious benefits. The unloading plan is evaluated as easier to implement than the hourly schedule due to its lower information requirement from clients.

4.5.2.2 Implementation and solutions development

A position description document (Annex L) was created for the warehouse supervisor solution, focusing on larger team warehouses, specifically A-de-Mourão and Carregado. Management indicates that this position already exists in both warehouses. At A-de-Mourão, it was established before the project, but a substitute manager took over from December 2022 due to unforeseen reasons. In Carregado, it was first implemented in February 2023. Since employee input on causes and potential solutions was gathered in May 2023, it's possible that the presence of this role has gone unnoticed by warehouse personnel. The purpose of this document is to formalize the position, providing detailed documentation to empower those in this role.

A preliminary operators' guide was prepared with two sections for better alignment with rack and bulk-stored cargo process variations (Annex M). Each section includes comprehensive instructions for the three primary sub-processes. Subsections feature warehouse worker-specific flowcharts with PDT images as necessary, and crucial insights from managers and experienced workers. Warehouse employees contributed significantly to the construction of this tool and their input highlighted the guide's user-friendly, clear, and accessible instructions. Despite the positive feedback, final approval from management was not confirmed.

The projected time needed for implementation (approximately 7 days) was computed for the location barcodes eye-level placement. Apart from time and materials (costs not disclosed), the cost of adaptation is minimal because this procedure is already in place in a portion of the warehouse. Management failed to approve the implementation.

Information on investments made was provided as shown in Table 4.2. Carregado received one machine in January 2023 and two in May 2023. All new PDTs were received by the end of July 2023.

Table 4.2 Final Number of Workers, PDTs and Machines per Warehouse

Warehouse	Warehouse Employees	PDTs after implementation	Machines* after implementation
A-de-Mourão	8	8	8
Benavente	3	3	4
Castanheira	2	3	2
Carregado	10	8	8

*Includes forklifts and carton clamps

Monthly and weekly planning documents were devised for the implementation of solutions 5 and 6, drawing from current department processes and desired improvements (Annex N). The monthly plan aimed for use in warehouses with information provided in advance and larger teams. In January 2023, Carregado adopted a weekly plan with positive employee feedback, prompting consideration of the monthly plan to standardize procedures and enhance planning. At Castanheira's warehouse a comparable initiative was introduced in February 2023, establishing a communication board for a client's procedure not accounted in this study (PDTs not used leading to data unavailability). The team's dedication to an organized workspace (Figure 4.15 - Image 1: organized workspace and communication board lacking information) led to a collaborative effort with the team leader and warehouse manager, resulting in a highly effective new communication board (Figure 4.15 - Image 2). Although this won't impact the study results, this serves as an example of successful implementation within the company's context.

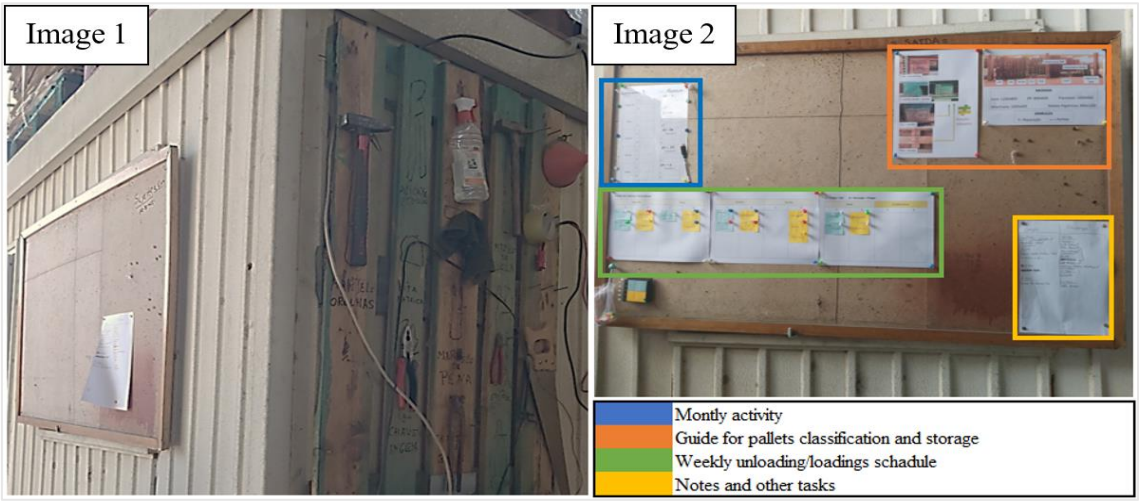


Figure 4.15 Photographs of Initial Board (Image 1) and Implemented Board (Image 2)

4.6 Control

4.6.1 Nineth Cycle – Final project evaluation

Following the analysis and improvement stages, process cycle time data from the previously used database was gathered and examined using JMP and SPSS software. The

dataset included 165 inbounds from August to September 2023, including all arrivals in the four warehouses that followed the complete procedure as well as inbounds that went through a "cross-docking" process, comparable to the baseline measures (Figure 4.16). The total cycle time averaged 47 hours per inbound during the control period, with a standard deviation of 71.9 hours, resulting in reductions of 34% and 52%, respectively. Although the frequency of extreme values reduced, the median increased by 52% to 17.3 hours. This value is still within the strategic target range of 11 to 22 hours. Furthermore, there was a 3 p.p. decline in inbounds that were under 22 hours.

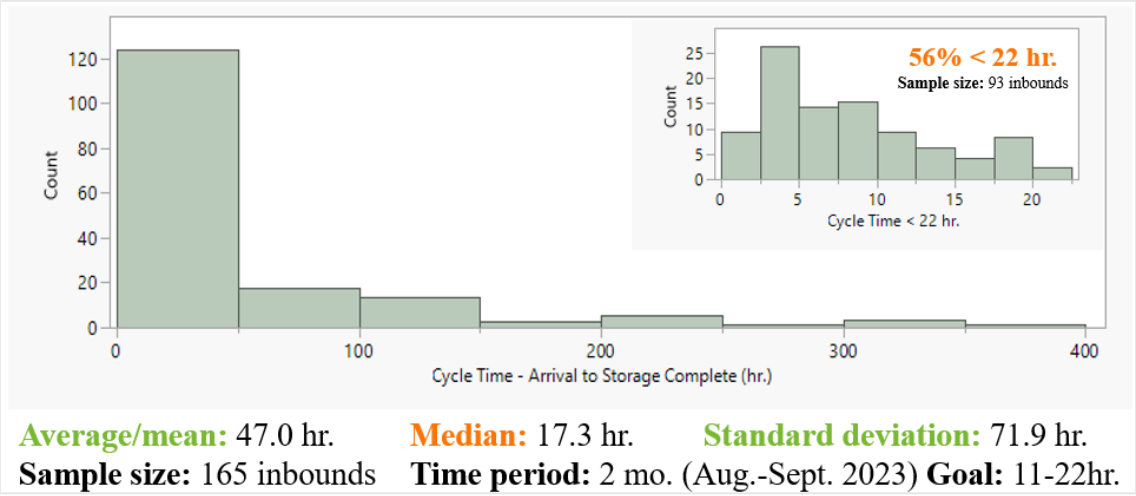
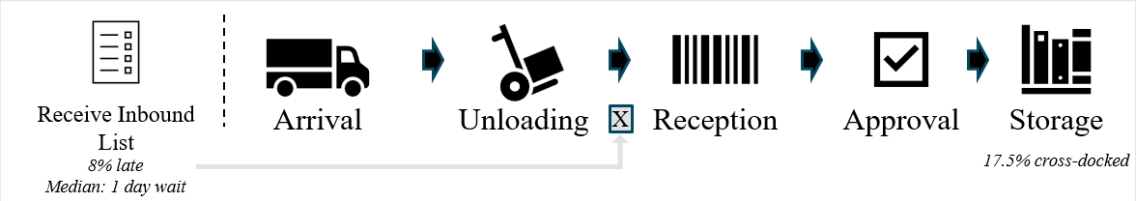


Figure 4.16 Inbound Process Cycle Time after Improvement Efforts



Subprocess	Arrival-Begin Reception* (hr.)	Unloading (hr.)**	Reception* (hr.)	Approve Reception* (hr.)	App. Reception-Begin Storage (hr.)	Storage (hr.)	Est. Total
Average (hr.)	4.1	0.8	0.5	1.1	10.1	31.3	47.1
Median (hr.)	2.3	0.6	0.2	0.2	1.3	2.9	6.9
Range (min.-max.)	0.01-49.6	0.2-2.2	0.01-4.65	0.01-13.2	0.01-264.9	0-381.8	0.2-386
SD (hr.)	5.5	0.5	0.7	2.1	29	64.7	---
Sample size	165	86	165	165	165	165	---
~Percentage	9-33%	---	1-3%	2-3%	**19-21%**	**42-67%**	

*Last reception, if done multiple times; **Manually collected (observation) data; Highest overall reduction; Highest impact on total cycle time reduction

Figure 4.17 Inbound Process Cycle Time after Improvement Efforts by Sub-process

Significant gains can be seen when the sub-processes are examined independently, notably in the storage sub-process, as illustrated in Figure 4.17. However, other from the significant reduction in all parameters of the reception sub-process, all other sub-processes exhibited higher times. The time between the conclusion of reception and the

start of storage is noteworthy, with the most substantial rise in all measures occurring during this transition.

By visualizing data over time in Figure 4.18, the project's effectiveness becomes more apparent by the continuous cycle time decrease during the baseline and control periods. It emphasizes the purposeful, consistent improvement, suggesting that the cycle time reduction was not a coincidental occurrence, but rather a project-driven effect.

