Framework to evaluate and improve E-commerce Efficiency in a Logistics Warehouse

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"The biggest room in the world is the room for improvement."

Helmut Schmidt

Guia de procedimentos para avaliar e melhorar a Eficiência do Comércio Eletrónico num Armazém Logístico

Resumo

A importância da gestão da cadeia de abastecimento como fator decisivo para aumentar a vantagem competiva entre organizações tem vindo a aumentar. No entanto, coordenar os fluxos de materiais e informações que representam o foco da logística dentro da gestão da cadeia de abastecimento é uma tarefa complicada. Este desafio tem surgido nos últimos anos como resultado de novas tendências nos hábitos de compra dos consumidores.

O negócio on-line tem vindo a alterar o desempenho das instalações de logística, exigindo flexibilidade para se adaptar à crescente procura dos clientes e aumentando a complexidade da operação. Desta forma, o presente estudo aborda o desenvolvimento de uma estrutura de procedimentos conceptual para avaliar e melhorar o desempenho de um processo de comércio eletrónico de um armazém logístico.

O guia de procedimentos desenvolvido apresenta cinco etapas sequenciais principais: 1) a construção do modelo do estado atual, 2) oportunidades de melhoria, 3) desenho do modelo idealizado, 4) implementação e 5) monitorização e controlo. O foco desta metodologia está no primeira etapa, já que a análise do processo atual da operação influencia fortemente a capacidade de melhorar um fluxo operacional. A implementação desta metodologia foi realizada no ambiente empresarial da HUUB, uma *start-up* de logística, fornecendo um caso de estudo real para análise. Para isso, o guia de procedimentos deve ser adaptado às características operacionais da empresa.

Em relação à atual condição de fluxo de comércio eletrónico, 43% do tempo de trabalho está ocioso, representando 37% do custo da receita por encomenda, o que significa que o processo de comércio eletrônico se encontra sobredimensionado. Além disso, apresenta 35% de eficiência, que mede a parcela de tempo de valor acrescentado no processo. A análise dos incidentes operacionais mostra que 80% dos tipos de erros geralmente resultam em envios extras, como reenvios e devoluções, que contribuem para o custo extra que a empresa acarreta. Após a compilação de todas as oportunidades de melhoria com o respectivo impacto que teriam no processo de correio eletrónico e no desenho do modelo idealizado, foi realizada a prioritização dos processos para encontrar os mais críticos. Eles são a inserção manual de encomendas, o processo de documentação, no qual as cartas de portesão criadas, e o embalamento.

Para a inserção manual de encomendas e os processos de tratamento de documentos, as oportunidades de melhoria envolvem desenvolvimentos tecnológicos no Spoke, portanto, a sua implementação está atualmente dependente da agenda da equipa de Tecnologia de Informação para trabalhos futuros. Assim, apenas os resultados estimados podem ser apresentados, que se centram num aumento da eficiência em 14,9% e diminuição da ocorrência de erros em 7%. Em relação ao processo de embalamento, foi estabelecida a normalização dos procedimentos, além de uma reorganização da área de trabalho do comércio eletrónico, facilitada pela introdução da metodologia 5S.

Com foco nos erros operacionais, foi desenvolvida uma plataforma e um ficheiro de registo para gerir os incidentes e armazenar as suas informações, apresentando vantagens como a visibilidade do estado de cada encomenda ao longo do tempo e a centralização de todos os incidentes num arquivo. Além disso, a possibilidade de quantificar o impacto de cada incidente é relevante para a empresa, uma vez que, antes deste estudo, não havia visibilidade sobre o assunto.

Apesar de não ser possível medir os resultados das melhorias, neste caso específico, devido à implementação ainda em curso, o guia de procedimentos permitiu entender as principais deficiências do processo de comércio eletrónico que se revelaram úteis no fornecimento de diretrizes para projetar e implementar oportunidades de melhoria.

Abstract

Supply chain management (SCM) has increasingly become an important way to enhance competitive advantage amongst organizations. However, coordinating the material and information flows that represent the logistics focus within the SCM is a complicated task. This challenge has been arising in the past few years as a result of new trends in consumer shopping habits.

The online business has been changing the way logistics facilities perform, requiring flexibility to adapt to the increasing customer demand and adding complexity to the operation. Therefore, the present study addresses the development of a conceptual framework to assess the e-commerce process of a logistics warehouse and improve its performance.

The framework developed presents five main sequential steps: 1) the AS-IS model construction, 2) improvement opportunities, 3) TO-BE model design, 4) implementation and 5) monitor and control. The focus of this methodology is on the first stage since the analysis of the current operation process highly influences the ability to improve an operational flow. The implementation of this methodology was conducted in the business environment of HUUB, a logistics start-up, providing a real case study for analysis. For that, the framework must be adapted to the operational characteristics of the company.

Regarding the current e-commerce flow condition, 43% of the working time is idled, representing 37% of the cost to revenue per sales order (SO), meaning that the e-commerce process is oversized. Additionally, it presents 35% of efficiency, which measures the portion of value-added time in the process. The analysis of the operational incidents shows that 80% of the types of error usually result in extra shipments such as resends and returns that contribute for the extra cost the company has to pay. After the compilation of all the improvement opportunities with the respective impact they would have in the e-commerce process and the TO-BE model design, a prioritization of the processes was conducted in order to find out the most critical ones. They are the manual insertion of SOs, the documentation process in which labels are created, and the packaging.

For the manual insertion of SOs and the documents handling processes, the improvement opportunities involve technological developments in Spoke, so their implementation is currently dependent on the Information Technology (IT) pipeline for future work. Hence, only the estimated results can be presented, which would increase efficiency in 14.9% and decrease the error occurrence in 7%. Concerning the packaging process, the standardization of the procedures was stablished alongside with a reorganization of the e-commerce work area, eased by the introduction of the 5S methodology.

Focusing on the operational errors, it was developed a platform and record file to manage the incidents and store their information presents advantages such as the visibility on the status of each order over time and the centralization of all the incidents in one record file. Furthermore, the possibility to quantify each incident's impact is relevant for the company, since, before this study, there was no visibility on this subject.

Despite not being able to measure the improvements results, in this particular case, due to the still ongoing implementation, the framework allowed to understand the main disabilities of the e-commerce process and revealed to be useful in providing guidelines for designing and implementing improvement opportunities.

Acknowledgements

This dissertation is a result of these seventeen years of education, particularly to the past five years of university studies. For that reason, I would like to thank to all the professors at FEUP that somehow influenced my passage through this course and provided me the knowledge that made me capable to write this dissertation. A special thank to my supervisor, Samual Moniz, for being always available to answer my questions and providing me guidance on the elaboration of this study and for keeping a positive attitude towards all the obstacles encountered.

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This dissertation represents the end of a cycle that began almost five years ago, and, during that time, I met the most amazing group of people which I can proudly call my friends – my *pantagruelic* friends. A funny and dysfunctional group mainly characterized by people who mostly do not agree with each other about every possible subject and begin discussions from nothing. This is my melting pot and I would not trade it for anything.

Although it represents the culmination of an educational path, there are some pillars that have always been present in my life and allow the materialization of my goals. That way, I would like to thank to my family, in general, for the influence they have in myself and the feeling of happiness I have whenever I am with him. A special thank to Tá for always being there for me and taking me to go in adventures with her.

Finally, to my parents for allowing me to follow my course and continuously trusting in me. To my mum for all the (sometimes exagerated) care, for being interested in my life, even though I am not always so willing to share it. To my dad for being my personal *chofer* and for always being available when I am need. To my litle brother for just being my annoying and loved prince.

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Nomenclature

B2C	Business to Consumer
CT	Cycle Time
FTE	Full-time equivalent
NNVA	Necessary but non-value-adding activity
NT	Normal Time
NVA	Non-value-adding activity
OPL	One-Point-Lesson
PDCA cycle	Plan-Do-Check-Act cycle
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SLA	Service-level Agreement
SO	Sales order
VA	Value-adding activity
VSM	Value Stream Map
IT	Information Technology

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1 Introduction

Supply chain management (SCM) has increasingly become an important way to enhance competitive advantage amongst organizations. SCM and logistics essence is to provide the best possible service, meaning the right product at the right time and at the right place, in a cost-effective way. (Savelsbergh and Woensel 2016) However, managing the supply chain and the logistics within the supply chain, regarding the coordination of material and information flows, from its point of origin to its consumption, is a very complicated and challenging task. (Lambert *et al.* 1998) The intra and interdependencies that exist within the supply chain network accentuate its complexity and the ever-changing paradigm of logistics makes it imperative for service providers to be constantly adapting to survive and prosper in this dynamic environment. (Pentina and Hasty 2009) This challenge has been arising in the past few years as a result of new trends in consumer shopping habits. (Hübner *et al.* 2015)

Internationalization and mobility are trends that contribute for the consumers shift towards online business. (Foundation 2017) As a result, the e-commerce is emerging as the most potential sales channel and is changing retail structures as they are known. This change is impacting the supply chain structure due to the appearance of multi-channel networks. Both bricks-and-mortar and online businesses can be jointly managed in an integrated supply chain network (Hübner *et al.* 2015), which emphasizes the need for flexible warehouses to support the handling and management of two different sales channels. An operational efficiency is especially important in this case due to the difficulty on forecasting online sales as result of its high dynamics and the growth of e-commerce. Furthermore, the increasing price transparency provided by the internet is strengthening competition and cost pressure between firms, which intensifies the need for more efficient operations as well.

Taking into account the ever-changing trends in SCM and logistics and the e-commerce growth and impact on warehouse management, the present dissertation intends to address the challenges of SCM regarding the articulation of processes in a warehouse and record, management and assessment of logistic errors. More specifically, the goal is to standardize and improve the efficiency of the e-commerce flow in a logistics warehouse, sustaining the potential growth of e-commerce sales in the company, alongside with the centralization and assessment of the impact of operational incidents. For that, the current project was conducted in the business environment of HUUB, a start-up that works in the areas of logistics and supply chain management, using technology as the basis for the logistics operation.

1.1 Scope and motivation of the project

Supply chains are complex networks with dynamic relationships that demand a careful management since it is determinant for logistic service providers to succeed. SCM contemplates several areas of action, representing a crucial factor in gaining competitive advantage in the logistics environment, especially for newborns in the market. One of those fields is targeted to the warehousing of logistics service providers, focusing on improving the efficiency of operational processes and, consequently, enabling them to offer a more cost-

effective and higher quality service. This becomes especially important when processes are manual since human factors contribute to the variability within processes and considerable error rates that generate rework and a negative impact in the business. The impact of these mistakes can go from an extra cost for the logistics provider to a negative impact in its clients' reputation due to a bad service provided to the final consumer. That way, this study tries to tackle these issues by finding improvement opportunities that can mitigate the inefficiencies of manual labor.

Logistics enterprises can fulfill all the sales channel, from big retailers, small boutiques and marketplaces (wholesale) to e-commerce orders that directly reach the final costumer. The retail e-commerce business is steadily growing, presenting a share of total global retail sales of 11.9% in the current year and an estimated growth of 13.7% and 15.5% for 2019 and 2020, respectively (Statista 2018a). This growth is graphically represented in Figure 1 on the right and represents a total sales value worldwide on the left with $2.8 trillion in 2018, reaching to $3.4 in the following year and almost doubling that value to $4.1 trillion in 2020. (Caton; Statista 2018b)

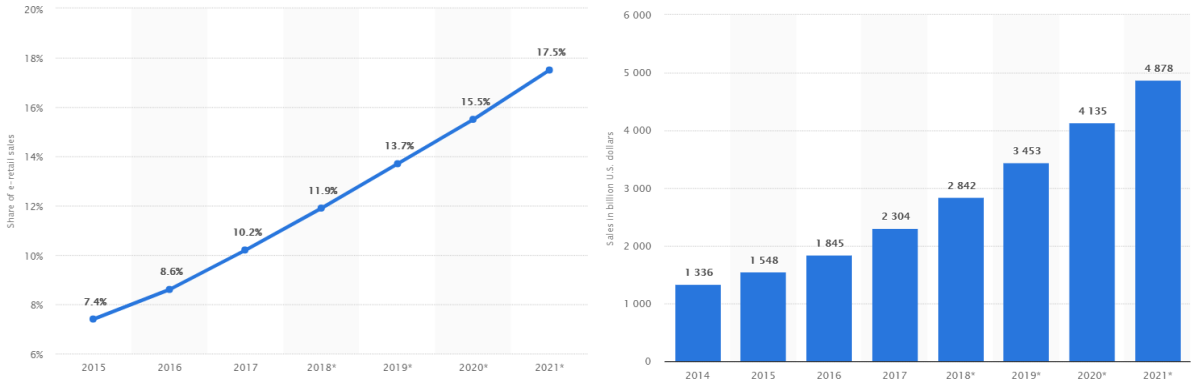


Figure 1 - E-commerce share of total global retail sales from 2015 to 2021 (on the right) and Retail e-commerce sales worldwide from 2014 to 2021 (in billion U.S. dollars) (on the left)

in (Statista 2018a) and (Statista 2018b), respectively

Additionally, the internet, e-commerce and urbanization are revolutionizing retail and, consequently, the type of warehouses people usually know. Nowadays, logistics facilities are progressively performing more and more functions of a store. (Caton) The enforcement of these retail activities emphasizes the complexity of the operation, which is increasingly challenging due to a continuous demand for superior service level.

Taking into account the operational context and the emergence of e-commerce as the sales channel with the most potential growth worldwide, the focus of this study concerns the elaboration of a methodology for the analysis and improvement of an e-commerce flow in a logistics warehouse. The purpose is to build a framework that allows to examine and evaluate each process individually and inside the macro flow, finding improvement opportunities to increase operational efficiency so that the potential increase of e-commerce sales can be sustained. Alongside, it is also intended to induce the cultural awareness of reporting the operational incidents among stakeholders, establishing a platform to manage their resolution and creating a data base in which all the necessary information for the incidents' assessment is compiled.

1.2 Objectives

This project addresses two main challenges regarding the management of warehouse e-commerce flow, which are the difficulty in costing the e-commerce operation and incidents,

and the incapacity to accommodate e-commerce growth within the logistics operation. For this reason, the focus is to develop a framework that would allow to improve the e-commerce flow of the logistics operation, which can be divided into two action areas: the operational management of the e-commerce flow and the control and record of e-commerce operational incidents.

Regarding the operational management of the e-commerce flow, this piece of research is intended to:

- provide better understanding and visibility of the e-commerce flow through the identification, description and mapping of the processes;
- quantify how much each process costs in terms of time and money for the company;
- suggest improvement opportunities and prioritize them according with the most critical processes;
- increase e-commerce warehouse efficiency by eliminating non-value-adding activities within the processes and reorganizing the e-commerce area;
- balance the e-commerce fulfillment process and standardize the product handling processes.

When it comes to the e-commerce incidents, the goals are:

- collect and conduct an analysis of the e-commerce operational incidents and assess their impact in the company;
- implement a platform to manage the resolution of incidents;
- create a record storage in order to compile all the necessary information for on-time analysis of incidents.

1.3 Methodology

To achieve the purposed objectives, the methodology was elaborated based on already studied subjects and relevant approaches for the current topic. That way, the knowledge found in the literature is aligned with the inherent particularities of an e-commerce flow, resulting in a specific sequence of steps and techniques adapted for the studied operational context – the e-commerce operation in a logistics warehouse. The starting point of this framework represents understanding the current functioning of the e-commerce flow and processes. For that, a study is conducted covering a detailed description, mapping and analysis of the processes. The AS-IS model is the result of that exercise and the basis for the subsequent analysis. The improvement opportunities that come from the model are identified and prioritized and the construction of the TO-BE model is conducted. Afterward, comes the implementation of the improvement initiatives and posterior monitorization to evaluate their impact in the e-commerce flow.

1.4 Dissertation Structure

The structure of this dissertation is divided in five chapters. The second chapter concerns a literature review of theoretical concepts related with the enterprise business and the state of the art of the fields of study involved in the development of this project. It is also presented the description of solutions currently applied in the industry.

The third chapter presents the methodological approach followed in this study to evaluate and improve the e-commerce flow in a logistics warehouse. It contemplates the five steps represented in **Error! Reference source not found.**, going from the stages that encompass t he AS-IS model creation, to the development of improvement opportunities that lead to the TO-BE model and its implementation, finishing with the monitoring and control mechanisms necessary to keep track of the processes evolution.

The fourth chapter, “Problem Context”, presents the operational context in which this work is conducted, introducing the organizational structure and the operational processes of the company.

Following the presentation of the case study, the fifth chapter, “Methodological Assessment”, exposes the application of the presented methodology in the chapter 3 to the company’s context, adapting the framework to consider the particularities inherent to the firm’s operation. The current state of the e-commerce flow is assessed, and improvement opportunities are presented to tackle the most critical processes in the warehouse.

Finally, the sixth chapter, “Conclusions and Future Work”, presents the final conclusions of this dissertation, the assessment on the accomplishment of the objectives proposed and the future work that can be implemented in the context of this work.

2 Literature Review

This chapter exposes a literature review of the main theoretical concepts related with the enterprise business and the state of the art of the fields of study involved in the development of this work. These topics are addressed in a sequential order where the former concept supports and gives information regarding the approach of the subsequent subject. The first concept regards the understanding of supply chain management (SCM), the broad field of study of this dissertation, narrowing down to the specific area in which the research focus on. After that, there is an introduction to continuous improvement culture and the main tools used during the dissertation. Finally, the main concepts regarding operations management related with this study are presented, as well as the possible tools that can be used for different approaches.

2.1 Supply Chain Management

A supply chain can be defined as an integrated network of business partners that collaborate with each other in three main fields: (i) the acquisition of raw materials, (ii) the conversion of these resources into final products, and (iii) the distribution of the finish goods to retailers or end-customers. It is the set of processes that produce and deliver value to the end consumer being that in the form of products or services. To achieve that, supply chains must be capable of working as a single entity, despite being complex flexible systems in which every intervenient wanders between uncertainty and control. (Beamon 1998; Harrison and Hoek 2008; LeMay *et al.* 2017)

A simple but realistic representation of a supply chain network structure can be seen in Figure 2. The focal firm is in the center of the network, in which are represented the key supply chain business processes, connecting the upstream and downstream agents, the corporate silos within the company, and the material and information flows. It is also present the possibility of several levels in both upstream and downstream ends. (Harrison and Hoek 2008; LeMay *et al.* 2017; Lambert *et al.* 1998)

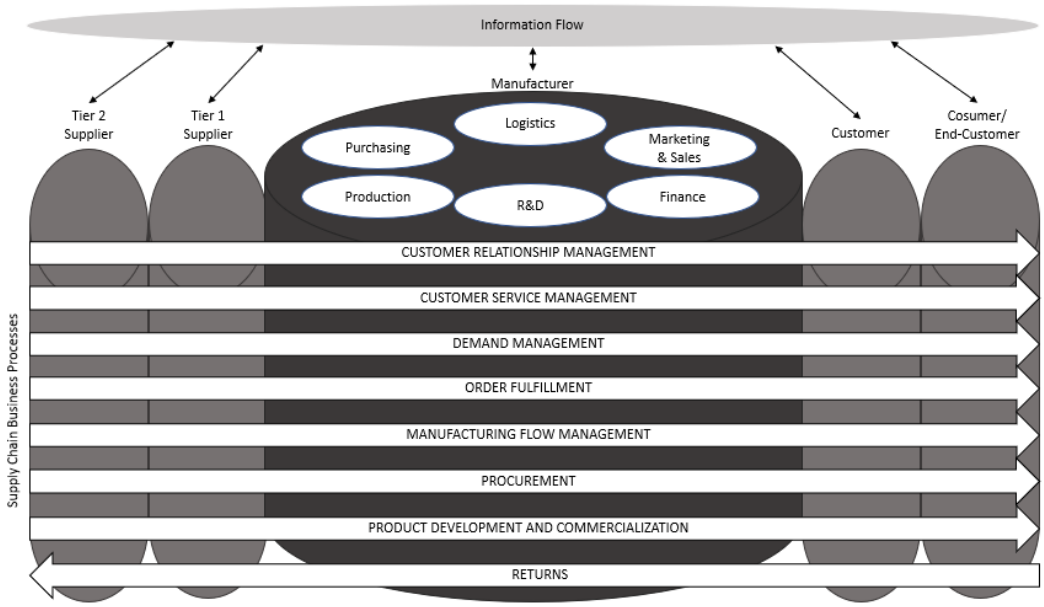


Figure 2 - Supply chain network structure

in (Lambert *et al.* 1998)

The capability of the supply chain to function as a unit is assured by the supply chain management (SCM). In Figure 2, SCM acts as the end to end management of the entire network, integrating all organizational units and coordinating material, information and financial flows. The main goal is to assure the fulfilment of customer demands by improving the supply chain competitiveness (Harrison and Hoek 2008; Meyr *et al.* 2002) Since focal firms are at the center of the supply chain, managing the relationships between the two sides of the network becomes crucial to achieve the best result for all the stakeholders involved and meet the performance objectives.

In addition to the already inherent complexity of a supply chain, the development and fast adoption of Internet technologies and the advances in mobile technology, as well, increased consumers interest in the online business. (Pentina and Hasty 2009) Factors such as internationalization and mobility also contribute for this shift. (Foundation 2017) These trends led to the growth of e-commerce worldwide, expecting to achieve a total sales value of $2.8 trillion in 2018 (Statista 2018b; Caton)and presenting a steady increase of the share of total retail sales over the next three years (Statista 2018a). The appearance and adoption of this sales channel amongst companies affected the supply chain structures as they are known due to the emergence of multi-channel networks. (Hübner *et al.* 2015) The challenge of competing in this dynamic and technological complex retail environment is emphasized by Pentina and Hasty (2009), especially for small retail businesses. Within the several areas involved in the supply chain management, logistics is one of the most important for the an efficient development of e-commerce. (Yang and Wu 2010)

2.1.1 Logistics

Logistics operates within the supply chain management and its main task is managing the material and information flow that concerns the operation of a company. Inbound logistics connects the focal firm and the upstream suppliers, while outbound logistics deals with the links between the focal firm and the downstream customers. (Harrison and Hoek 2008)

According to Rushton *et al.* (2010), logistics job is to deliver goods or services “at the right time, in the right place, at the right cost, at the right quality”. This definition embraces the

three hard objectives of logistics: time, cost and quality. The relationship between these three elements is present in Figure 3. (Harrison and Hoek 2008)

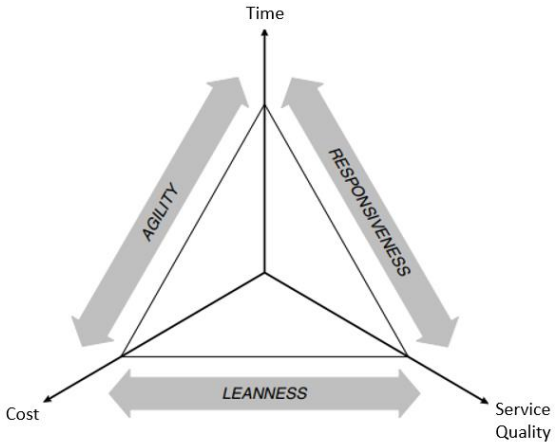


Figure 3 - Logistics Triangle.

adapted from (Guedes *et al.* 2010)

Quality not only sustains the other two objectives, but also it is the most evident component of supply chain efficiency. Low quality performance can negatively impact customer's loyalty and, consequently, affect an organization's business viability. To fight that, enterprises must invest in robust processes to eliminate and prevent errors and increase service or goods quality performance. The time element represents how long a customer must wait so that his order is fulfilled. In an ever-accelerating world, the speed or responsiveness of a supply chain becomes a crucial success factor. Finally, a cost-effective structure can leverage a firm in the marketplace by enabling a lower price for the product/service or higher margin. Partnerships throughout the supply chain are usually the way to achieve that positioning. (Harrison and Hoek 2008)

The recognition of the importance and impact logistics management can have in accomplishing a competitive advantage is recent. (Christopher 2011) Additionally, the emergence of e-commerce as a new business economy increased the challenge of logistics service performance and the achievement of the three logistic hard objectives, hindering the survival of small retailers in the market. (Yang and Wu 2010; Pentina and Hasty 2009) In order to enter and prevail in the e-commerce business, there are three types of e-commerce logistics models retailers can follow: the self-logistics model, the third-party logistics model, and the logistics alliance model. In the first model, as the name says, the company itself arranges, operates and manages its own logistics and distribution systems. Despite providing a higher control over the supply chain and its stability, this model requires a bigger staff and inhibits the ability to improve customer service. The second model allows the company to be focused on its core business, by outsourcing the logistics activities to a logistics service provider (LSP), a specialized logistics service. Additionally, this model lowers operating costs for the company and eases the improvement of customer service. Finally, the third model is a mix between the first two models by a "win-win" long-term collaboration, in which two or more entities cooperate towards the achievement of a common goal. Although it lowers down the risk of the previous two models, it is difficult to choose the right logistics partner to build the alliance. (Yang and Wu 2010)

The role of logistic service providers (LSPs) in the enhancement of competitive advantage of the supply chain makes it an interesting choice to develop the e-commerce business. (Yang and Wu 2010) Also known as Third Party Logistics Service Providers (3PLs), LSPs act as an intermediary within the supply chain by carrying out logistic activities for one or more enterprises. The fields of action can go from warehousing, inventory and transportation to

logistics management and customer service (Krauth *et al.* 2005) According to Harrison and Hoek (2008), the LSPs who can develop and sustain the highest standards of service quality have advantage towards the ones who cannot.

The challenges associated with an omni-channel structure arise the need for an efficient, speedy and low-cost operation. (Pentina and Hasty 2009) The jointly management of both bricks-and-mortar and online business in an integrated supply chain network requires an increased flexibility in warehouse operation. Furthermore, the uncertainty related with the online sales and its forecast, and the increasing price transparency provided by internet intensifies competition and cost pressure between companies, emphasizing the need for efficient operations. (Hübner *et al.* 2015)

2.2 Continuous Improvement

Continuous improvement (CI) is a culture of sustained improvement that focuses on identifying opportunities to streamline work and eliminate waste in all processes of a company. This philosophy is based on the involvement of all people, every day, in every area of the organization, without incurring in large capital investments. The main goal is to reduce overall costs and increase the quality and service level that is offered, emphasizing the role of stakeholders in this search. These results can be achieved through the implementation of incremental improvements in an evolutionary way or by a new technology or innovation resulting in drastic changes. (Bhuiyan and Baghel 2005)

There is an intrinsic connection between CI and the lean concept. Lean thinking has its origins in Japanese manufacturers, more precisely at Toyota Motor Corporation installations, as a waste elimination approach. This concept involves some principles such as the identification of customer value, management of the value stream, develop the ability to flow production and the quest for perfection through decreasing to zero all types of waste, meaning any human activity which absorbs resources but creates no value (Hines *et al.* 2004; Womack and Jones 2003) There are several types of waste that can occur inside the processes, namely the waste of overproduction, inventory, defects, motion, processing, waiting and transport. Of all the *Muda*[1], producing more than what is necessary is the worst one because it gives workers a false sense of security. (Imai 2012; Jacobs and Chase 2011)

Despite being critical for companies to achieve competitive advantage, CI success is not always assured. According to Lodgaard *et al.* (2016), two out of three CI initiatives fail by not meeting the desired results. The causes for this failure can come from badly designed CI systems, mislead use of tools and methods or organizational and managerial barriers. That way, it is important to select the most adequate CI methods according to the enterprise needs and to make sure they are supported by training and monitoring initiatives, and the organizational culture of the organization.