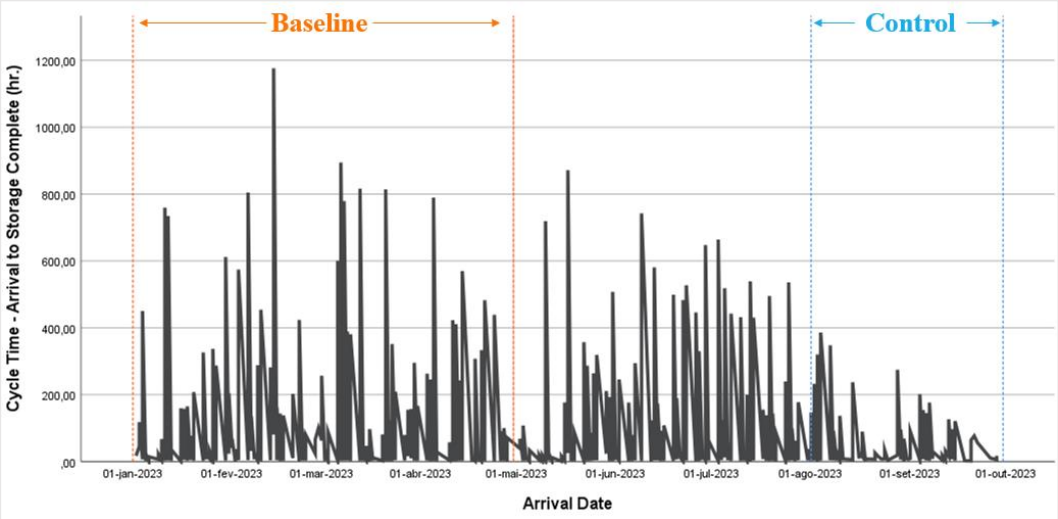


Figure 4.18 Inbound Process Cycle Time Evolution

5 Discussion and Conclusion

The study aims to improve the cycle time of the inbound logistics process at four S&V warehouses, a Portuguese 3PL. Its key goals were to identify the core causes of long cycle times, provide effective reduction strategies, and analyze the impact of these strategies on the inbound process cycle time.

The research made use of AR cycles as well as LSS tools, especially the DMAIC methodology. This mixed method approach resulted in considerable improvements in cycle time. The research effectively identified the causes of process inefficiencies by combining LSS principles with thorough data analysis. The result was a 34% reduction in average inbound process cycle time and a 52% reduction in standard deviation. Furthermore, the research highlighted the broader benefits of LSS, such as increased employee engagement, data accuracy, and performance metric reliability.

The results of the research are consistent with previous studies (see for instance Ray & John, 2011 or J. V. Kovach & Ingle, 2019), giving empirical proof of the value of LSS in optimizing inbound logistics processes. It emphasizes the need of integrating stakeholders into the improvement process, employing precise data analysis, and implementing the methodology gradually and continuously. The study offers future research topics such as adopting LSS to further logistical domains, investigating cultural and organizational success factors, and assessing the long-term sustainability of improvements.

The study admits certain limitations, such as its focus on a single organization, which may restrict the generalizability of its findings to other companies or sectors. Furthermore, due to significant data limitations and restricted data availability, a full cost-benefit analysis was not possible. Also, while the study provides useful short-term insights on improvements, it does not give long-term follow-up on the implemented changes.

In conclusion, this study provides substantial empirical proof that AR and LSS are beneficial in improving inbound logistics processes in a 3PL setting. It emphasizes the value of employee engagement, proper data use, and a cyclical strategy for implementing change. The study not only contributes to the field of operations and supply chain management, but it also provides vital information for firms seeking to enhance their logistics processes and gain a competitive advantage.

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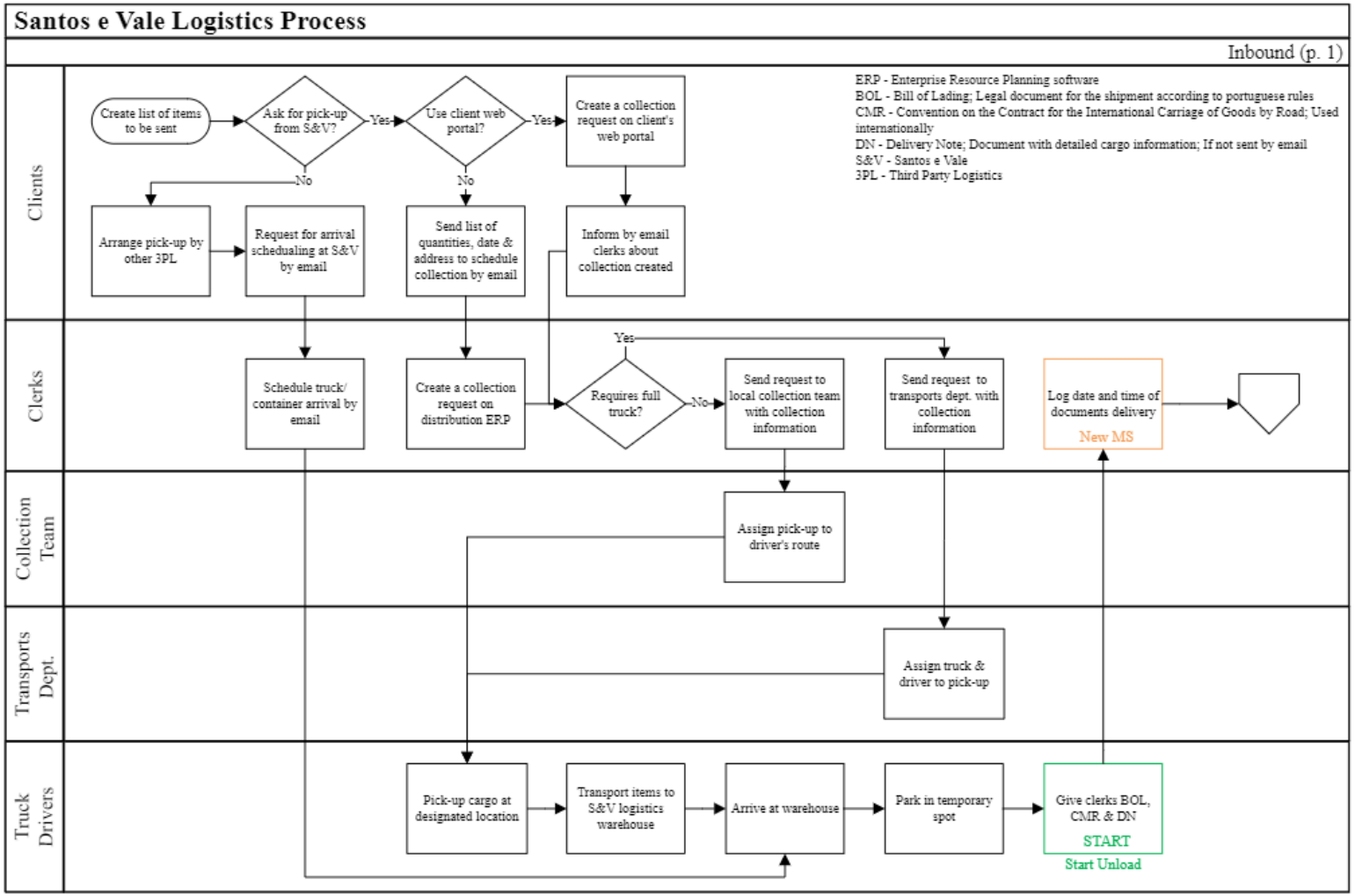
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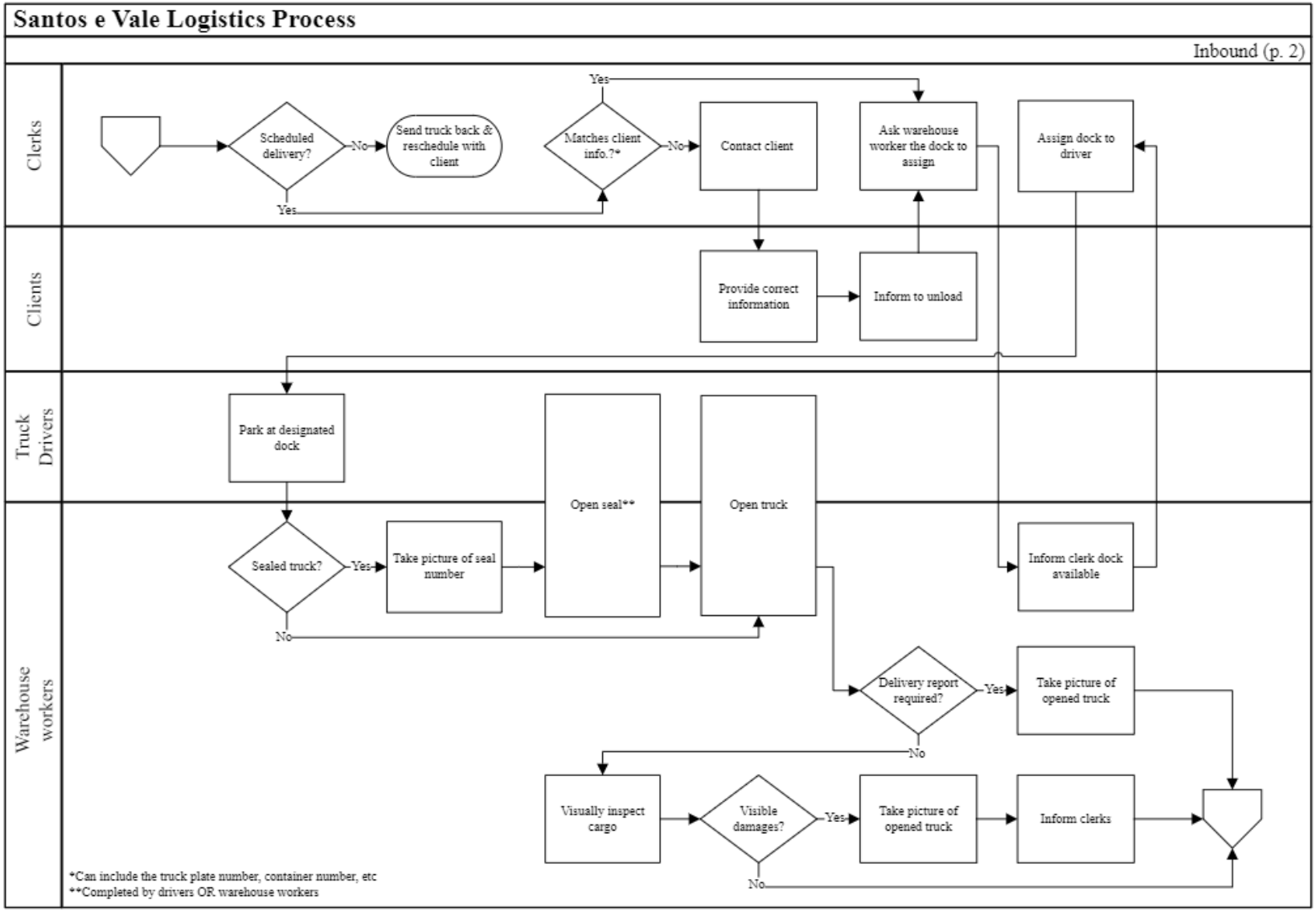
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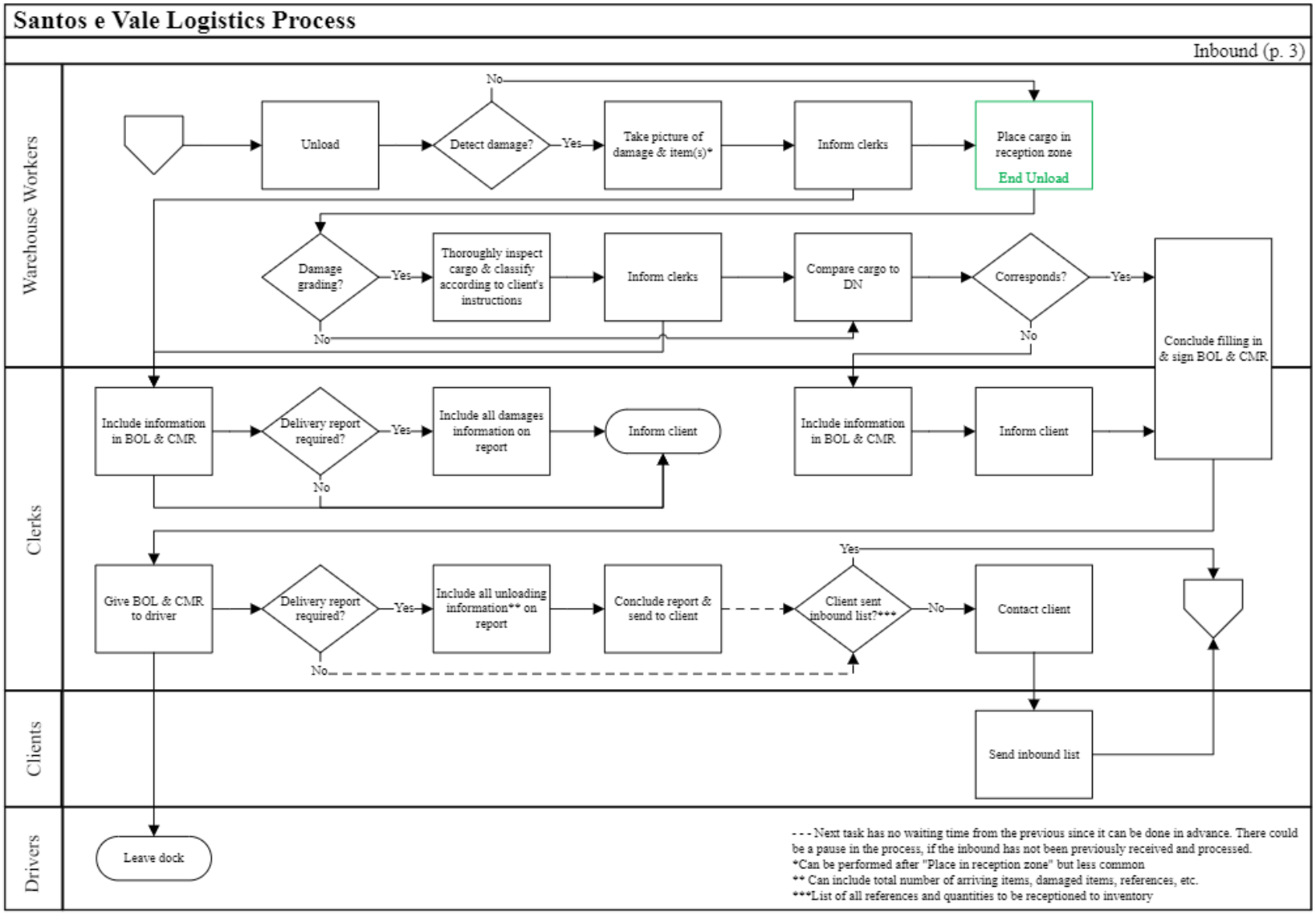
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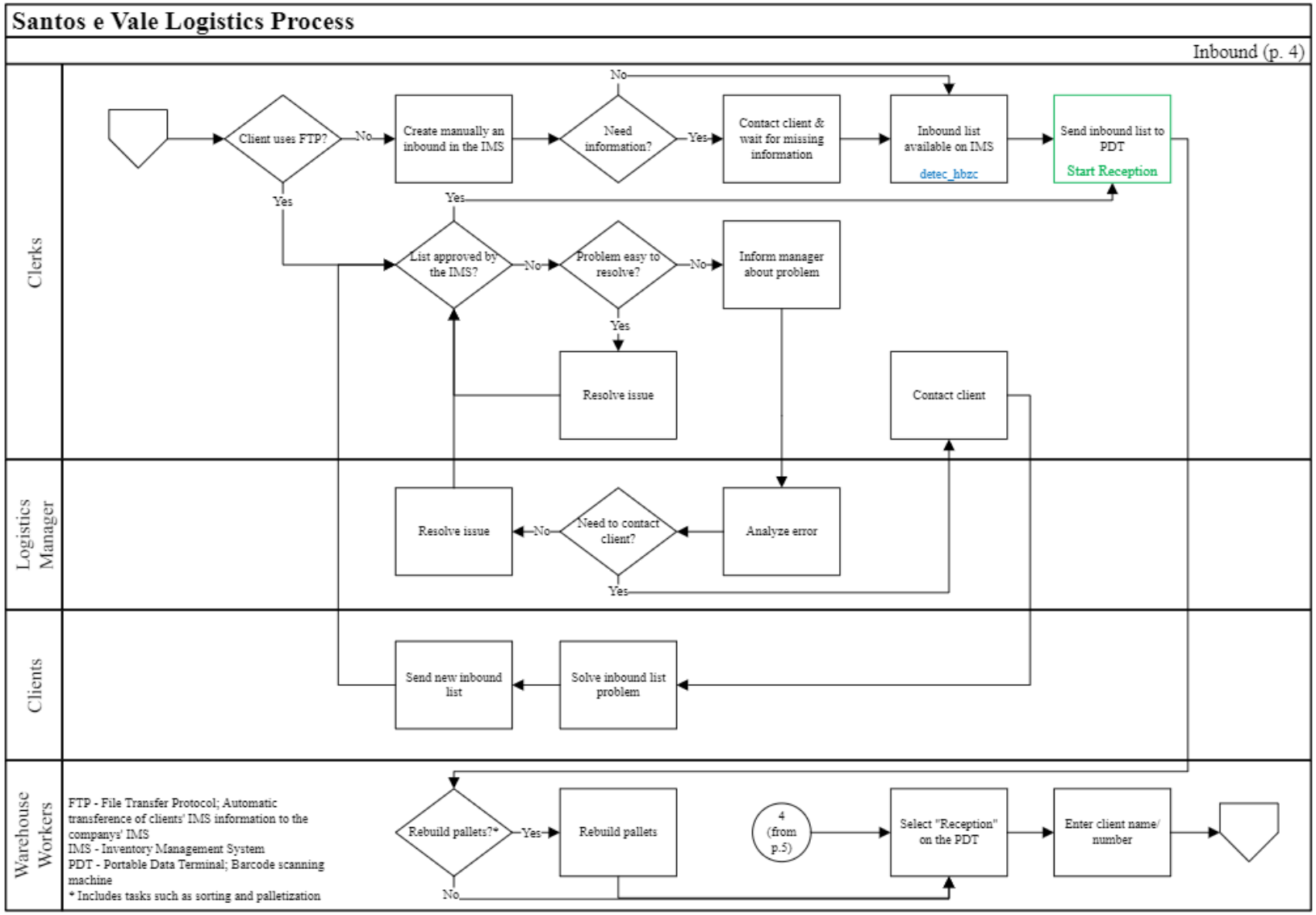
Annexes

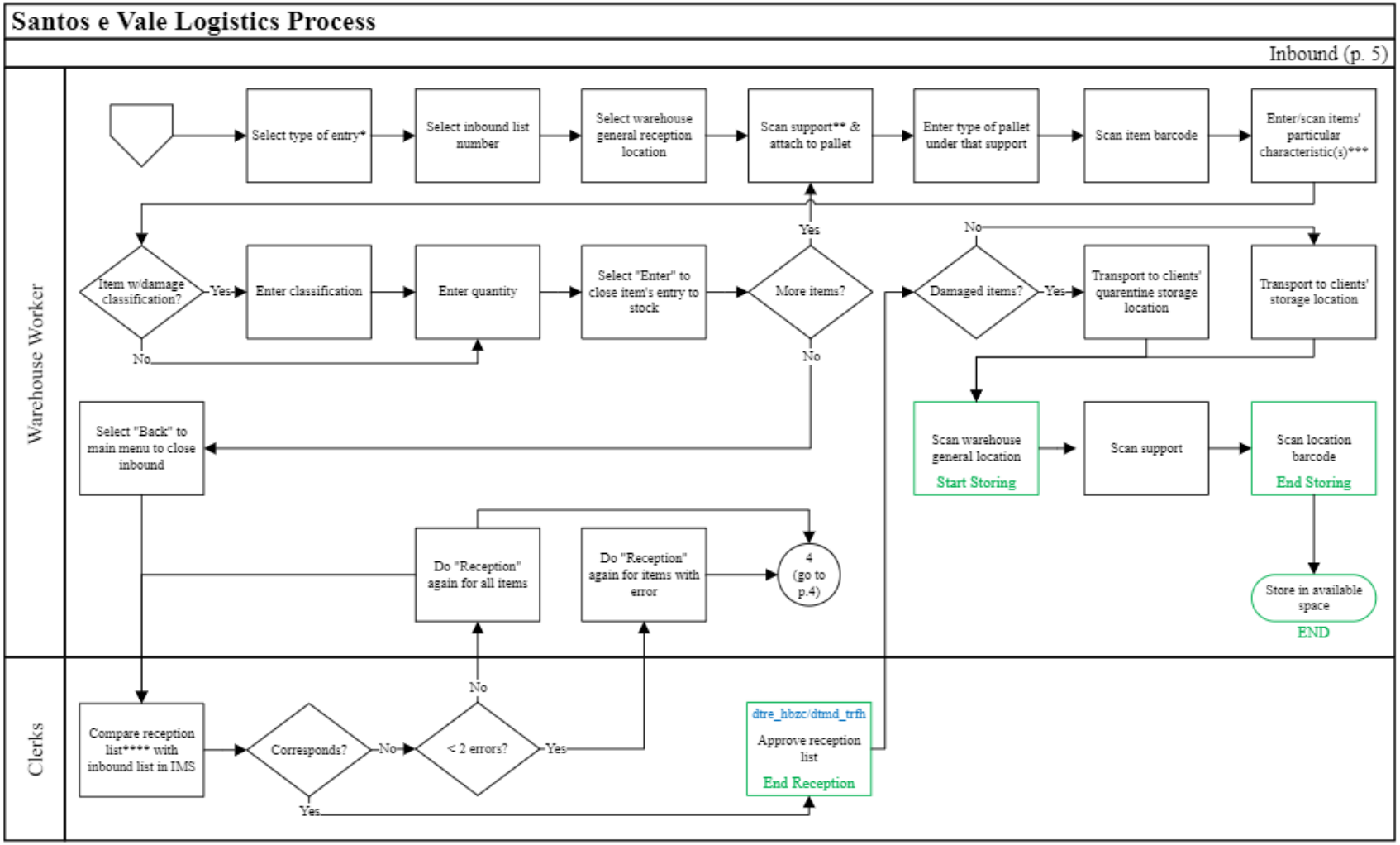
A. Swim-lane Diagram




Santos e Vale Logistics Process
Inbound (p. 2)
Clerks
Clients
Truck Drivers
Warehouse workers
Scheduled delivery?
No
Send truck back & reschedule with client
Yes
Matches client info.?*
Yes
No
Contact client
Ask warehouse worker the dock to assign
Assign dock to driver
Provide correct information
Inform to unload
Park at designated dock
Sealed truck?
Yes
Take picture of seal number
No
Open seal**
Open truck
Inform clerk dock available
Delivery report required?
Yes
Take picture of opened truck
No
Visually inspect cargo
Visible damages?
Yes
Take picture of opened truck
Inform clerks
No
*Can include the truck plate number, container number, etc
**Completed by drivers OR warehouse workers