Throughout the time, the CI approach has evolved from its manufacturing roots as a method to increase quality to a management principle involving the whole enterprise that consists of a set of sophisticated tools and techniques committed to find the source of problems, waste and deviation, and ways to mitigate them. (Bhuiyan and Baghel 2005; Schmidt *et al.* 2014) This evolution allowed companies to establish better operational and strategic objectives towards waste reductions, aligned with a more effective management of resources. (Shah and Naghi Ganji 2017) Within the several tools, an explanation of the ones addressed in this study is going to be conducted.

[1] Japanese word for waste

2.2.1 PDCA cycle

The PDCA (Plan-Do-Check-Act) cycle is one of the most well-known and crucial methods to implement and support a CI approach. This four-step model is suitable for any type and at any level of an organization, being explained in Table 1. (Schmidt *et al.* 2014)

Table 1 - PDCA cycle explanation

Step	Meaning
Plan	The planning stage involves problem analysis and solution development, alongside with the preparation of the plan for the improvement action to take place by the team.
Do	The realization of the best solution and execution of the predefined plan of action.
Check	Validation step where the outcome of the improvement action is compared to the expected results, gathering relevant information.
Act	Based on the information and feedback collected, the acting step refers to analyzing and interpreting the differences encountered and conduct a plan for their elimination or the design of a new solution.

adapted from (Schmidt *et al.* 2014; Zhang *et al.* 2012)

According to Schmidt *et al.* (2014), the principles that determine and support the PDCA cycle demonstrate not only an iterative, but also a recursive approach to CI. The success underlying the implementation of this framework is related to the continuous control and analysis of the consequences that come from the designed action plan and implementation outcomes, taking corrective actions if necessary. For that, the PDCA cycle should be continuously repeated, ensuring a gradual learning experience by the organization and the ability to improve on the required areas so that the desired results can be achieved. Additionally, the full improvement potential can be achieved by the occurrence of PDCA cycles within cycles, which allows access to more extensive knowledge of the process under study. This usually happens in the "Do" stage, as it can be seen in Figure 4, having the designation of advanced PDCA cycle.

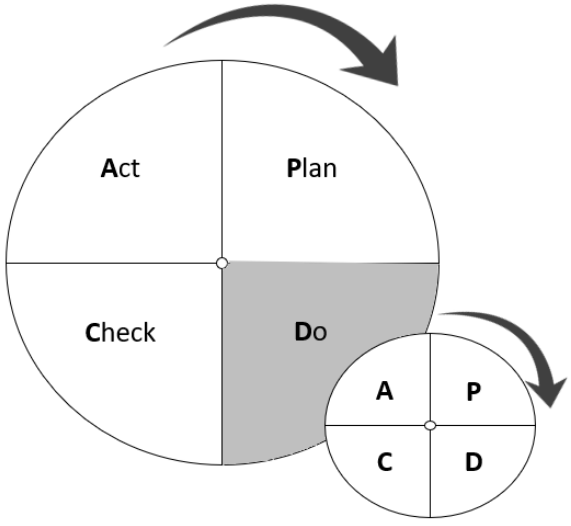


Figure 4 - Advanced PDCA cycle.

in (Sokovic *et al.* 2010)

Zhang *et al.* (2012) adds that the PDCA cycle does not rotate at the same level. When starting a cycle, the goal is to reach a new quality level by achieving the planned objectives. That way, after each cycle is completed, the purpose is to the climb the CI ramp with the emergence of new targets and requirements to be accomplished.

2.2.2 5S

According to Jaca *et al.* (2014), the 5S methodology is one of the best tools to stimulate a change in workers attitude towards the importance of implementing and maintaining improvement initiatives within the workplace. It can be interpreted as a strategy approach towards organizational development and knowledge, aiming towards improvements in efficiency and working conditions or a basic removal tool that acts as a prerequisite for the implementation of other improvement actions. The name of this CI tool comes from five Japanese words starting with S, as well as their English equivalents. Each word represents a step to follow in a sequential plan in order to achieve a clean and organized workstation, explained in Table 2.

Table 2. 5S meaning

	5S (in Japanese)	5S (in English)	Meaning
1.	Seiri	Sort	It represents the use of resources and aims to define and separate what is necessary from what is unnecessary and leads to entropy in the workplace.
2.	Seiton	Set in order	Refers to the sense of organization or neatness, which stimulates to place everything that is necessary in predefined locations. The premise of this step is to place every tool in its proper place.
3.	Seiso	Shine	The sense of cleanliness. In this step, the focus is towards cleaning and maintaining the workplace as clean as possible. With this, it is also possible to identify issues or damages throughout the work area, allowing their restoration.
4.	Seiketsu	Standardize	After removing what is disposable, organizing and cleaning, it is necessary to create rules and norms that sustain the previously established culture and organization is kept. This is also called the normalization phase.
5.	Shitsuke	Sustain	Finally, it comes to the sense of discipline. This step consists on the knowledge and application of the already elaborated norms and performing audits to certify their follow-up.

in (Randhawa and Ahuja 2017b)

The 5S concept comes from the Japanese culture, which is based on the values of cooperation, respect, trust and harmony. These principles contribute for a quicker and smoother assimilation of 5S into operational practices and are the foundation for the development of a Lean culture in the organization. They also ease workers' participation and commitment to improvement activities, which are important components for their long-term sustainability. Additionally, for Japanese companies, employees are a valuable asset whose inputs should be encouraged and implemented, since their well-being directly influences the enterprise's performance (Jaca *et al.* 2014)

Randhawa and Ahuja (2017a) made a survey on the most common barriers that hinder the successful implementation of 5S initiatives. They can be summarized in four main challenges which are the non-commitment of employees, lack of leadership, bad communication and the resistance to change. The enterprise's culture can be responsible for the failure of the 5S program by not instilling employees' empowerment at the workplace, inhibiting their involvement in CI activities and undermining Lean culture. Alongside, the lack of top management support and commitment towards 5S initiatives leads to low motivation of employees and the inability to convince them about the importance of following the CI methodology. The unclear purpose of 5S methods and the inability to communicate them can also damage their implementation and long-term sustainability.

The same study was conducted regarding the success factors that sustain the implementation and progress of 5S programs and overcome the issues presented. The survey revealed that the most crucial success factor for the 5S implementation in an enterprise is the support and involvement from the top management. The existence of a support system that encourages and provides resources for employees' training and formation, and the establishment of a working atmosphere of open and honest communication between the several departments and teams becomes crucial for the 5S development. In order to improve that exchange of information, it is important to create detailed and understandable 5S instructions to guide all employees in its way of functioning and clearly present its purpose. (Randhawa and Ahuja 2017a; Gapp *et al.* 2008) This comes along with one of the two main pillars that Jaca *et al.* (2014) found being fundamental for the successful implementation and sustainability of 5S method, which is the consistency in the message that is transmitted from top management to shop floor operators. The other rule regards the capacity to wait for results and is related to the CI approach of implementing 5S with small incremental changes that help in the adaptation process of the employees. Another aspect is related to efforts that must be conducted to induce the importance of keeping workers' dedication towards a sleek, organized and secure workplace, and, consequently, maintaining the 5S culture. Finally, 5S audits and an effective feedback system should be implemented in order to assess the status and progress of the program, conducting changes if necessary. (Randhawa and Ahuja 2017b, 2017a)

A research conducted by Randhawa and Ahuja (2017b) in 92 different Indian manufacturing industries revealed that the implementation and commitment towards the 5S methodology led to a positive impact in seven important outcomes related with the overall organization goals, and in the areas of quality and continuous improvement, production, cost optimization, workspace utilization and safety, not disregarding employee-related achievements. This not only proves the success of 5S approach, but also that Lean principles are not bound to Japanese culture; they can be developed in organizations with other cultural contexts. (Jaca *et al.* 2014)

2.2.3 Standardization

Standardization can be defined as the process of implementing a set of actions and measures that all members of the organization must follow so that processes are performed within the specific guidelines, thereby leading to the unification of processes and solutions. This never-ending process is one of the bases for CI, also acting a good practices maintenance tool. (MÍkva *et al.* 2016)

The main goal of standardization is to enable the proper execution of a process at the first time without incurring in errors or negative impact for workers welfare. The correct implementation of standards prevents defects, rework and the associated avoidable costs (whether financial or time), acting as a prevention measure to errors that can heavily impact the organization. Other benefits come from the documentation of all processes, reductions in

variability, easier training of new workers and the increase of discipline to the culture. (MÍkva *et al.* 2016; Košturiak and Frolík 2006)

In order to successfully implement standards, they should be concise, clear and visually understandable, so that employees can quickly find and perceive the instructions. An effective work standardization ensures that teams perform their tasks effectively, thereby the results are expected to be also consistent. Moreover, their implementation must be monitored and the assessment of their impact on the process parameters must be conducted. (MÍkva *et al.* 2016; Imai 2012)

According to Imai (2012), before focusing on the improvement stage, the process should be firstly stabilized with the creation of standards by means of a SDCA (Standardize-Do-Check-Act) cycle. For this reason, the SDCA cycle must be deployed before initiating the PDCA one since, once the standard is established, it becomes the starting point for the implementation of improvements. The interrelation between these two cycles can be demonstrated in Figure 5.

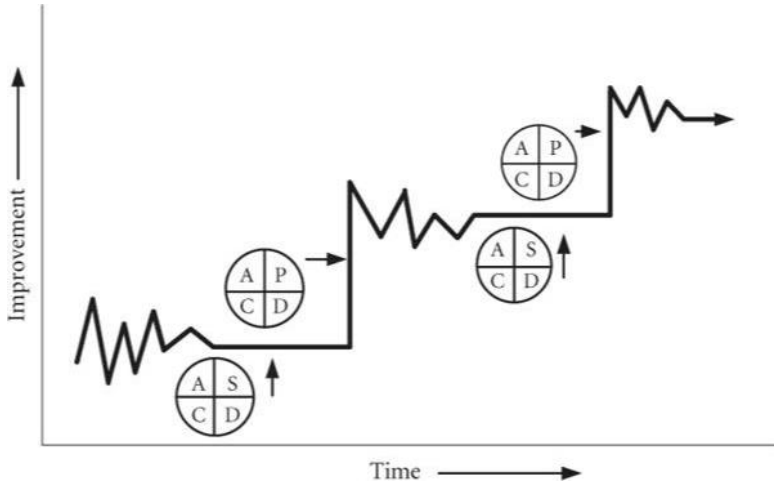


Figure 5 - Relation between the SDCA and PDCA cycles

in (Imai 2012)

2.3 Process Design

"Facing the truth about the flow or lack of it in the supply chain is the first step in starting a change process. It is the first part of supply-chain design (SCD)" (Coimbra 2013)

An organization is only as efficient as its processes. (Hunt 1996) As Coimbra (2013) suggests, the improvement of supply chain and processes performance depends on their current design, meaning the structure and configuration in which they are based on, in addition to the equipment and implementation needs. An effective process design means one step closer towards the achievement of operations performance objectives, by improving quality (error-free processing), speed (minimizing throughput time), flexibility (providing resources with an extent of abilities) and decreasing costs (eliminating process wastes). (Slack *et al.* 2007)

Process design is usually done using a visual approach like process mapping, which involves the description of the processes in terms of how the activities within the process relate to each other. (Slack *et al.* 2007) Process mapping acts as a management tool to identify the current AS-IS business processes and improve its performance by providing a holistic approach to the operational context and a better documentation of the processes. Furthermore, it brings visibility on the sequence of activities within the process, allows improvements by removal of duplicated activities, inspections, and movement of work, and contributes to simplify the processes by combining related activities, conducting processes in parallel and outsourcing inefficient activities. (Hunt 1996; Jacka and Keller 2009)

Although there are several techniques that can be used for process mapping, they all identify the types of activity that compose the process and the material and information flow through it. Those activities and flows are usually identified by the symbols presented in Figure 6. (Slack *et al.* 2007) The power of a standard notation reflects on the communication capability it provides to the tools used in process mapping. (Aguilar-Savén 2004)

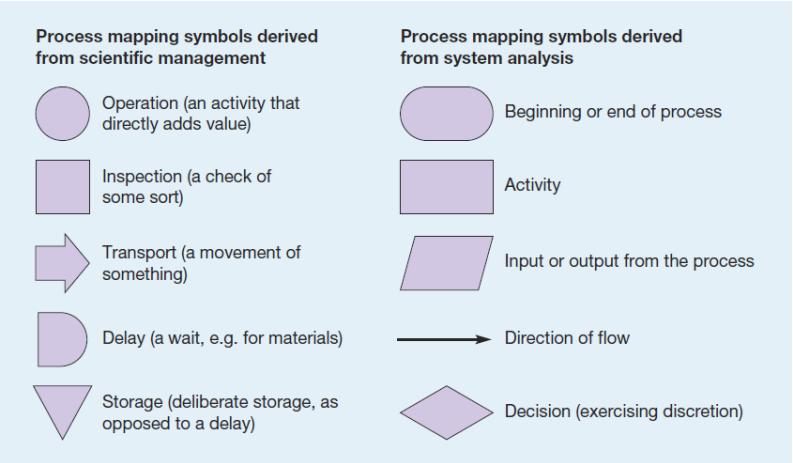


Figure 6 - Process mapping symbols

in (Slack *et al.* 2007)

The degree of discretion desired in a process analysis influences the level of aggregation in the process mapping: a broader view on the process is often described by a high-level process mapping, whereas a lower and more detailed level, where the sequence of activities is presented, is called outline process map. The degree of detail in a process mapping can be adjusted to each situation. (Slack *et al.* 2007)

2.3.1 Flowchart

Flowchart is probably the first process notation, being defined as a graphic representation of an algorithm, workflow or process, in logic sequence, considering the concurrent performance of several activities. (Jacobs and Chase 2011) It is one of the most used process mapping tools due to its understandable representation and ease of use. The standard notation it uses, represented in Figure 6, makes it easy to identify and understand the activities it describes. (Aguilar-Savén 2004)

According to Aguilar-Savén (2004), the main attribute of the flowchart technique is also its main weakness: flexibility. Despite allowing to describe a process in several different ways and a short period of time, the line that limits the process may not be well-defined. Additionally, flowcharts tend to be very large and do not distinguish main and sub-activities within the process. The absence of sub-layers makes it harder to follow the sequence of the flow and find information in the chart. However, it is still a goof visualization method to identify bottlenecks or inefficiencies where the process can be streamlined.