Santos e Vale Logistics Process
Inbound (p. 3)
Warehouse Workers
Clerks
Clients
Drivers
Unload
Detect damage?
No
Yes
Take picture of damage & item(s)*
Inform clerks
Place cargo in reception zone
End Unload
Damage grading?
Yes
No
Thoroughly inspect cargo & classify according to client's instructions
Inform clerks
Compare cargo to DN
Corresponds?
Yes
No
Conclude filling in & sign BOL & CMR
Include information in BOL & CMR
Delivery report required?
Yes
No
Include all damages information on report
Inform client
Include information in BOL & CMR
Inform client
Give BOL & CMR to driver
Delivery report required?
Yes
No
Include all unloading information** on report
Conclude report & send to client
Client sent inbound list?***
Yes
No
Contact client
Send inbound list
Leave dock
- - - Next task has no waiting time from the previous since it can be done in advance. There could be a pause in the process, if the inbound has not been previously received and processed.
*Can be performed after "Place in reception zone" but less common
** Can include total number of arriving items, damaged items, references, etc.
***List of all references and quantities to be receptioned to inventory


Santos e Vale Logistics Process
Inbound (p. 4)
Clerks
Logistics Manager
Clients
Warehouse Workers
Client uses FTP?
No
Yes
Create manually an inbound in the IMS
Need information?
No
Yes
Contact client & wait for missing information
Inbound list available on IMS
detec_hbzc
Send inbound list to PDT
Start Reception
List approved by the IMS?
No
Yes
Problem easy to resolve?
No
Yes
Inform manager about problem
Resolve issue
Contact client
Resolve issue
Need to contact client?
No
Yes
Analyze error
Send new inbound list
Solve inbound list problem
FTP - File Transfer Protocol; Automatic transference of clients' IMS information to the companys' IMS
IMS - Inventory Management System
PDT - Portable Data Terminal; Barcode scanning machine
* Includes tasks such as sorting and palletization
Rebuild pallets?*
Yes
No
Rebuild pallets
4 (from p.5)
Select "Reception" on the PDT
Enter client name/ number



*Includes "Order", "Transfer", "Return"
**An internal cargo tracking system. Barcode label that associates an item's information and location.
*** Includes, for example, batch number, series number and expiration date
**** List of all items physically receptioned and supports associated

B. Process Tasks and Process Roadmap

Process step	Data available?	Where?	Observations	IMS Data Label	
Inbound sent by client	No	Email/ Phone	For studying subprocess; Not a priority		
Inbound available in the system	Yes	IMS	Some clients send in much advance. Can affect cycle time determination	dtec_hbzc INdoc	
Container/truck arrival	Yes	-	PRIORITY. Starting point for the logistics process	New system	START
Container/truck start unloading	No	-	For studying subprocess; Not a priority		
Container/truck end unloading	No	-	For studying subprocess; Not a priority		
Reception available on PDT	No	-			
Start reception	Yes	PDT data			
End reception	Yes	PDT data			
Reception approved	Yes	IMS	Possible end since inventory information is made available for clients at this stage	dtre_hbzc INdoc	END 1
Storing	Yes	IMS	Possible end. More realistic considering S&V activity		END 2

C. Car Arrival Data Collection Plan

Car Arrival Data Collection Plan

- What data do we need to collect? Car's (trucks and containers) arrivals to warehouses to unload cargo.
- Why do we need to collect it? This is the start of the physical process under analysis and this step is not being measured.
- Who will collect it? Clerks and warehouse workers (Castanheira's case).
- How will they collect it? Clerks log into a shared file the date and time when the driver delivers them the transportation documents. To cross information with the system the name of the client and number of inbound is associated to the time and date logged.
- When and for how long will they collect it? Starting on November the 7th 2022 and at least until the end of the process.

Operational Definitions

Inbound is the list of arriving items that will be/is available in Warepack (Inventory Management System - IMS). Each inbound is associated with a specific and unique number that allows to cross information with the measurement system and the IMS.

Collection Form

Warehouse 1 Document

Client	Date	Time	Nr Inbound
Client A	1/1/2022	9:30	123456

- Clerks access to their specific warehouse document in the shared folder *"Chegadas"*
- In date include the date of car arrival
- In time log the hour and minute when the driver delivers que transportation documents
- For Castanheira's case (particularly IPP client) the warehouse workers take the time and date of documents delivery on the top of the documents and clerks then log it to the shared document
- Each inbound is logged in its own line, which means, cargo with more than one inbound should have more than one line although time and date is the same

1

Measurement System Analysis

Two-part Measurement System Analysis: Reconciliation and Repeated Measures. The goal is to answer: Are all arrivals being logged? Are the date/times logged for each arrival accurate?

Reconciliation

Comparing weekly total arrivals available in the IMS with the ones logged in the new system.

At least 90% of total arrivals need to be consistently logged over time to consider a "good" measurement system.

Repeated Measures

A sample of 30 arrivals* will be randomly analyzed by comparing logged time with observation.

A match of 80% is the goal for a "good" measurement system.

*After first analysis, Carregado's warehouse was performing poorly. Measures were taken to increase accuracy of logged times (provide more feedback, clarify collection form, etc.). After, 10 more observations were taken to assess measurement system quality.

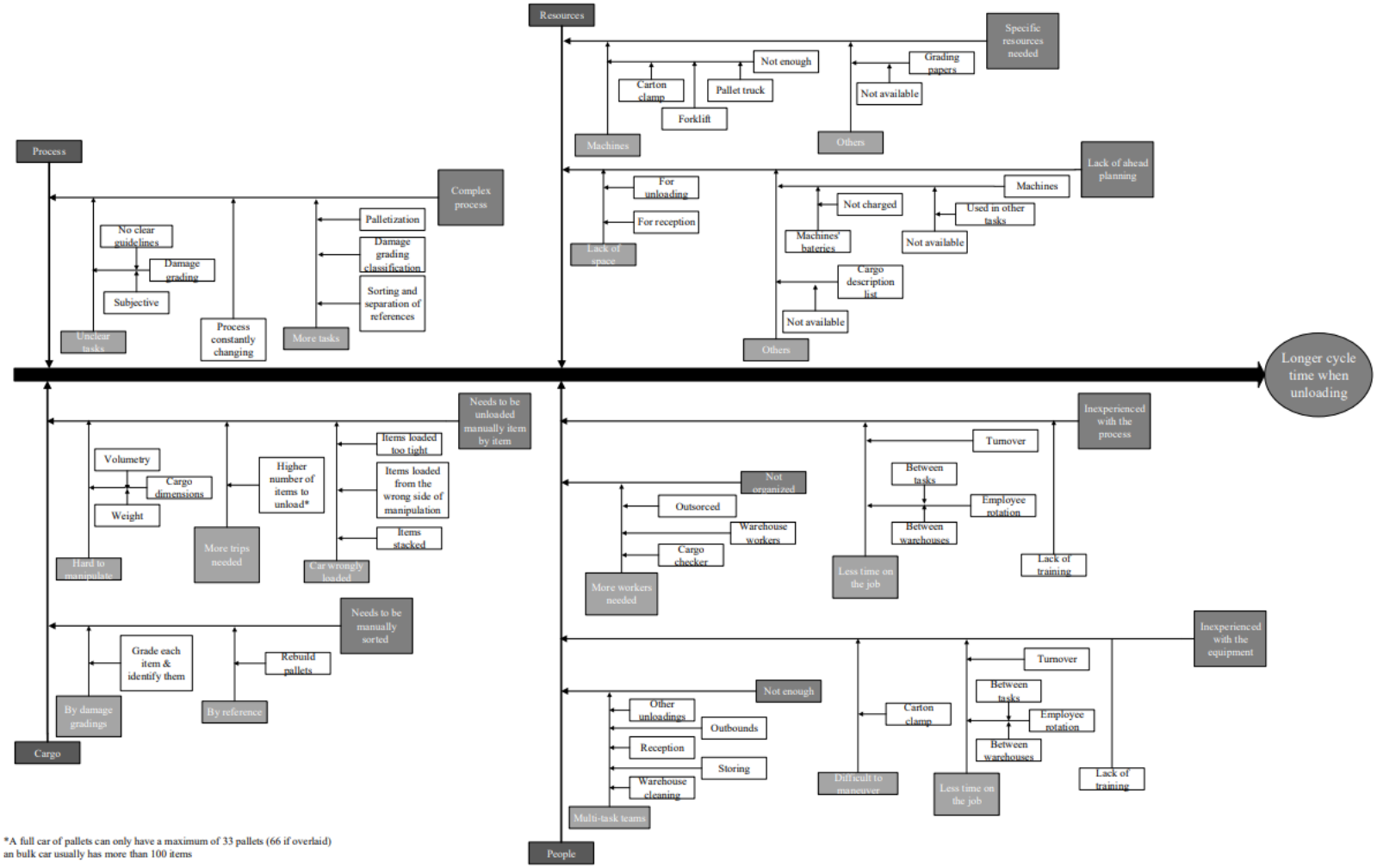
2

D. Final Project Charter

FINAL PROJECT CHARTER	
Date	01/07/2023
Project Title	Inbound Process Cycle Time Reduction
Project Leader	João Rocha
Company/Department Description	Santos e Vale logistics department operates the longest in four locations that vary in type of products (food, chemicals, appliances, etc.), procedures, area, teams, and work volume. Currently, it is challenging to fully address customers' logistics needs/requirements (communication, documentation, etc.). Much of this is tacit knowledge held by current employees that is not documented in standard operating procedures. There are no key performance indicators (KPIs) to describe the performance of the logistics operations.
Team Members	Ana Catarina Branco; Nuno Jacinto; José João; Filipe Trindade
Problem Statement	Average logistics inbound process cycle time (Jan-Apr 2023) is 71.2 hr. and 59% of inbounds are within the strategic goal (11-22 hr.), which limits warehouse throughput.
Mission Statement	Reduce process cycle time to provide opportunity to increase warehouse throughput.
Stakeholder	Joaquim Vale, Administrator