Regarding the level of detail desired, the flowchart works better for processes that need a high level of detail. Furthermore, flowcharts do not portray the entities responsible for each step of the process in the chart, hindering the relation between organizational functions or departments to activities. (Aguilar-Savén 2004)

2.3.2 Cross-functional Map

Cross-functional map, or swim lane, as it is commonly known, is a diagram that not only describes the sequence of the activities that compose that process, but also presents process

ownerships, which are not contemplated in the flowchart tool. This visual workflow model illustrates *what* is the activity, *who* is the entity responsible for that task and when it is executed in the progression of the process. (Sharp and McDermott 2008; Jeyaraj and Sauter 2014)

In contrast to flowcharts, cross-functional maps can be used to display a process at any level, from a broader perspective, representing only the points of involvement by the participants in the process (designated as actors), down to a low-level where each individual task is presented. (Sharp and McDermott 2008)

The defining characteristic of this type of diagrams is that each actor involved in the process is shown in an individual swim lane, which also contains all the activities conducted by that actor. This becomes important in business process modeling since business processes usually involve actors from several departments within the organization. The sequence and time dependency (time) of the flow is represented from left to right, with simple symbols (the standard ones), and showing every actor that holds the work, as it is represented in Figure 7. (Jeyaraj and Sauter 2014)

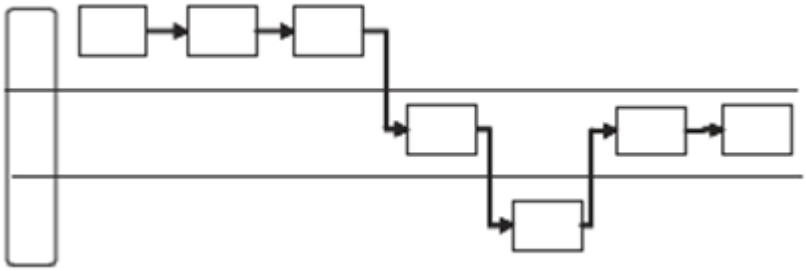


Figure 7 - Representation of a swim lane diagram

adapted from (Sharp and McDermott 2008)

2.3.3 Value Stream Map

The value stream concept differs from the supply or value chain one by only considering the segments of the companies that actually add value to the product or service in consideration, whereas the supply chain englobes all the activities involved in the process. For this reason, the value stream is more focused to the value-adding process. That way, value stream mapping (VSM) is described as a tool for identifying wastes in an individual value stream and provide an adequate path towards waste removal. (Hines and Rich 1997; Shou *et al.* 2017)

Despite the difficulty in understanding and improving the current condition of complex systems, according to Toivonen and Siitonen (2016), the VSM has been successfully applied in several domains. It has been used as a lean method to explore wastes, inefficiencies and non-value-added activities in product development process and as an efficient management system to improve performance of designing supply chains. (Shou *et al.* 2017)

The VSM application in the service sector, such as the one provided by logistics service providers, focus on eliminating incorrect procedures, delays, errors and improving customer loyalty. From the research conducted by Shou *et al.* (2017), the benefits that arise from that deployment are related to the improvement of value-added ratio and work efficiency. Despite the positive changes VSM can trigger when analyzing a supply chain or process, there are some limitations that can affect its value. On one hand, the lack of single and consistent definition of value and waste, two core concepts associated with the construction of a VSM.

On the other hand, VSM should focus on what types of lean metrics should be implemented taking into account the value stream itself and the flow attributes.

2.4 Work Measurement

Work measurement is concerned with the determination of the amount of time required to perform a specific job at a defined level of performance. Time estimates are one of the steps to fully characterize a process and assess its need for improvement. Besides that, it reveals to be important in the planning and management side of the warehouse by affecting its operational capacity and scheduling and being a way of evaluating the warehouse performance and all its stakeholders. (Chase *et al.* 2005; Jacobs and Chase 2011)

There are several methods to measure processes and evaluate workers' performance when conducting them. The direct methods consist on time study and work sampling; the indirect ones are predetermined motion-time data systems (PTMS) and elemental data. The explanation of each one of these methods and the context in which they must be applied are explained in Table 3. (Chase *et al.* 2005; Jacobs and Chase 2011)

Table 3 - Explanation of both direct and indirect work measurement methods

Method	Explanation	When to use
Time study	Time the work using a stopwatch.	For highly detailed, repetitive work.
Work sampling	Record random observations of a person or teams at work.	For infrequent work or that entails a long cycle time.
Predetermined motion-time data systems (PTMS)	Divide the manual work into small basic elements that have established times, and then add the time factors for each element to estimate the task time.	For highly detailed, repetitive work with predefined times for each element based on a large sample of workers.
Elemental data	Sum times from a database of similar combinations of movements to arrive at work time.	When work is done recurring to fixed-processing-time equipment to decrease the need for direct observation.

in (Chase *et al.* 2005; Jacobs and Chase 2011)

There are several techniques for conducting time study on-spot. The path process chart is one of them, which studies both the course taken by the worker, as well as the process of work. It consists of a chart in which each task is recorded by the analyst, enabling to breakdown and fully characterize the process' elements. Each activity is timed and identified as operation, transport delay and storage (establishing the link with process mapping symbology), tracing a continuous line which represents the movement of the worker through the process. (Magu *et al.* 2015)

2.5 Performance measurement

Performance can be defined as the process of quantifying action, where measurement relates to the process of quantification and the action leads to performance. (Jothimani and Sarmah 2014) The assessment of process performance reveals to be fundamental when trying to improve an operational flow or process. Not only it provides metrics to evaluate the efficiency and effectiveness of processes and understand if the results meet the organization's expectations, but also allows to prioritize the processes in which improvement efforts should focus on. (Borsos *et al.* 2016; Jacobs and Chase 2011; Jothimani and Sarmah 2014)

There are several metrics used to evaluate a process, namely (Jacobs and Chase 2011; Slack *et al.* 2007):

- Utilization, which represents the ratio of time that a resource is actually bring used relative to the available time for use;
- Productivity, which stands for the ratio of output to input. This can be measured in monetary units by using the output as the sales value and the input as the production cost, known as total factor productivity, or regarding an individual input, such as labor, in the so called partial factor productivity;
- Efficiency, which is the ratio between the actual output of a process relative to a standard value;
- Throughput rate, representing the output rate that the process is expected to produce over a period of time. This metric is the inverse of the cycle time.

According to Borsos *et al.* (2016), the output performance of a process is a multivariable function which depends on the quality of the products, the amount produced, the cost of production and the productivity. The KPIs (Key Performance Indicators) developed to assess a process are based on those variables and must support the strategy of the organization, facilitate comparisons between the enterprise's process and other organizations in the same sector, and reflect the organization's capability to growth and change, while meeting the desired results. (Chorfi *et al.* 2015) Additionally, KPIs must be SMART, meaning:

- Simple: easy to understand;
- Measurable: able to be measure and have meaning;
- Attainable: achievable;
- Realistic: adapted to the organization's reality;
- Time-related: time oriented, the results can be achieved during a specific period of time.

The SMART criteria is one of the best ways to evaluate the relevance of KPIs. (Chorfi *et al.* 2015)

After quantifying the performance variables, it is important to distinguish what is more important so that improvement measures can be focused on those processes. The Pareto diagram, also referred to as the 80/20 rule, is based on the phenomenon of few causes explaining most of effects. It is a straightforward technique which orders the types or causes of incidents into their order of importance, usually measure by frequency of occurrence. (Slack *et al.* 2007)

After measuring and analyzing KPIs to understand which the processes with more opportunities to improve are, there is a need to monitor the results of those improvements or just the usual process status throughout the time. For that, statistical process control (SPC) can be implemented so that it can be analyzed if the process is operating according with the specified parameters or not. It is also a mechanism to distinguish and reduce both common and assignable causes of variation in the process (Slack *et al.* 2007)

3 Methodological approach

This chapter presents a conceptual framework to evaluate the flow of process in a logistics warehouse. The presented methodology can be applied to all types of operational processes and even to non-operational ones. The first step is related with the construction of the AS-IS model, the basis for study and posterior analysis. Afterwards, a set of improvement opportunities can arise, and a TO-BE model can be constructed from those changes. The implementation stage follows the prioritization of the improvement opportunities according to the AS-IS analysis, meaning that the most critical processes are the ones that must be implemented first. Finally, the monitorization of the implemented changes must be conducted in order to assure the expected results are being achieved. The followed methodology can be visualized in Figure 8.

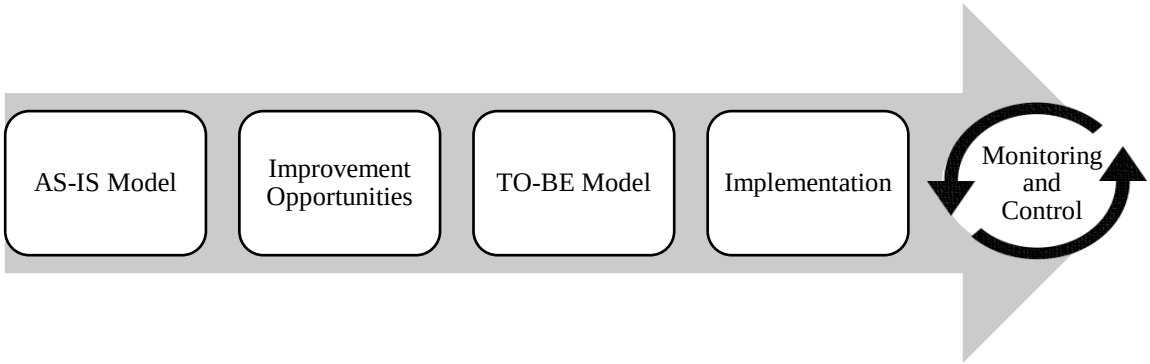


Figure 8 - Methodology approach

3.1 Step 1: AS-IS Model

The ability to improve an operational flow is highly influenced by the construction and analysis of the current state of the operation. As Goldratt (1990) stated, “an hour lost at a non-bottleneck stage is a mirage”, so there is no use in improving a non-bottleneck process since the flow will continue to be limited by the existing bottleneck. This citation emphasizes the need and importance of a diagnosis analysis to the stream so that efforts can be targeted towards mitigating the most critical processes, such as bottlenecks situations. Therefore, the first step of this framework is the construction of the AS-IS model, which is the foundation for improvement opportunities.

For that, methods and tools from process mapping, work measurement and performance measurement are implemented, following a sequence of steps that is going to be presented. The following sequence is adapted from Harrison and Hoek (2008) and Jacka and Keller (2009) approaches of process mapping, including the performance metrics.

Stage 1: Process Identification

The first step towards improvement is to identify the process in which to focus on. Although it seems to be a rather simple and easy step, it can be tricky for companies that are not process-oriented. The diffusion of responsibilities of parts of a process between several functions or departments within an organization hinders the process identification process by complicating the task of finding the relevant parts that create the entire process.

Besides recognizing all the parts that constitute the process for further analysis, the trigger that starts the process must be also identified. Although the input and the trigger of a process can be the same, it is still essential to make sure that the trigger is determined since it is usually the first point in which the customer is involved in the process.

After identifying the key trigger events, it is time to look at the major processes which those events start and name them. It is important to define all the beginning and ending events and describe the interrelationship of processes so that the overall boundary for each process can be delimited. Meetings with people that represent a good cross-section of the business must be conducted in order to achieve this knowledge.

Stage 2: Gathering Information

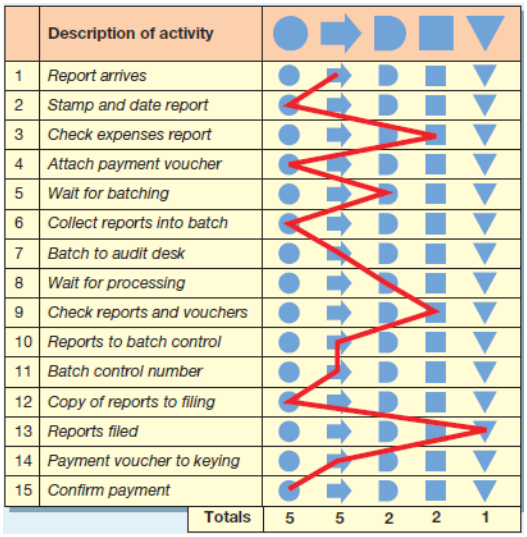
After identifying the core processes of the context of the analysis, it is necessary to gather or collect information about the processes in order to learn about them. Beyond that, before starting to put together a process map, a clear and exhaustive understanding of the process must be achieved. Both gathering and collecting information actions start from the first moment the process is being analyzed and carries on throughout the development of the next stage – process mapping. Within this phase of the framework, there are three main points that must be addressed, which are explained thereafter.

1. Process Description

Each identified process or activity that makes up the core process in analysis must be described. Depending on the depth of the desired analysis, this description can be a definition of each process, a summary of what the main activities that compose each process, or a more detailed description, in which actions and small elements of the process are characterized. However, in the three cases, each definition must include enough information to determine where the process begins, where it ends and what are the major actions that occur in it.