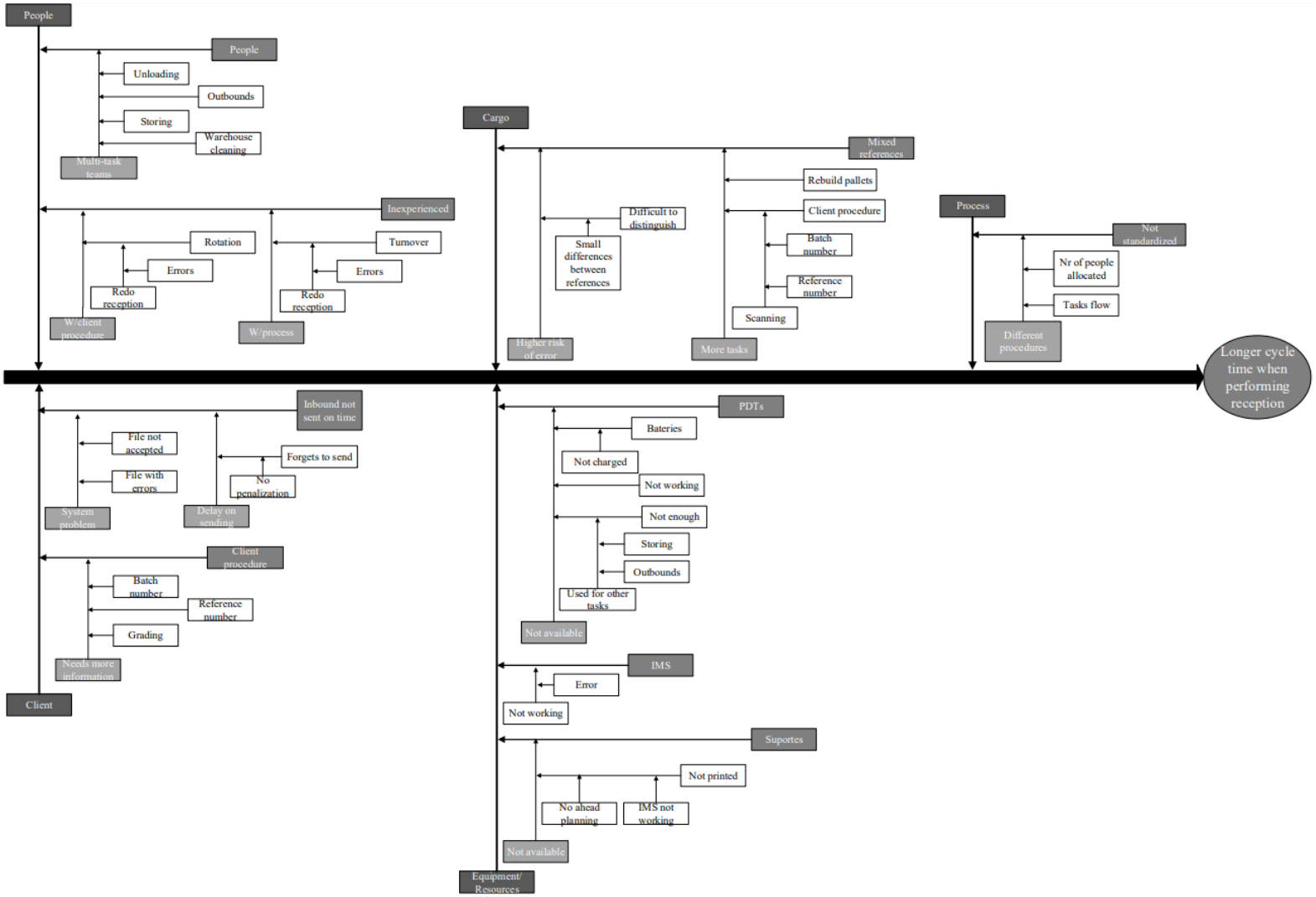
E. Root Causes Cause-and-Effect Diagrams

a. Unloading Cause-and-Effect Diagram

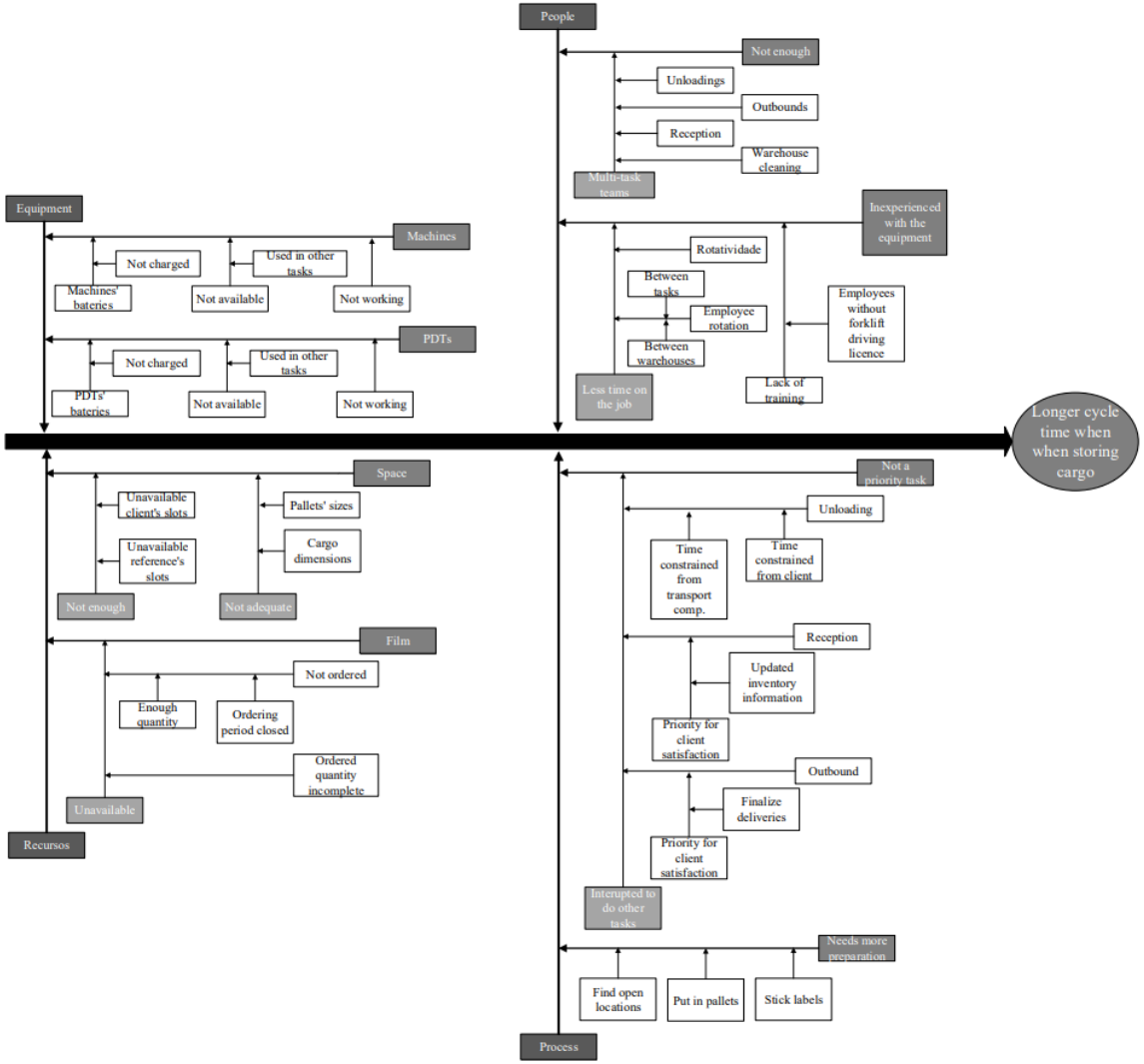


*A full car of pallets can only have a maximum of 33 pallets (66 if overlaid) an bulk car usually has more than 100 items

b. Reception Cause-and-Effect Diagram



c. Storing Cause-and-Effect Diagram



F. Logistics' Employees Sample

LOGISTICS EMPLOYEES

Warehouse	Upper management Logistics	Second level management	Clerks	Warehouse workers	Total Staff/Warehouse	% Total Staff/Warehouse
A-de-Mourão	1		4	8	13	34.21%
Castanheira		1	1	2	4	10.53%
Benavente		1	1	4	6	15.79%
Carregado		1	2	10	13	34.21%
x	2				2	5.26%
Total /Level	3	3	8	24	38	
% Total/Level	8%	8%	21%	63%	100%	

LOGISTICS EMPLOYEES SAMPLE

Warehouse	Upper management Logistics	Second level management	Clerks	Warehouse workers	Sample/Warehouse	% Sample/Warehouse
A-de-Mourão	1		4	6	11	36.67%
Castanheira		1	1	2	4	13.33%
Benavente		1	1	2	4	13.33%
Carregado		1	2	7	10	33.33%
x	1				1	3.33%
Sample/Level	2	3	8	17	30	
% Sample/Level	7%	10%	27%	57%	100%	
				% Sample/Total	78.95%	