For a broader description of a process, a simple two-column table with the process name and process definition can be assembled. The second approach involves the division of the process into its main activities, so a high-level flowchart of the process can be an easy and fast way to reach them. Finally, the third one includes *walking through the process*, meaning that a close observation at the *Gemba*[2] needs to be conducted, following the product through the process. The record of this information should be done in a more structured way by using the process chart tool, for example, which is represented in Figure 9. (Slack *et al.* 2007)

[2] Japanese word for shopfloor.



	Description of activity					
1	Report arrives					
2	Stamp and date report					
3	Check expenses report					
4	Attach payment voucher					
5	Wait for batching					
6	Collect reports into batch					
7	Batch to audit desk					
8	Wait for processing					
9	Check reports and vouchers					
10	Reports to batch control					
11	Batch control number					
12	Copy of reports to filing					
13	Reports filed					
14	Payment voucher to keying					
15	Confirm payment					
	Totals	5	5	2	2	1

Figure 9 - Exemplification of a process chart

in (Slack *et al.* 2007)

As it can be seen in Figure 9, each activity is associated to an operation, transport, delay, inspection or storage, enabling a more specific characterization of each activity and how many of each of these activities are performed in the process. The distinction of tasks into those five types facilitates the non-value-adding (NVA) activities analysis, which is explained in the Stage 4: Analysis. This tool also presents the sequence of the conducted tasks.

2. Work Measurement

A time-based approach can be used to manage processes since it is easier to understand instead of approaches based on cost or quality, so work measurement must be conducted to provide the necessary information for that approach. Besides that, time measurements are the inputs for a bottleneck analysis – mentioned in the stage 4 -, enabling to identify the most time-consuming processes of the operational flow.

This framework contemplates the case of not having predefined information regarding the time each activity takes to be performed, so the focus is on the direct methods of time measurement, most specifically the time study technique.

The steps to perform time study are (Jacobs and Chase 2011):

1. Define the process to be studied;
2. Determine the number of times to measure the process;
3. Divide the process into precise tasks;
4. Time and record the time each worker takes to complete the task and rate the performance;
5. Complete the average observed time for each task;
6. Compute the normal time for each element as showed in (3.1) equation:

$$Normal\ Time = [Average\ observed\ time] \times [Performance\ rating\ factor] \quad (3.1)$$

In which the average observed time is calculated by dividing the sum of the times recorded by the number of cycles observed, in minutes, and the performance rating (PR) factor is a conceptualization of the speed of the operator conducting the process. This PR factor is originated by a comparison between the operators' performance and the analyst's concept of normal performance, which is rated as 100%. That way, operators that are considered faster than the normal conception of the analyst are rated with a PR factor above 100%, in contrast with workers slower than the average, which are rated below 100%.

7. Add the normal times for each task to determine the total time for the process;
8. Calculate the standard time for each process using the (3.2) equation:

$$Standard\ Time\ (ST) = \frac{Total\ Normal\ Time}{1 - Allowance\ factor} \quad (3.2)$$

Depending on how many different processes are needed to time and the level of specification desired when conducting work measurement, processes can be aggregated according to a predefined criterion. For a more in-depth analysis, the level of aggregation must be low, meaning that every different process must be time and analyzed. When it refers to a more macro analysis, that level must be higher, being possible to combine several processes as one.

The number of cycles appropriated to conduct time study is given by (3.3) equation.

$$Sn = [\frac{Zs}{h\bar{x}}]^2 \quad (3.3)$$

Where,

Z – standard normal deviation for the desired confidence level

s – standard deviation of the initial sample

h – accuracy level desired in percent of the work element, expressed as a decimal

$\bar{x}$ – mean of the initial sample

However, there is a table with predefined number of cycles according to the time per cycle and the minimum number of cycles the process is performed per year in the company. Those values can be seen in APPENDIX A.

Stage 3: Process Mapping

This stage is the point at which all the information begins to come together, presenting the real picture of the process. There are several tools to build a process map, however, according to Shou *et al.* (2017), value stream mapping (VSM) is one of the best process improvement lean technique to design the flow of a process, allowing to leverage points where significant improvement is possible. Additionally, it is a very complete tool that allows to characterize a process according with the features that are relevant for the current context. A set of those specific features can be composed by:

- Number of operators, in average, that carry out the process;
- Distinguish the ownership of each process;
- The number of shifts;
- In case of processes that do not occur 100% of the times, define the frequency of occurrence of the processes in percentage;
- Process time which comes from the work measurement;
- Waiting time between processes;
- Process frequency – the percentage of times each process occurs;
- Number of IT platforms and devices used in each process;
- Representation of the material and information flow.

The VSM presents specific symbology which is presented in Figure 10.

Swimlane diagrams and flowcharts can also be constructed to further detail specific processes, specially the most critical ones. Progressive levels of detail must be used until the process is fully understood.

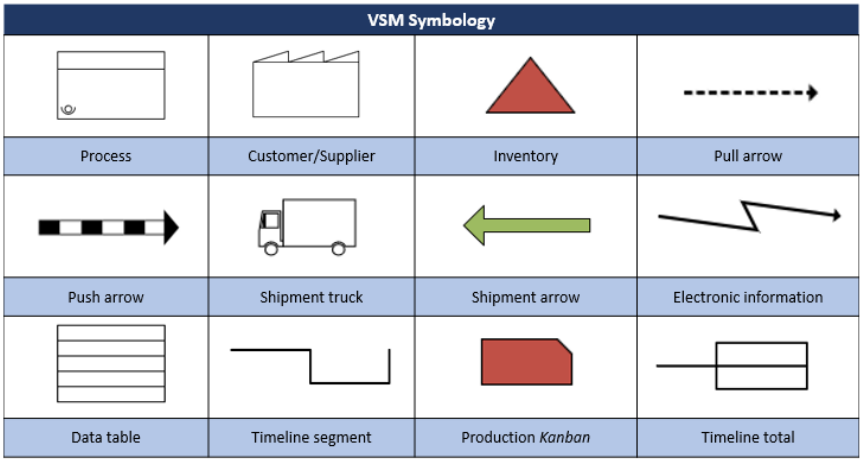


Figure 10 - VSM symbology

Stage 4: Analysis

Despite being stated as the stage 4 in the AS-IS model phase, the analysis process must be conducted from the beginning of the study.

The first part of the analysis focuses on the processes: the time and energy they dispend alongside the waste they incur. Each one of the stages covered in this analysis provides information towards the most critical processes within the e-commerce fulfillment process. The work measurement and activities characterization outcomes are valuable inputs for this analysis. The further equations within the analysis can be found in Jacobs and Chase (2011) book.

Bottleneck Analysis

The first step is to determine the process that limits the capacity of the operational flow. The bottleneck can be found by analyzing the cycle time through the equation presented in (3.4), which considers the number of operators that can perform the process.

$$Cycle\ Time\ (CT) = \ Average\ time\ between\ completion\ of\ successive\ items \quad (3.4)$$

Being expressed in time period per part produced.

Utilization Rate Analysis

In order to understand the percentage of time the operators spend in each process, the utilization rate is assessed using the equation (3.5).

$$Utilization\ Rate = \frac{Processing\ Time}{Working\ Time}\ x\ 100 \quad (3.5)$$

In which both processing and working times are presented in time period units.

Efficiency Analysis

The efficiency provides a measure of the processes' perfection, meaning that it compares the output of the real process, with inefficiencies, with a standard output which can be defined as the optimum output for the process and, consequently, without inefficiencies.

$$Efficiency = \frac{Actual\ Output}{Standard\ Output}\ x\ 100 \quad (3.6)$$

Being both the actual and standard output presented in part produced per time period.

Labor Cost Analysis

The equation (3.7) can be used to assess the labor cost of a process, which relates the cost of an operator per working time and the output performed by that operator during the working time.

$$Labor\ cost = Cost/Working\ Time \times Output/Working\ Time \quad (3.7)$$

In which the cost is presented in a monetary unit, the working time in a time period unit and the output in products or orders. It is important to make sure that both measures are being calculated in the same time period unit.

Within this analysis, the cost to revenue ratio can also be assessed recurring to the (3.8) equation. This metric represents the portion of the revenue that is consumed by that process due to its associated cost. Both cost and revenue must be calculated with the same monetary units.

$$Cost\ Revenue\ Ratio = \frac{Cost}{Revenue} \times 100 \quad (3.8)$$

Non-value-adding Activities Analysis

Besides determining the time each process takes to be executed, it is also relevant to understand the portion of that time that is spent in activities that truly add value for the final consumer. According to Borsos *et al.* (2016), there are three types of activities within an enterprise: activities that add value (VA), activities that do not add value (NVA) and activities that do not add value but are necessary (NNVA). This study helps to prioritize the processes that need to be optimized based on the percentage of the NVA activities, which are the ones that generate biggest losses. Despite having broad definitions, value- and non-value-adding concepts can be adapted to each particular situation.

The association of each type of activity existing with the tasks of the process can be done by using the process chart previously presented in Stage 2: Gathering Information. The division of the tasks into the five different variants in the process chart helps to allocate them to the three kinds of activities due to the link between operation and VA activities, and the other four variants with NVA and NNVA activities.

Effectiveness Analysis

The effectiveness analysis involves ensuring that the right work is being done, contemplating the occurrence of errors within a process and, consequently, assessing the service quality of the organization. In order to conduct this analysis, the first two steps are analogous to stages 1 and 2 of the AS-IS model. They consist in identifying the possible errors and gathering information of incidents that already happened in order to collect data to proceed with the analysis.

Errors Characterization

Based on the identification and information collected, each error must be characterized, according to the type of error, cause of error, process in which the error occurred and the responsible, meaning the individual or team accountable for the execution of that process. In order to characterize each incident, the chain of events that triggered that error needs to be clearly understood. For that, the 5 Why technique can be used since it is an iterative interrogative tool that aims to examine the cause-and-effect relationships underlying a particular issue. The segmentation of errors into types of errors needs to follow the MECE criteria: each type of error must be mutually exclusive (no overlap) and completely exhaustive (no gaps).

Errors Analysis

After typifying each incident, it is interesting to analyze the frequency of occurrence of each type of error, the process in which the most errors occur and the causes of error that are more frequent. The Pareto diagram is an easy and understandable tool that can be used to build this type of analysis, allowing to identify the most important errors to address regarding its frequency of occurrence. (Slack *et al.* 2007)

The factors that affect the service quality of logistic service providers (LSPs) are intrinsically related to the time and cost of the service. For this reason, in order to assess the impact of operational mistakes in the companies' service, the extra cost that incurs of that incident and the impact for the client in terms of delays in the arrival of the products are calculated.

$$Extra\ Cost = Real\ Cost - Expected\ Cost \quad (3.9)$$

in which the real cost corresponds to the sum of the expected cost with the costs that arose from the error occurrence.

$$Delay\ on\ Arrival = Real\ Date\ of\ Arrival - Expected\ Date\ of\ Arrival \quad (3.10)$$

in which the real date of arrival is when the customer receives the products in its totality.

The Pareto diagram can be also used to identify the types of errors that have the most impact regarding the extra cost it brings for the company and the negative impact on the service quality and, consequently, customers' satisfaction. This technique supports the further prioritization for the implementation of improvement opportunities. (Slack *et al.* 2007)

3.2 Step 2: Improvement Opportunities

The detailed analysis of the AS-IS model is used to aid in determining the set of improvements or design characteristics that will the basis for the construction of the TO-BE model. In fact, by performing the AS-IS assessment, a step into the design of the TO-BE process is taken, as can be seen in Figure 11 (Sharp and McDermott 2008) These improvement suggestions come along during the whole process of the AS-IS model creation and are dependent on the sector, the company's activity and the type of processes involved. The VSM can be used so that each improvement is associated to a specific process or activity, being easily identified within the major process.

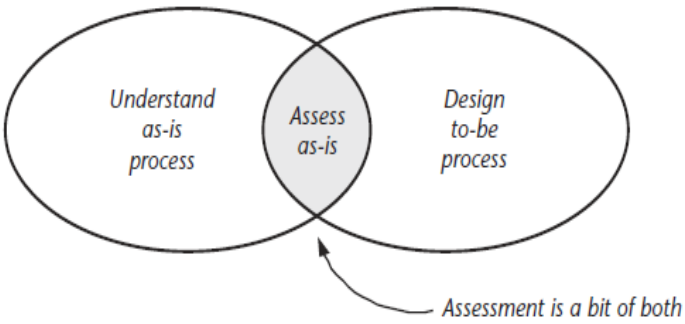


Figure 11 - Representation of the final assessment of AS-IS model, which is part AS-IS, part TO-BE

in (Sharp and McDermott 2008)

According to Schmidt *et al.* (2014), the PDCA cycle is a fundamental method to implement the lean principle of continuous improvement. This stage contemplates the first step of the

PDCA tool – *Plan* -, where the goals for the process are established and a plan of action to achieve those goals is set up.

3.3 Step 3: TO-BE Model

Based on the improvement opportunities encountered, the TO-BE model can be designed in a VSM format, the same tool used to present the AS-IS model. By using the same tool, it is possible to fully compare both models and easily understand the differences between them. The expected results from this change are assessed in this stage by making the same analysis presented in the stage 4 of the AS-IS Model, meaning that a new bottleneck is determined, alongside with new productivity, efficiency and labor cost values are calculated. The impact on the incidents occurrence in the process is also assessed. By calculating these values, it is possible to quantify the improvements of the new process.

Afterwards and according to the expected results of the TO-BE model, the organization must decide on the direction to take: stay AS-IS, improve, redesign or outsource. (Sharp and McDermott 2008)

3.4 Step 4: Implementation

If the decision is to improve or to redesign the process, the implementation of the proposed improvement opportunities is the next step to follow. This step corresponds to the *Do* phase of the PDCA cycle, in which the defined plan previously defined in the *Plan* stage must be implemented. For that, the prioritization of the improvement suggestions is conducted so that efforts can be targeted to the most critical processes. For this prioritization procedure, it is possible to assign a different weight to specific metrics in order to differentiate them.

The 5S methodology is a good way to encourage a change in workers attitude towards the implementation and sustenance of improvement initiatives within the workplace. It is a tool that can be implemented in order to remove waste in workstations and organize them, acting as a basis for further improvement actions. (Jaca *et al.* 2014)

3.5 Step 5: Monitoring and Control

Subsequently, comes the *Check* phase of the PDCA where the assessment of the improvement measures implemented is compared to the results previously defined. The last stage of the PDCA cycle is designated as *Act* and refers to the normalization of the procedures outlined in the *Do* stage. In this last step, deviations from the previously established goals should also be corrected.

The monitorization of the process is important so that the compliance with the expected design and performance can be assured. This procedure must be implemented recurring to feedback loops that depend on the organizational structure of the company and the platforms already used. The conduction of audits can also be a good measure to control the progress of the implemented improvement opportunities.

4 Problem Context

In order to tackle the SCM challenges regarding an efficient operation that enables its scalability, this study is conducted in a business environment that provides a real case study for analysis. The operation of HUUB, the company of study, incorporates several processes within the inbound and outbound flows and the storage management in the warehouse. In addition, there are several stakeholders that impact the logistics operation, alongside with the information system of the company. This section aims to contextualize the problem in detail by presenting the company of study and the relationship of all intervenient in HUUB operation, focusing on the organizational structure and operational processes that support the enterprise logistics operation. After that, the case study is presented, contemplating the key reasons that encouraged its realization within the business environment of the company.

4.1 Company Overview

HUUB is a start-up company created in 2015 which business core is in the logistics and supply chain management areas, mainly focusing in the kids' fashion industry. The company value proposition is to offer an end-to-end logistic service that enhances the client's business by locating itself at the center of a dynamic ecosystem made of brands, final customers, suppliers and partners, as seen in Figure 12. This service involves the handling of products in the enterprise's warehouse and the technological features that allow brands to control their supply chain without having to manage it.

Figure 12 - HUUB's central positioning within the supply chain

HUUB reveals to be an enabler when it comes to the clients' business by supporting their supply chain management, allowing them to focus only on what matters: selling. The involving structure where HUUB connects to every stakeholder settles in a web-based platform called Spoke, designed and developed by the company itself, which reveals to be the core element of the company's value proposition.

In March of the current year, HUUB presented 36 clients, from 12 different countries, mainly children's clothing brands. Nonetheless, HUUB's client portfolio includes adult clothing

brands and even non-textile products brands. Since September 2016, when Spoke began functioning, about 442000 products have passed through the company, making up more than 18000 shipments, related to two seasons per year (fall/winter and spring/summer), even though some brands need a third division. However, the rise of e-commerce business and the entrance of B2C stakeholders in the company will lead to a more intense operation and, consequently, a greater need for efficient and cost-effective operation.

4.1.1 Organizational Structure

HUUB internal organization lies on 6 different departments: Operations, Account Management, Business Intelligence & Artificial Intelligence (BI&AI), Information & Technology (IT), Financial & HR and Marketing & Sales.

Operations

The Operations team is responsible for the coordination of the physical flow of products within the warehouse situated in Portugal, being that the storage of incoming material or the fulfillment of sales orders (SOs). In addition to the planning of warehouse functions, on a weekly period, and their management and control on a daily basis, the Operations team also has a continuous improvement approach so that improvement opportunities can be found and implemented to increase operational processes efficiency. The practice of daily Kaizen meetings with the warehouse personnel is one example of that CI mindset.

Account Management (AM)

The Account Management department is the bridge between HUUB and its brands. On account of this positioning, the team has two major functions. The first one is to guarantee that the brands incorporated in HUUB's ecosystem are familiarized with the company's platform, providing all the necessary information and guidance for them to fully understand how to use Spoke. The second task relates with the use of HUUB's competences to give business insights to the brands. This approach comes from the high correlation existing between HUUB and their clients' success. Better business approaches mean brands have more sales, which turns into bigger projects with HUUB and, consequently, higher revenue values.

Besides the brands support role, the Account Management team also provides inputs that influence the Operations team functioning. Since they are the point of contact with HUUB's clients, the AM team is the one responsible to provide information for the operations planning along the season, by providing dates and quantities of inbound deliveries in the warehouse, and the daily work to be accomplished, regarding the wholesale sales channel. For this reason, AM and Operations teams need to be coordinated in order to keep a smooth operational flow.

Business Intelligence & Artificial Intelligence (BI&AI)

The Business Intelligence and Artificial Intelligence team is accountable for providing the knowledge needed for the AM team conduct its function of advising brands on business directions. For that, they analyze the data collected and identify insights from it. Furthermore, this team is also focused in developing algorithms, such as machine learning functions, with the goal of optimizing the operational aspect of the company.

Information & Technology (IT)

The IT department mainly focus is the development and maintenance of Spoke, the information system of the company. By connecting all the stakeholders involved in the supply chain of a brand, the Spoke reveals to be the foundation for HUUB's logistics operation, since it includes a Warehouse Management System (WMS), an Order Management System (OMS) and a

Distribution Management System (DMS). Regarding the Internet of Things (IOT), the main goal is to distribute sensors through the supply chain that enable a faster and more precise compilation of data, improving the optimization process of the supply chain.

Financial & HR

The Financial team controls the company finances and assures that every transaction is conducted according to all norms. Besides the bureaucratic function, this team also focuses on the development of a cost framework from which key performance indicators (KPIs) can be established. The analysis of those KPIs provides information regarding the financial trend of the company. This project can contribute on the construction of those KPIs by providing information that can be integrated in the cost method.

Marketing & Sales

The Marketing & Sales department focuses on the customer acquisition and relationships with the clients. Fairs are the most chosen method to initiate the customer acquisition process since it provides a direct and personal contact between the company and the potential clients. Although it usually assures a well-qualified entry in the acquisition process, meaning that the conversion ratio is high, the cost of reaching new brands is higher due to the associated expenses.

4.1.2 Operational Processes

Since this study is focused on HUUB's logistics operation, both physical and information flows are presented so that a more concrete operational context can be provided.

At the moment, the organization has two warehouses available, one in Portugal, managed by its operations team and a second, in the Netherlands, belonging to partner DAMCO. This partnership allows HUUB, from one moment to the next, to carry out logistics warehouse operations in any part of the world where partners have infrastructures. However, the company is not yet conducting operations in the DAMCO's warehouse.

Physical Flow

At the beginning of each collection, the onboarding process is carried out, where operations are planned, and the products of the brands are introduced into the information system, with a record of the sales already accomplished. Most of HUUB clients conduct dales to retailers even before giving production orders to their suppliers. The integration of information with the brands enables the anticipation of costs and better planning of logistics and warehouse operations.

When the products arrive at the HUUB warehouse, the reception process is initiated. At the time of the reception, HUUB is responsible of verifying that the delivered quantities comply with the service levels agreed (SLAs) between the brands and their suppliers. If there is a mismatch between the estimated quantity and the real quantity that arrives, the system automatically informs the brand and sends an alert to the supplier to address this type of events as fast as possible.

The reception of items can follow two different flows, depending on the sales orders to be fulfilled in the system. If there are no sales orders that require products from the reception, those items are received directly to stock in a process designated of Reception to Stock. On a subsequent moment, when a sales order is activated, the picking process begins. The items required to fulfill that sales orders are picked from stock; the pack is assembled, and the shipping procedures are initiated. When the pack is finished, and the documentation is prepared, the sales order is ready to be transported from the warehouse and serve one of two

possible sales channels: e-commerce and wholesale. This stream is represented in Figure 13 as the Stock Flow, where all five major processes are carried out.

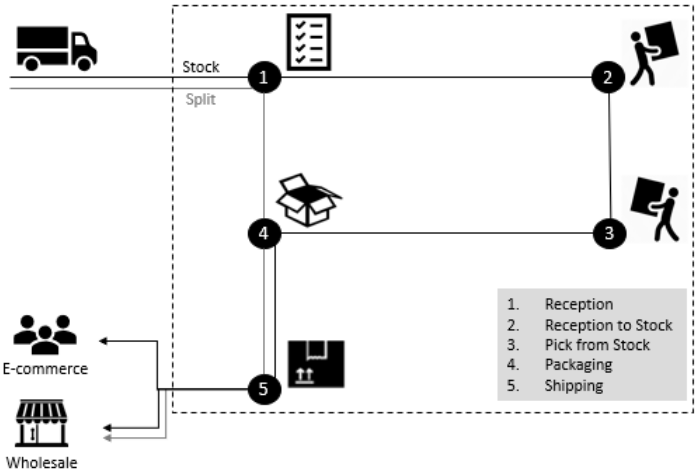


Figure 13 - Stock and Split operational flows

The existence of sales orders that need its fulfillment at the time of the arrival of material triggers the Split Flow. In this flow, the packs are already assembled and the items that fulfill those orders are directly picked to those shipping packs; the remaining products are picked to stock, following the Stock Flow. When the pack is fulfilled with all the required items, then it is closed, and the final shipping procedures are conducted, similarly to what happens in the stock stream. This process avoids the storage and picking processes (identified as number 2 and 3 on Figure 13, respectively), decreasing the cycle time and the work-in-progress of the operation. That way, the segmentation of the operation into these two flows leads to a minimized response time with the same assets.

The disposition of items in the warehouse is according to its rotation, meaning that the products with a higher rotation are located in a rack closer to the shipping/reception dock so that the picking time can be minimized. When all the required items are picked to a pack that corresponds to a fulfilled sales order, the packing occurs. The confirmation of the items, also known as picking confirmation, is conducted and then the pack can be sealed. To finish the order fulfillment process, the pack is weigh-in, the shipping information is inserted in the system and the labels and other documents required for the transportation are printed. The stream ends when packs are stored in the shipping rack, waiting for the carrier to come.

Information Flow

In addition to the physical processes of the products, coordinated by the Operations team, there are several processes of information management. Although Spoke is the mainly source of information within the company, there are still several platforms and services used to exchange information, like the ones represented in Figure 14. The operational processes are managed by the Operations team in Trello, a project management platform based on the *Kanban* system. Projects are represented by boards, which contain task lists. So, the warehouse has one board that links the AM and Operations teams, in which the AM team adds cards created within the predefined frames, which represent operational processes to conduct. Those cards are added to a *Backlog* list, which are subsequently managed by the Operations team. The warehouse operations are divided by four teams – dock, picking, e-commerce and special operations, referring to processes such as returns, labeling, and other procedures -, each one of them having its respective task list. The job of the Operations team is to allocate each card to the respective team in order to trigger the processing of that task. After completing the task, the operator responsible for its execution moves the card to the

Done list. The progress of each card can be monitored by each AM member since they can be enrolled in the cards, receiving notifications each time the card is moved from one task list to another. Trello also allows to add comments to each card, enabling further communication possibilities regarding a specific process.

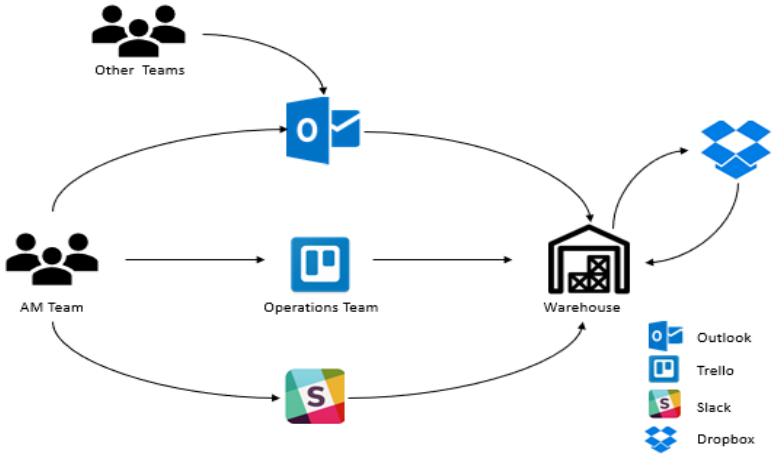


Figure 14 - Sources of information for operational processes

Besides the management tool for operational processes, there are used three other platforms that support those processes and are cross-sectional within the company: Dropbox, Slack and Outlook, as it can be seen in Figure 14. The first one refers to a file sharing and storage service that allows every stakeholder to have access to all the required information to conduct its work. Regarding the operations, the OPLs for the packaging procedures and information related to the carriers' services are stored into respective folders. Furthermore, the shipping documents for each SO are saved in that platform, as well. The last two tools are communication platforms, being Slack an internal application and Outlook both internal and external. Slack is used as a daily communication tool, where information about the ongoing processes is exchange, while Outlook regards more occasional information related to developments in the company and incidents report.

The presence of several communication channels and sources of information within the operational information flow hinders a smooth operational process and leads to scatter and lost information along its transmission through the several existing means.

Sales Channels

The service provided by HUUB encompasses two sales channels: e-commerce and wholesale sales. They present differences regarding the number of items per order, their shipping frequency and the processes involved in the fulfillment of one and another sales channel. On one hand, the e-commerce emerges as the most frequent type since it involves orders that are directly shipped to the final customer (B2C). On another hand, the wholesale orders comprise a high quantity of items per order, as seen in Figure 15, and a larger time window to deliver the products. Within this segment, usually the sales orders are divided into smaller lots designated as *drops*. This means that brands can ship a sales order to a specific customer for a particular season in stages, where each stage corresponds to a *drop*.