G. Root Cause Multivoting Results

MULTIVOTING RESULTS

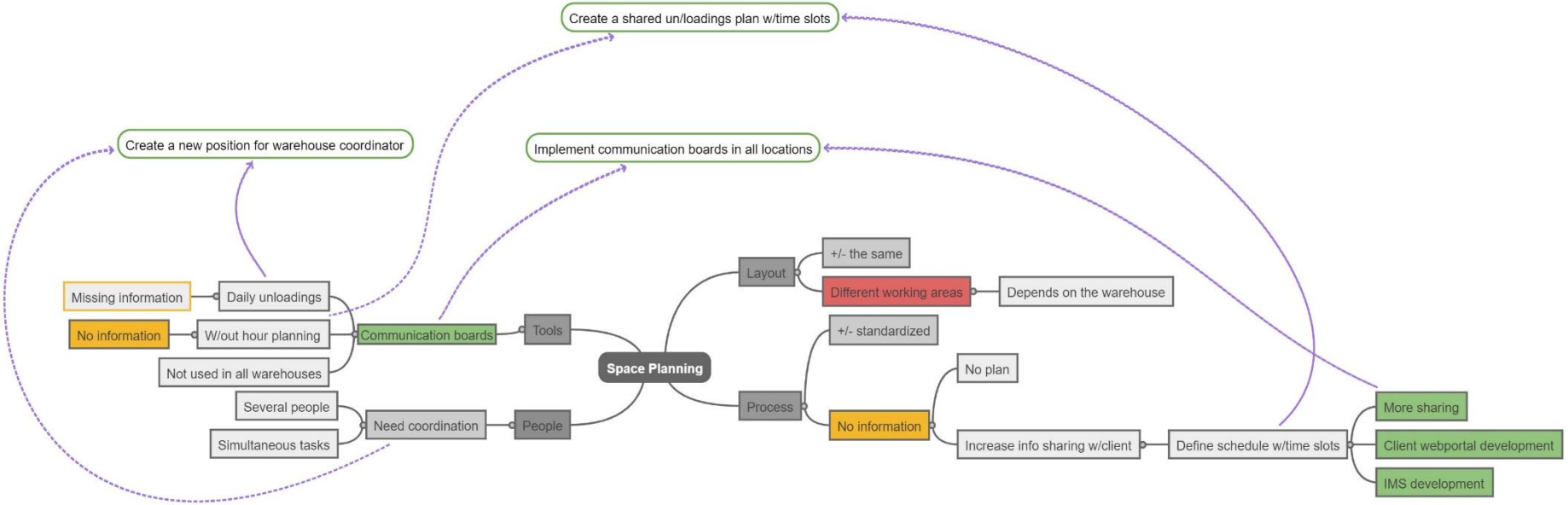
Subcause	Subprocess	Votes	% Sample
Resources: Space - Not enough - Client space	S	18	60%
Cargo: Needs to be unloaded manually item by item - Car wrongly loaded - Items loaded too tight	U	18	60%
Cargo: Needs to be manually sorted - By reference - Rebuild pallets	U	18	60%
Cargo: Needs to be unloaded manually item by item - Car wrongly loaded - Items stacked	U	17	57%
Process: Complex - More tasks - Sorting and separation of references	U	16	53%
People: Unexperienced - W/process - Turnover - Redo reception	R	15	50%
Client: Client procedure - Needs more information - Batch number	R	14	47%
Cargo: Mixed references - Higher risk of error - Difficult to distinguish - Small differences between references	R	14	47%
Cargo: Mixed references - More tasks - Rebuild pallets	R	13	43%
Equipment: Machines - Unnavailable, Equipment: Machines - Unnavailable	S	13	43%
Process: Needs preparation - Search for available spaces	S	13	43%
People: Inexperienced with the machines - Less time on the job - High rotation - Between tasks	U	13	43%
Process: Needs preparation - Build pallets	S	12	40%
Resources: Lack of ahead planning - Lack of space - For unloading	U	12	40%
Resources: Lack of ahead planning - Lack of space - For reception	U	12	40%
People: Not enough - Multi-tasked teams - Outbounds	S	11	37%
People: Inexperienced with the machines - Less time on the job - Rotation - Between tasks	S	11	37%
Equipment/Resources: PDTs - Unnaveilable - Not enough	R	9	30%
Equipment/Resources: Supports - Unnaveilable - Not printed - No ahead planning	R	9	30%
Process: Not standardized - Different procedures - Tasks flow	R	8	27%

H. Root Cause Nominal Group Technique Results

NOMINAL GROUP TECHNIQUE RESULTS

Subcauses	Subprocess	Votes
Resources: Space - Not enough - Client space	S	69
Cargo: Mixed references - Higher risk of error - Difficult to distinguish - Small differences between references	R	45
Cargo: Mixed references - More tasks - Rebuild pallets	R	39
Resources: Lack of ahead planning - Lack of space - For reception	U	39
Cargo: Needs to be unloaded manually item by item - Car wrongly loaded - Items stacked	U	36
Resources: Lack of ahead planning - Lack of space - For unloading	U	33
Cargo: Needs to be manually sorted - By reference - Rebuild pallets	U	25
Equipment: Machines - Unnavailable, Equipment: Machines - Unnavailable	S	22
People: Not enough - Multi-tasked teams - Outbounds	S	22
Process: Needs preparation - Search for available spaces	S	20
Client: Client procedure - Needs more information - Batch number	R	18
People: Inexperienced with the machines - Less time on the job - Rotation - Between tasks	S	16
Process: Needs preparation - Build pallets	S	13
Cargo: Needs to be unloaded manually item by item - Car wrongly loaded - Items loaded too tight	U	13
Process: Complex - More tasks - Sorting and separation of references	U	13
Equipment/Resources: Supports - Unnaveilable - Not printed - No ahead planning	R	12
Equipment/Resources: PDTs - Unnaveilable - Not enough	R	6
People: Inexperienced with the machines - Less time on the job - High rotation - Between tasks	U	4
Process: Not standardized - Different procedures - Tasks flow	R	3
People: Unexperienced - W/process - Turnover - Redo reception	R	2

I. Possible Improvement Initiatives Mind Map



J. Possible Improvement Initiatives Prioritization Matrix

SOLUTIONS	Operator's guide	Client procedure guide	Integration plan	Un/loadings boards	Hourly Un/loading plan	More/more potent machines	More PDTs	More people	Realocation of clients	Walkie-talkies	Warehouse supervisor	Unlock locations	Summary code	Automatic reference fill	PDT warnings for reception	Unloading scanning	Restrict manual scan writing	Interface development	Implement uniproduct pallets	Clearer item's identification	Space planning with 24h	Storing items per zones	Grading color coding	Eye level location labels
CHARACTERISTICS																								
Impactful	○	○	◎	○	◉	○	○	◎	◎	○	◉	○	◉	○	◉	○	○	◎	○	○	◉	◎	○	○
Needed resources available	◉	◉	◎	◉	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	○	○	◎	○	◉
Needed time available	◎	○	○	◉	○	○	○	○	○	○	◉	○	○	○	○	○	○	○	○	○	○	○	◉	◉
Easy to implement	◉	◎	○	◉	○	◉	◉	◉	○	◉	◎	○	○	○	○	○	○	○	○	○	○	○	◉	◉
Easy to use	◉	◉	◎	◉	◎	◉	◉	◎	○	◎	◉	○	○	○	◉	◉	○	◉	◉	◉	◎	○	◎	◉
Valuable to management	○	◉	○	○	◉	◎	◉	○	◉	○	○	◉	○	◉	◉	◎	◎	◉	○	○	◉	○	○	○
Valuable to employees	◎	◎	◎	◎	◎	◉	◉	◎	◉	◎	◎	◎	◉	◎	○	○	○	○	◉	◉	◎	◎	○	◉
Increases time efficiency	◎	◎	◎	○	◉	◎	◎	◎	◎	◎	◉	○	◉	○	◎	○	◉	◎	◉	○	◉	◎	○	◎
Increases space efficiency	○	○	○	◎	◉	○	○	○	◎	○	◉	◎	○	○	○	○	○	○	○	○	◉	◎	○	○
Reduces reception error	◎	◎	◎	○	○	○	○	○	○	○	◎	○	◉	○	◉	○	◎	○	○	◎	○	○	○	○
Standardizable	◉	○	◉	◉	◉	◉	◉	◎	○	○	◎	◉	○	○	◉	◉	○	◎	○	○	○	◎	○	◉
Not dependent on 3rd parties	◉	◉	◉	○	○	◉	◉	◉	◎	◉	◉	◉	○	○	○	◉	◉	○	○	○	○	◎	○	◉
Integrates issues outside project	○	◎	◉	○	○	◎	◎	◉	◉	◉	◉	○	○	○	○	○	◉	◉	◎	○	◉	◉	◉	◉
Not dependent on updates	○	○	○	◉	◉	◉	◉	◉	◉	◉	◎	○	○	○	○	◉	○	○	◉	○	○	○	◉	◉
TOTAL SCORE	62	56	50	66	66	68	74	56	54	52	88	42	46	24	56	48	42	44	48	32	58	36	48	88

LABEL:	1 ○	3 ◎	9 ◉

K. Eye-level Locations Impact Study

OBSERVATIONS			
Worker	**Experience**	**Writing Time_Sec**	**Scanning Time_Sec**
1	Less	8,95	1
1	Less	7,71	1,2
1	Less	7,59	1,89
1	Less	8,37	1,2
1	Less	8,4	1,42
2	More	3,57	1,59
2	More	2,64	1,04
2	More	3,1	2,19
2	More	3,38	1,15
2	More	2,63	1,16
3	More	4,22	1,4
3	More	3,77	1
3	More	3,42	1,94
3	More	3,42	2
3	More	3,5	1,57
4	Less	2,6	1,4
4	Less	2,5	1,4
4	Less	2,48	1,14
4	Less	2,69	1,64
4	Less	3,64	1,4
Average		**4**	**1**

Client	**Total Locations**	**Total High-level Locations**	**%High-level Locations**	**Avg Inbounds/Month**	**Avg Lines/Inbound**	**Avg Extra Time/Line_Sec**	**Extra Sec/Month**	**Extra Min/Month**	**Extra Hr/Year**
ADT	54	30	56%	1	4	3	6,67	0,11	0,02
Beepro	171	111	65%	8	6	3	95,14	1,59	0,32
Christeyns	1737	1260	73%	28	21	3	1273,06	21,22	4,24
Sutter	963	723	75%	8	35	3	608,13	10,14	2,03
Ecolab	1758	1266	72%	32	31	3	2171,83	36,20	7,24
Average			**68%**						**13,85**

L. Warehouse Supervisor Role Description

Matriz de Competências - Supervisor de Armazém

Título e estrutura de reporte

O Supervisor de Armazém reporta diretamente ao Responsável Operacional da plataforma em questão.



Sumário da posição

O Supervisor de Armazém tem um papel crucial na coordenação de operações no terreno. Trabalhando diretamente com o Responsável Operacional, este deve focar-se na gestão de pessoas e espaços tendo por objetivo o cumprimento das tarefas diárias de uma forma eficaz e eficiente seguindo as normas de segurança e zelando pela organização e limpeza dos espaços.