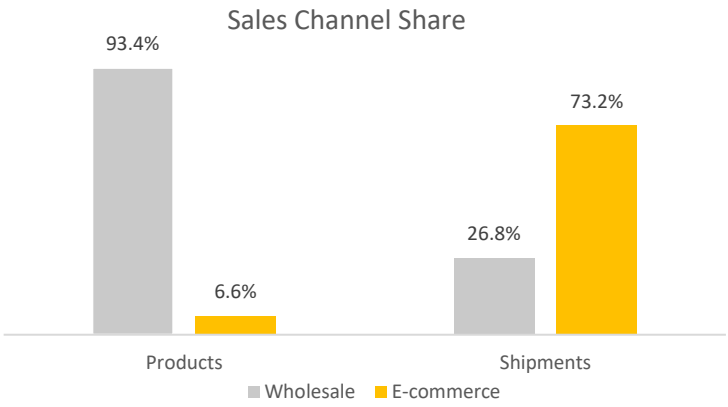


Figure 15 - Sales channel per Product/Shipping perspective

By comparison, the e-commerce sales stand out as the costliest in terms of the operation. The wholesale segment is characterized by a prior agreement between brands and retailers regarding the orders to ship, since the number of products to be produced depends on the sales that brands' have. For this reason, the planning of the wholesale orders is done with weeks in advance, enabling a course of action where the company maximizes the fulfillment of the Split Flow at the time of arrival of material. When it comes to the e-commerce sales, the production of items is estimated by the brand that then are sent and stored at HUUB's warehouse. The preparation of e-commerce sales follows the make-to-order approach, meaning that the order only starts to be fulfilled when a sales order comes up in the system. Hence, the e-commerce fulfillment process is mainly performed through the Stock Flow, which is the one that represents a higher cost for the company.

4.2 Use case description

Since the logistics paradigm is changing, HUUB intends to anticipate and adapt to changes by establishing a disruptive strategy which aim is the optimization and integration of all the supply chain stakeholders. For that, the company relies on the technological and operational knowledge of its collaborators and the development of tools in the areas of information systems and business analytics. Within this strategic approach, HUUB focuses on the supply chain areas in which believes it can create value, developing partnerships in the other fields of action, such as the logistic transportation.

Within the several areas of interest in the organization spectrum, the logistics operation of HUUBS's main distribution center is the focus of this dissertation. The structure of the supply chain does not consider the procurement of materials, production and sales since they are planned by external elements. This lack of control regarding the upstream flow accentuates the supply chain complexity because it compromises the logistics warehouse planning due to the low reliability of delivery dates of suppliers. Although the logistics processes are controlled and supported by Spoke, they are all manually conducted by operators at the *Gemba*. Hence, human intervention is crucial for the current warehouse functioning and the resulting high variability within each process and occurrence of operational mistakes becomes an important point of analysis.

At the beginning of this work, there was no visibility on how the logistics operation of the company was flowing. Besides the manual handling process of goods, the non-standardization of the processes accentuates the variability within each process, leading to an inefficient operation. The mitigation of this inefficiency is not only important to increase productivity, but also because the operation is one of the few steps in the supply chain that the enterprise fully controls: the deadlines are dictated by the brands and the suppliers, inhibiting the ability to build a smooth operational flow. An effort has been made to standardize the procedures in

operations and, consequently, reduce the existent variability within each process with the introduction of Kaizen concepts and daily meetings. However, there is still a lot to improve in the operation.

Inside the logistics operation, there are two main flows that can be analyzed: inbound and outbound. Being a logistics provider, HUUB aims to assure quality, time and cost excellence standards for its clients. The outbound stream comprises the Split flow and the further order fulfillment processes, beginning with the picking from stock to the shipping of the sales order. That way, it is a stream that not only involves more processes than the inbound flow but also more expensive ones, making it the costliest stream within the logistics operation and, consequently, the focus of this study.

Narrowing down, the outbound stream can be divided into two flows that represent the wholesale and e-commerce sales channels. The e-commerce flow reveals to be the one that represents higher operational costs for the company and it is also perceived as the most inefficient process by the company itself. Alongside, the e-commerce business is growing globally, and the company is also experiencing that rise with the increase of sales on the e-commerce segment and the entrance of new B2C stakeholders. It is expected that e-commerce sales orders will triple in 2019 and be 6 times superior in 2020, so the company needs to assure that it has capacity to accommodate this potential growth in a near future.

The scope of this project lines up with HUUB's business model, relating with a quick order preparation, operational efficiency and a better control and assessment of the company incidents. Furthermore, the scalability of the company is also considered due to its growth in the market, especially in the e-commerce segment, always focusing in providing quality, time and cost excellence standards.

5 Methodological Assessment

This chapter presents the application of the methodology presented in Chapter 3 on the context approached in the Chapter 4, adapting the proposed framework to the company's particularities. That way, the AS-IS model is presented with an explanation of how the methodology was adapted to the process characteristics. From the analysis of the current state of the process, improvement opportunities are suggested and prioritized to the most critical processes, culminating in the TO-BE model.

5.1 AS-IS Model

This section presents the processes that constitute the AS-IS model and in which the assessment is going to be conducted.

5.1.1 Process Identification and Description

The e-commerce flow is managed by a dedicated team within the warehouse. This team is composed by the e-commerce team-leader, responsible for managing the flow and ensuring the correct execution of each process, and one or more operators, depending on the number of sales orders to be fulfilled, that process the sales orders. Each process was decomposed into small elements to build process charts. These process charts can be seen in APPENDIX B.

The e-commerce flow initiates when there are sales orders of that segment that need to be fulfilled. Those sales orders can be directly connected in Spoke or manually inserted in the information system. In the first case, the brands' e-commerce platforms and websites are integrated with the company's information system, meaning that, at the time of purchase, the order automatically enters in Spoke to be fulfilled. However, this integration functionality is not working for all the universe of platforms that HUUB's clients use. The manual insertion of sales orders emerges as a solution to tackle this issue. So, there are two different entry points in the system for e-commerce sales orders and, consequently, two different processes for each case. However, for both processes, only sales orders that reach HUUB by automatic integration, e-mails or e-commerce platforms until 11am can be shipped on that current day. This process is managed by the e-commerce responsible.

Validation of automatic SOs

For sales orders that are automatically integrated there is a validation process associated, which represents a double check on the SOs that entered the information system and their insertion on Trello. For that, the e-commerce responsible receives an e-mail called HUUB Reporting at 8 am and 11 am, which comes directly from Spoke, providing information about SOs to be fulfilled on that day and SOs from other days that are not yet fulfilled, mostly due to non-stock. The team-leader checks the brands that have SOs to be processed and searches them in Spoke. In parallel, the responsible creates a card for the e-commerce SOs of that day on Trello, in which checklists for each brand are added, containing the correspondent SOs that need to be processed in each line, such as demonstrated in Figure 16. From Spoke, the

responsible verifies that the SO is really integrated and copies the SO number and carrier to the respective brand's checklist on Trello. Despite being automatically integrated, there are still e-mails received from some brands with SOs information that need to be verified due to the existence of alterations regarding that information. If there is some e-mail referring a SO that was not integrated in Spoke, the Account Management team is notified to conduct the follow-up of the situation, while the team-leader waits for further information. Finally, after all SOs are checked and inserted on Trello, the already seen e-mails are filed and the process is concluded.

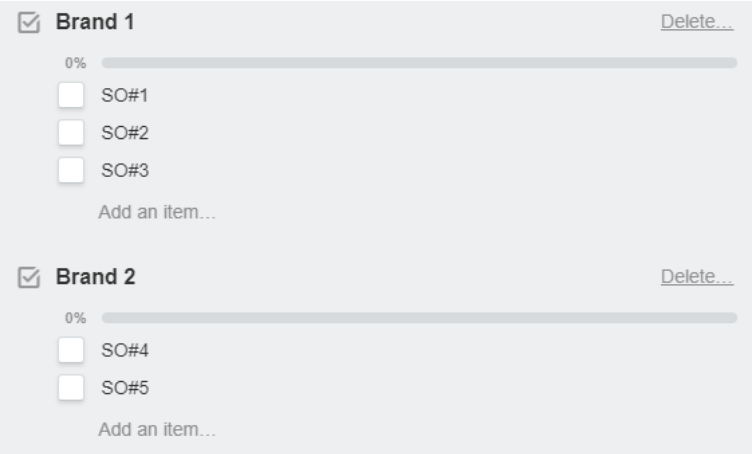


Figure 16 - Trello card with checklists per Brand and SOs to be fulfilled by each line

The Trello platform acts as a *Kanban* ticket system by which the e-commerce operators can manage their work. That way, from the moment the first SO is inserted on Trello, the operator can start the fulfillment process.

Manual insertion of SOs

The validation process of automatic SOs is followed by the manual insertion of SOs that are not directly integrated in Spoke. The e-commerce responsible consults the mailbox, e-commerce open source platforms, such as PrestaShop, or the brand's own website to check if there is some SO that needs to be inserted in the system. If so, the team-leader needs to insert the SO. First, he searches for the customer in the system and, if he exists, meaning that he already purchased something from HUUB's clients, the information in the system must be compared with the one in the e-mail. If there is some change, the responsible must update the respective information and follow with the insertion of the SO information. However, if the customer does not exist in the system, the e-commerce leader needs to create the customer, inserting all the required information in Spoke.

This process involves the insertion of specific SO information, such as the brand, customer, client's reference from the e-mail or website, and sales channel; the insertion of items, which can be a very time-consuming step depending on the number of products of the brand existing in the system; and the selection of the logistic unit in which the SO will be sent, which depends on the service level requested from the customer and the SLA agreed with the brand. This last step allows the creation of the outbound, meaning that information regarding the pack and carrier of the SO automatically appear afterwards according with the selected logistic unit, minimizing the processing time of the order. Finally, the SO is inserted in the specific brand checklist on Trello.

Pick from stock (PFS)

The first process conducted by the e-commerce operators is the picking, more specifically the picking from stock. The insertion of SOs on Trello acts as a Kanban that triggers the

beginning of this process, which has two variants. The first one is the picking of single orders, which means that the operator picks each order separately. The second one refers to the picking of several orders at a time of the same brand, designated of bulk picking. The interaction between the operator and the Spoke is basically the same in both processes, only changing in the first moment of the process: in the picking of single orders the operator searches the SO number in Spoke and prints one EAN tag, whereas in the bulk picking the operator searches for the sales channels and then for the brand, printing several EAN tags. After that moment, the procedure is the same: the EAN is read by the picking tool and the operator opens a page where a list of SKUs and respective locations appear. From that moment, the operator goes to the first location it appears to pick the respective item. To pick the required product, the location where it is (box) is picked, like as if it was opened, the item is picked and removed from the box, and the box is picked again, like it was closed and the number of items on that location is updated. This process is repeated until all the SKUs required to fulfill the SO are picked. Finally, SOs are placed in the e-commerce packaging station to continue the process.

Packaging

This process begins with the picking confirmation, which consists on picking the products to confirm that the quantities and the items are correct. If there is missing one item due to non-stock, the Account manager responsible for the brand is notified on Trello and the products are inserted in a flyer and put on a box specific for incomplete SOs, where it stays waiting for further information. If all items are confirmed, the next step is to update the logistic unit where the SO will be sent (if it does not correspond to the initial forecast) and proceed to the packaging. This is a highly variable stage since the packaging procedures are different between brands. It can involve the withdraw of products from the polybag, the wrapping in silk paper or the assemblage of boxes, alongside with the merchandise that can involve cards, catalogues and bags. There are OPLs of packaging procedures that operators can consult on the Dropbox. However, they do not contemplate all brands.

After the customized packaging, the SO is packed, which is the step where the operator inserts the SO in the pack or logistic unit in which is going to be shipped and the EAN tag is stick on it. After that, the pack is weighted and a pocket, a plastic documents holder, is placed on the pack, concluding the packaging process.

Carrier Validation

As the name says, this process is a validation of the carrier that is associated to SOs that can come from two motives, in the case of the SO outbound is already created. On one hand, if the SO was automatically integrated, the change of the carrier and/or carrier service can derive from an incident that occurred since the entrance of the order in the system and its fulfillment or a request from the brand and/or customer to change the predefined service. One another hand, if the order was manually inserted, this alteration can be a consequent of the incorrect association of the logistic unit to the SO. This change can be based on information included in e-mails or on the notes field of the SO outbound in Spoke and can result on a matching between the requested service level by the customer with the SLA agreed with the brand for those type of shipments. This process should be supervised by the e-commerce responsible since this information is not fully available on the Dropbox.

If the SO outbound is not yet created, the first step is to create the pack, meaning that a logistic unit is associated with the SO, and after that the carrier and service are inserted. This outbound creation also takes into account the aspects regarding the service level and SLA requested from the customer and client, respectively.

Documents Handling

The documents handling process involves all the documentation required for the correct shipment and delivery of the SO and it is only initiated when it is certain that the order leaves the warehouse on that day. The flow of this process depends on several factors and it can be seen in APPENDIX C. The first factor that influences the flow of the process is the carrier integration with Spoke: if this is possible, the process follows the automatic label stream; if not, the process is manual label. At the moment, the first one is only executed for the carrier A, the second one includes carriers B, C and D.

The automatic label involves only one click to create the label, which is saved on a Dropbox folder that it is created at the moment of that click inside the brand's folder, whereas the manual label, similarly to the manual insertion of SOs, involves the insertion of all information in the respective carrier's website. In the automatic label flow, the operator needs to go to the folder where the label was saved so that the label can be printed. However, in the manual process, after inserting all the required information, the operator clicks on the print button so that the label appears in a pdf format and saves it on the brand's folder, creating a specific folder for that SO. After that, the label is printed and inserted in the pocket.

Sales orders that are shipped to outside the European Union (EU) need to have invoices. In addition, there are brands that demand that all their SOs are accompanied by that document, regarding the destination country. For brands that use e-commerce platforms such as Shopify and PrestaShop, the e-commerce responsible needs to login into the websites and find the respective invoice. When the team-leader does not already have the invoice on the mailbox, the SO is placed in the *No invoices* box while waiting for the brand to send the respective invoice. This document is printed three times: two copies go inside the order or the pocket, and the other one is handed to the carrier. Moreover, SOs that go outside the EU also need to have a document called customs declaration in order to avoid customs issues on the customers' side. In those cases, the operator fills the declaration and places it together with the SO to deliver to the carrier at the time of the shipment.