Deveres e responsabilidades

- Coordenar com o Responsável Operacional os objetivos operacionais.
- Supervisionar e liderar a equipa de armazém de forma a atingir os objetivos operacionais diários.
- Coordenar e priorizar tarefas para responder às expetativas de receção e expedição dos clientes.
- Coordenar a equipa de armazém atribuindo tarefas aos operadores tendo em conta as competências necessárias à eficaz execução das mesmas.

- Coordenar e planear os espaços para as tarefas diárias.
- Colaborar com a equipa respondendo a possíveis lacunas.
- Colaborar com a equipa na formação de novos elementos.
- Responder a quaisquer problemas operacionais ou discrepâncias de forma rápida e eficaz ou escalar caso necessário.

Aptidões necessárias

- Experiência na área operacional
- Fortes habilidades de liderança e comunicação, com capacidade de motivar e guiar uma equipa.
- Conhecimento das normas de segurança e higiene.
- Habilidades de resolução de problemas e tomada de decisões.

Expetativas de performance

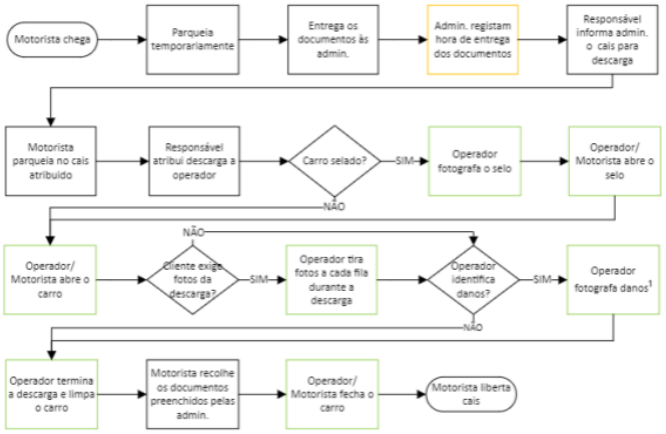
- Garantir o cumprimento das diretrizes de segurança eliminando/reduzindo o número de incidentes no local de trabalho.
- Alcançar as metas diárias determinadas para a operação.
- Melhorar a produtividade e eficiência do armazém através da adequada atribuição de tarefas e organização de espaços.

M. Operator's Guide

Manual do Operador de Armazém

Processo de Entrada

1. Descarga



[1] Fotografias dos danos são tiradas preferencialmente dentro do carro

O operador deve antes da descarga:

- Certificar-se que possui todos os materiais e em bom estado de operacionalidade necessários para a descarga
- Confirmar com o supervisor o cais e a zona atribuída à descarga
- Garantir que a zona de descarga está desimpedida e com visibilidade

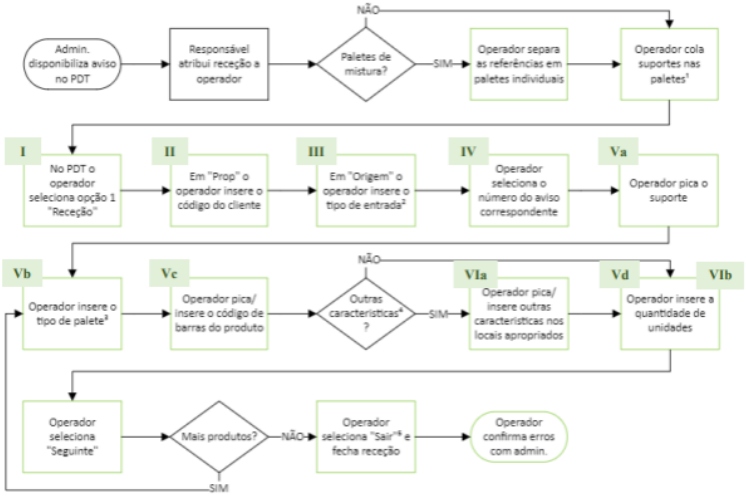
O operador deve durante a descarga:

- Garantir que a descarga segue as normas operacionais e de segurança
- Estar atento a possíveis danos na carga

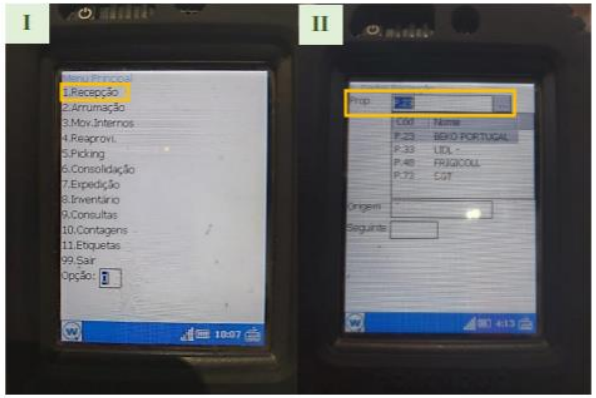
Após a descarga o operador deve:

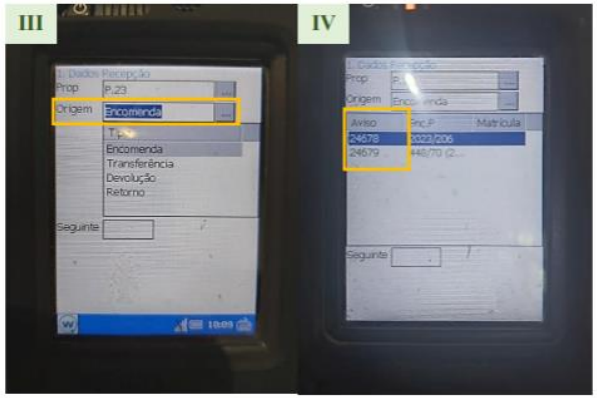
- Fazer a limpeza do carro e do seu posto de trabalho
- Confirmar que o motorista recebe todos os documentos
- Certificar-se que o material utilizado mantém o seu bom estado de conservação

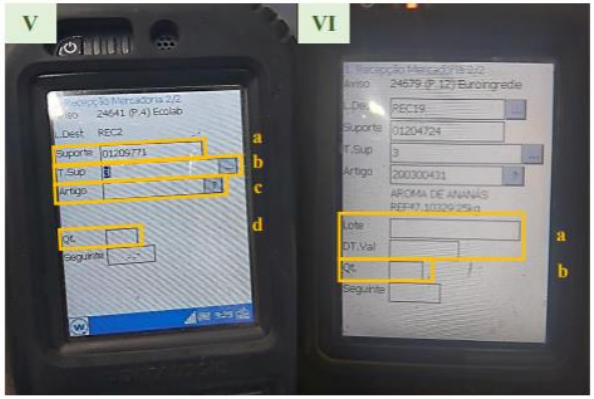
2. Receção



[1] Ver instruções de colagem de etiquetas
[2] "Encomenda" = novas entradas, "Transferência" = entre plataformas, "Devolução" = devolvido s/danos ou "Retorno" = devolvido c/danos
[3] "3" Palete Euro, "5" Estrado/IBC,
[4] Pode ser necessário inserir o lote, número de série, data de validade, grading ou estado (ok/nok)
[5] Tecla ESC







O operador deve antes da receção:

- Certificar-se que possui todos os materiais e em bom estado de operacionalidade necessários para a receção
- Confirmar qual o processo do cliente em questão com o supervisor (o que deve picar/inserir)

O operador deve durante a receção:

- Estar atento aos códigos, referências e quantidades
- Estar alerta de forma a evitar erros na receção
- Colar novos suportes mesmo que sejam produtos devolvidos de forma a garantir a rastreabilidade destes
- A colagem dos suportes deve ser feita no centro da palete, acessível à picagem em empilhador



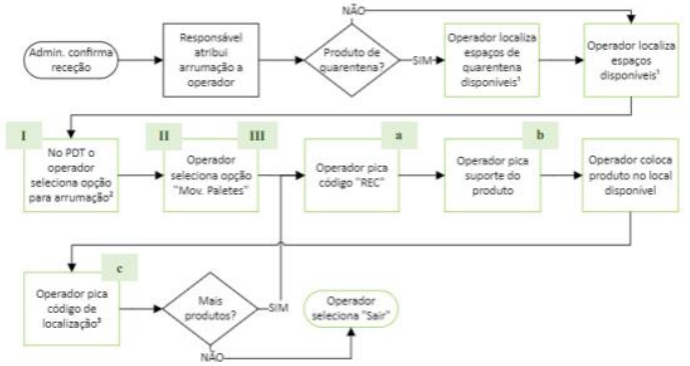
- A colagem dos suportes deve ser feita de forma parcial em paletes cujo produto é enviado à unidade



- Em paletes que são enviadas completas os suportes podem ser colados na totalidade

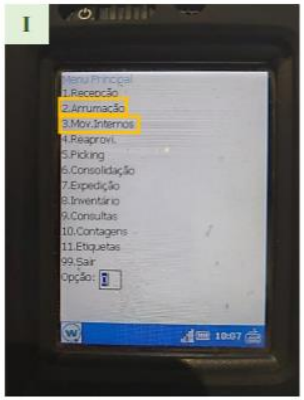


3. Arrumação



¹ No corredor/área reservada ao cliente
² Opção 2 "Arrumação"/Opção 3 "Mov. Internos"
³ AR[Código do Armazém] - Nº corredor - Nº da secção - Nível - Lado

I



II



III



O operador deve antes da arrumação:

- Certificar-se que possui todos os materiais e em bom estado de operacionalidade necessários para a arrumação
- Certificar-se que a separação de artigos em paletes monoproduto foi feita corretamente

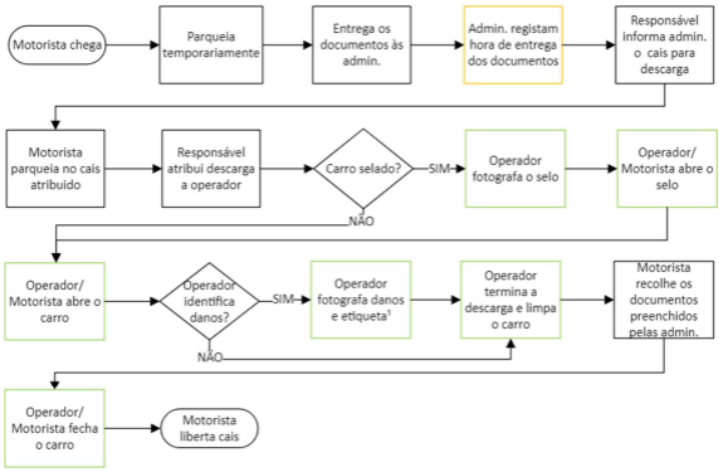
O operador deve durante a arrumação:

- Fazer o manuseamento da carga de forma cuidadosa, cumprindo as regras de segurança
- Estar atento a quaisquer danos que possam não ter sido identificados anteriormente

Manual do Operador de Armazém

Processo de Entrada

1. Descarga



[1] Fotografias dos danos são tiradas preferencialmente dentro do carro

O operador deve antes da descarga:

- Certificar-se que possui todos os materiais e em bom estado de operacionalidade necessários para a descarga
- Confirmar com o supervisor o cais e a zona atribuída à descarga
- Garantir que a zona de descarga está desimpedida e com visibilidade

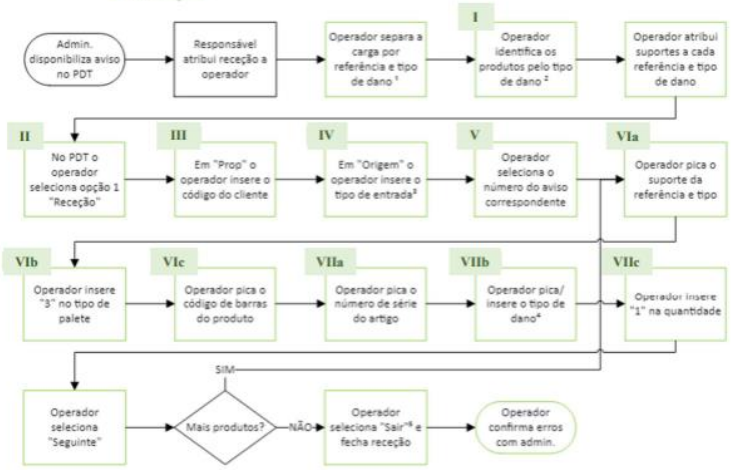
O operador deve durante a descarga:

- Garantir que a descarga segue as normas operacionais e de segurança
- Estar atento a possíveis danos na carga

Após a descarga o operador deve:

- Fazer a limpeza do carro e do seu posto de trabalho
- Confirmar que o motorista recebe todos os documentos
- Certificar-se que o material utilizado mantém o seu bom estado de conservação

2. Receção



[1] Tipo de dano divido por Grading (X, A, B, S) ou OK/NOK (bom/danificado)
[2] Papéis/etiquetas identificativas (ver foto)
[3] "Encomenda" = novas entradas, "Transferência" = entre plataformas, "Devolução" = devolvido s/danos ou "Retorno" = devolvido c/danos
[4] Com grading picagem do código, caso contrário inserir "ok" ou "nok"
[5] Tecla ESC

I

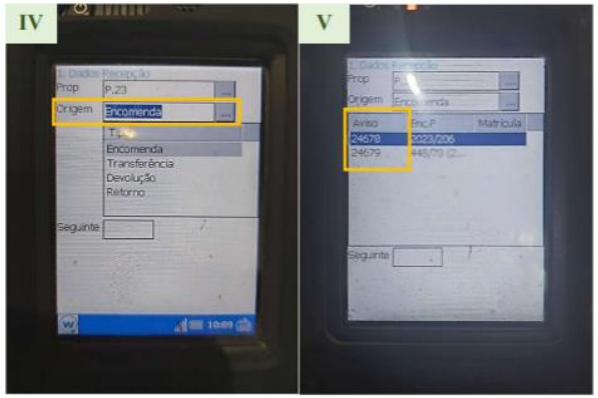


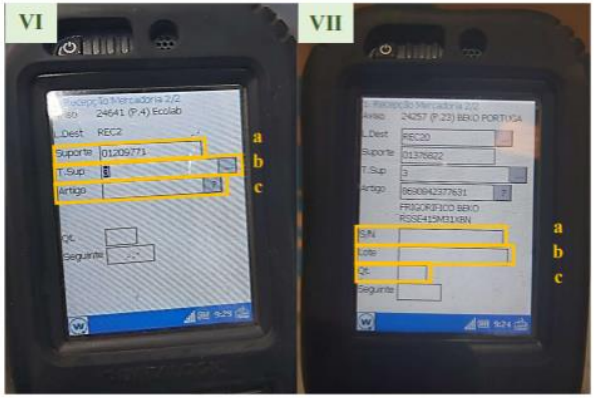
II

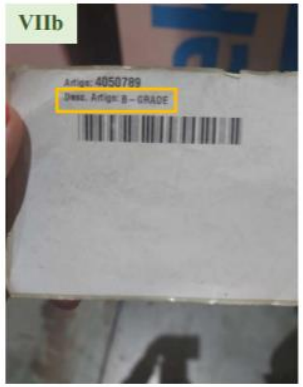


III









O operador deve antes da receção:

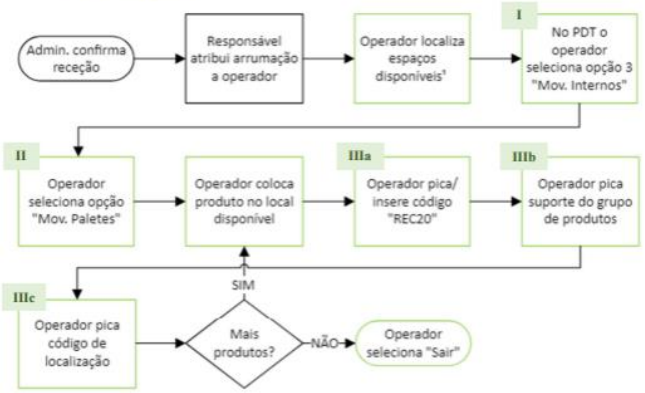
- Certificar-se que possui todos os materiais e em bom estado de operacionalidade necessários para a receção
- Confirmar qual o tipo de classificação de danos a seguir
- Separar os produtos por referência e tipo de dano de forma a evitar erros na receção

O operador deve durante a receção:

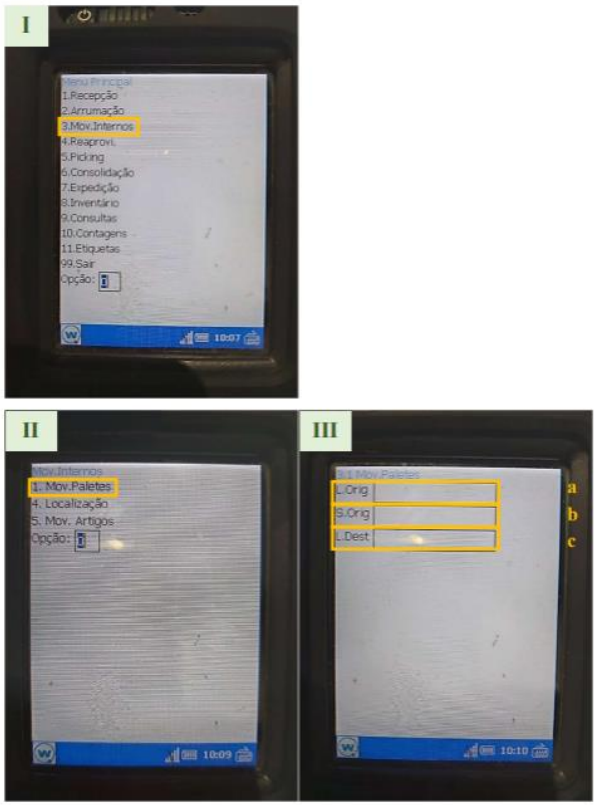
- Estar atento aos códigos, referências e danos
- Estar alerta de forma a evitar erros na receção
- A colagem dos suportes deve ser feita de forma parcial de forma a não danificar o produto (ver foto)



3. Arrumação



¹ Conforme o artigo e grading/tipo de dano
² Opção 2 "Arrumação"/Opção 3 "Mov. Internos"



O operador deve antes da arrumação:

- Certificar-se que possui todos os materiais e em bom estado de operacionalidade necessários para a arrumação
- Fazer a filmagem em molhos de 4 ou 8 para estabilizar a pilha durante a arrumação

O operador deve durante a arrumação:

- Garantir que a carga é colocada no local apropriado tendo em conta a referência e tipo de dano
- Fazer a manipulação cuidadosa dos equipamentos
- Garantir que os equipamentos estão devidamente filmados

Após a arrumação o operador deve:

- Certificar-se com o responsável que a arrumação fica concluída em sistema e na sua totalidade

N. Communication Boards

a. Unloadings and Loadings Planning Boards

PLANEAMENTO DE CARGAS E DESCARGAS				MÊS set/23			santosevale			
SEMANA 14	SEGUNDA	DIA	TERÇA	DIA 1	QUARTA	DIA 2	QUINTA	DIA 3	SEXTA	DIA 4
CARGAS										
DESCARGAS										
SEMANA 15	SEGUNDA	DIA 7	TERÇA	DIA 8	QUARTA	DIA 9	QUINTA	DIA 10	SEXTA	DIA 11
CARGAS										
DESCARGAS										
SEMANA 16	SEGUNDA	DIA 14	TERÇA	DIA 15	QUARTA	DIA 16	QUINTA	DIA 17	SEXTA	DIA 18
CARGAS										
DESCARGAS										
SEMANA 17	SEGUNDA	DIA 21	TERÇA	DIA 22	QUARTA	DIA 23	QUINTA	DIA 24	SEXTA	DIA 25
CARGAS										
DESCARGAS										
SEMANA 18	SEGUNDA	DIA 28	TERÇA	DIA 29	QUARTA	DIA 30	QUINTA	DIA 31	SEXTA	DIA
CARGAS										
DESCARGAS										

b. Unloadings and Loadings Hourly Schedule

PLANEAMENTO HORÁRIO DE CARGAS E DESCARGAS

PLATAFORMA			SEMANA	37
Descarga	Carga			

DIA	CLIENTE	TAREFA	INICIO	FIM
SEGUNDA				
	A	Descarga	8:00	9:00
	B	Carga	9:00	10:00
	C	Descarga	9:00	10:00
	D	Descarga	12:00	13:00
	A	Descarga	11:00	12:00
	B	Descarga	11:00	12:00
	C	Carga	13:00	14:00
	D	Carga	14:00	15:00
	A	Carga	15:00	16:00
	B	Descarga	17:00	19:00
	C	Carga	16:00	17:00
	D	Descarga	8:00	10:00
TERÇA				
	A	Descarga	8:00	9:00
	B	Carga	9:00	10:00
	C	Descarga	9:00	10:00
	D	Descarga	10:00	12:00
	A	Carga	11:00	13:00
	B	Descarga	11:00	12:00
	C	Carga	13:00	16:00
	D	Descarga	14:00	15:00
	A	Carga	15:00	16:00
	B	Descarga	10:00	11:00
	C	Carga	9:00	10:00
	D	Carga	18:00	19:00