There are some brands which return's policy demands the creation of a return label in order to facilitate the return process by the customer. For this reason, the e-commerce leader needs to login into the carrier's website and create a return label by filling in all the required information. Afterwards, the label is printed and inserted inside the SO.

When the documents handling process for SOs that are shipped through carriers A to E is concluded, the person that finalized it does a check on the respective SO on Trello, so that the other operators involved know that the SO is already fulfilled and takes the order to the shipment station.

For SOs that are shipped through the carrier F, the process is a bit different. The documents handling process begins in the mailbox where the e-mails that entered until 11 am are imported to a Notepad file which are then imported to an Excel file. Through that file, the labels are printed and placed on the order. Afterwards, a document containing all the SOs that are shipped through that carrier is saved in the Dropbox and two copies are printed, being one for the carrier and the other one remains in the company. In this case, the tracking numbers are manually associated to the SOs by the operator, having to stick the tracking number to the SO itself and to both documents so that the customer can keep track of the order, weighting all the orders. For SOs that go to EUA and Canada, only the HUUB document needs the sticker, a CN22 document needs to be stick in the order, which prevents customs issues, and a red sticker. After that process is finished, the responsible divides the SOs by the service and the weight, according to carrier thresholds and grabs a Multiproduct Guide document per service. The filling of this document can be automatically done in a software; however, it not always works. When that is the case, the information required for the document needs to be written. To conclude, the SOs are placed in a box to be delivered in the carrier station by the

e-commerce responsible, which leaves the warehouse 30 minutes earlier for this task, meaning that the team-leader working time is actually 30 minutes less than it should be. In this process, the insertion of the SOs tracking number in Spoke is only manually done in the following day, if there is one working shift, or on the present day if there are two shifts.

Shipment Record I

For the SOs that are shipped through carriers A to E, before their shipment, SOs are picked to an Excel file so that the company can be sure that those SOs are really leaving the warehouse. Most e-commerce SOs are small quantity orders that fit in a flyer. After picked, the SOs with that logistic unit are placed in a box to be shipped. This box is for SOs that leave through the carrier A due to its higher utilization rate. If there are SOs with larger boxes as logistics units, they are placed in the respective carrier pallet. When the carrier arrives, the dock team-leader takes the packs to the carrier.

Shipment Record II

By picking the orders for the Excel file, all the information regarding the SOs appears, from which it is possible to analyze if there are some discrepancies and the status of a specific column designated *Fulfillment* column. This column warns if the order is missing marked as shipped (step done in the Packaging process), the cost, value that the company pays for the shipment, and charged, the value that is debited to the client. If the mark as shipped is missing (MAS), the dock team-leader needs to open the SO in Spoke and click on the MAS checkbox, changing the status of the order. If one of the cost or charged values are missing, the team-leader needs to consult an Excel file where the cost and charged tables of the respective brand are. A match between the SO information presented in Spoke and the information of the tables needs to be done so that the values of cost and/or charged are found. After finding the correct values, they are updated in Spoke. To note that there are Excel files that contain cost and charged information of several brands while other files are specific for one brand.

It is important to point out that both shipment record processes, I and II, are not executed by the e-commerce team, but instead by the dock team responsible. However, they are still part of the SO e-commerce fulfillment process, making them relevant for the present study.

5.1.2 Work Measurement

The e-commerce stream is composed by processes with short execution times, thus, according to Chase *et al.* (2005), the time study is the most appropriate work measurement method for short cycle times and provides the required detail to fully breakdown each process into several tasks.

The e-commerce stream involves eight main processes to fulfill a sales order. However, there are some processes that can have several variants that need to be studied. For example, there are two different ways to pick an e-commerce SO from stock: by picking each order individually or doing bulk picking. These two ways have differences in its execution, so it is pertinent to distinguish them in the time study. Furthermore, the manual label process of documents handling depends on the carrier that is used since they do not require the same amount and/or type of information to create the label. That way, the time measurements were individually conducted for each carrier. When it comes to the packaging of SOs, the high diversity of brands and, consequently, the packaging procedures, led to the creation of clusters per type of packaging. By examining this process in brands with different packaging procedures, it was concluded that several of them had the same baseline for packaging, only with some minor changes, especially regarding the merchandise. For this reason, the brands with the same basic packaging procedures were grouped together, creating ten clusters to represent the packaging process of 30 brands, which refers to the number of HUUB's clients

with e-commerce business from September 2017 until March of 2018. These clusters are represented in Table 4.

Table 4 - Clusters per basic packaging procedure

Cluster	Basic Packaging Procedure	Number of Brands
1	Withdraw the products from the polybag, silk paper and sticker	8
2	Withdraw the products from the polybag and card box	1
3	Insert items in the flyer	10
4	Withdraw the products from the polybag, bend dress and silk paper	1
5	Assemble card box	5 + hats of one brand from cluster 1
6	Insert product in the paper bag, insert a clamp and a card	1
7	Withdraw the products from the polybag and insert in an envelope	1
8	Assemble the brand's specific box	1
9	Withdraw the products from the polybag, insert items in the brand's envelope, and insert the envelope in the flyer	1
10	Withdraw the products from the polybag, silk paper, sticker and assemble card box	2

The determination of the number of times each process needs to be timed was based on a guide provided by Chase *et al.* (2005) that can be consulted in APPENDIX A. That way, the initial sample of measurements is based on the first assessment conducted and is subsequently updated if further measurements significantly change the first timed value.

Every measurement of this time study was recorded with the respective performance rating factor. For this PR factor, it was assumed that the e-commerce team-leader has a higher than normal performance when executing the processes (110%), one operator was ranked as PR factor of 100% and other two were evaluated below the normal PR factor (95%).

After all the required measurements were completed, the normal time (NT) was calculated recurring to the (3.1) equation. The NT values for each process can be seen in APPENDIX D. Since this study contemplates the fulfillment process of an e-commerce SO, which is not interrupted from the moment it begins, there are no allowances associated. Consequently, in this specific case, the standard time is the same as the normal time.

5.1.3 Value Stream Mapping

From all the collected and gathered information, it is possible to map the e-commerce flow using the VSM, presented in Figure 17. The analysis of the VSM shows that the E-commerce flow is mostly sequential, presenting, however, mutually exclusive processes when it comes to the fulfilment process of a SO: 81.6% of orders are automatically integrated and, consequently, go through the validation process, while 18.4% of SOs need to be manually inserted. The first batch of automatic orders that are validated works as a *Kanban*, triggering the picking process.

The variability also happens in the picking process, where most of times is used the single order PFS (84.2%) and just 15.8% of the times is used the PFS bulk order, and in the documents handling step the orders can follow three different processes, being the automatic

label the most frequent one with 50% of the occurrence, followed by the manual process for carrier F with 42% and the manual label with just 8% of the cases.

As it can be seen, the PFS bulk order involves inventory during its course since the products already picked stay idle while waiting for being packed. This waiting time in this process is also represented, being almost 37 minutes per order. When it comes to the documentation step, for orders that go through processes 1 and 2, automatic and manual label, respectively, after being processed, they are placed in the *Orders to be shipped* box, while the flow goes back to the packaging process, if there are orders awaiting to the packer, or to the PFS single order process, if there is not a batch of orders to be packed that came from the PFS bulk order process.

The VSM also shows the number of operators that usually perform each process, the number of shifts in which that process is conducted and the ownership for each one of them (if a regular operator can execute that process, it is designed as *undefined*).

Between the packaging and documents processes, the flow can be disrupted in two moments: if the order is incomplete, meaning that there is no stock to fulfill the order, the flow is broken after the packaging process, while waiting for AM notification about how to proceed; if the order has no invoice, the fulfilment process is stopped before handling the documents, waiting, once again, for the AM member to connect with the brand, ask for the invoice and send it to the e-commerce team-leader. Both situations have very unstable resolution periods since they depend on the stock availability, in the first case, and the communication with brands, in the second one. However, in the second situation, the invoices are usually sent in the same day so that the orders' shipment is not delayed.

Finally, the VSM demonstrates the diversity of IT platforms and devices used in this fulfillment process besides the information system of the company – Spoke-, going from communication applications, such as Slack and Outlook, to a storage and sharing information service named Dropbox, several external websites used by the brands which are not yet integrated in Spoke and the Excel tool.

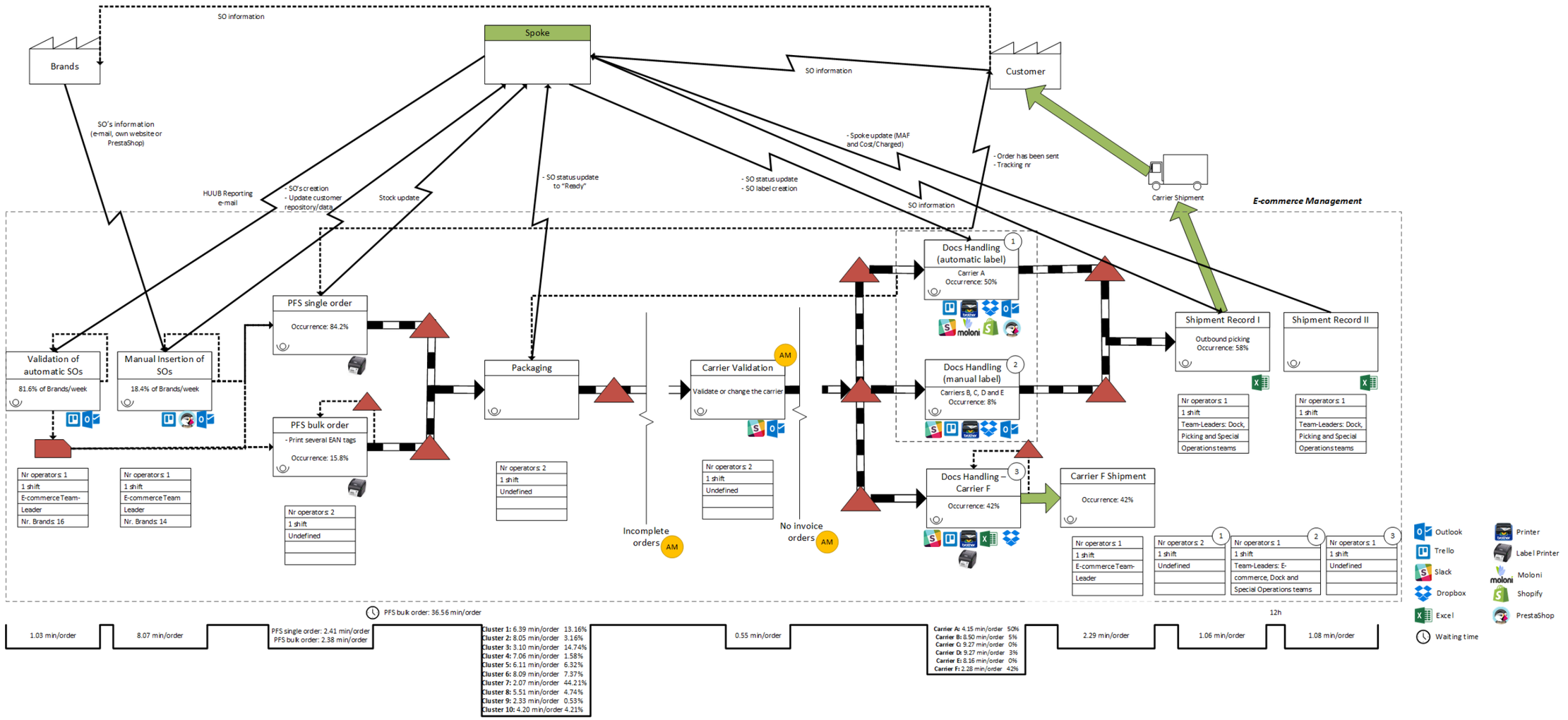


Figure 17 - Value Stream Map of the current e-commerce flow

5.1.4 Bottleneck Analysis

After a broad analysis on the e-commerce process provided by the VSM, it is time to focus on each process individually. The current and subsequent analyses values were conducted relating the number of orders since the number of items per order was disregarded due to its insignificance in the handling of processes. Besides being part of the e-commerce process, both shipment record processes are not executed by the e-commerce team, so the analysis of the flow does not take into account the existence of these processes.

The determination of a bottleneck implies knowing the cycle time of each process, which was calculated using the (4.3) equation in the section 3.1Stage 4: Analysis. By visualizing the Figure 18, the processes with the longest cycle time are the manual label process and the manual insertion of SOs, which are significantly above the remaining processes' cycle times by exceeding both the 8 minutes of processing per order, while the other processes are all below the 3 minutes per order. It must be emphasized that both procedures with the highest CT represent administrative processes which contemplate the manual insertion of data in the computer.

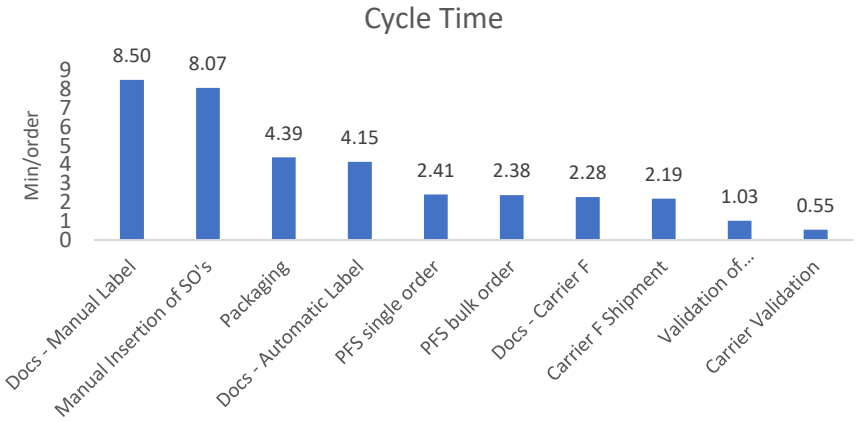


Figure 18 - Cycle time per process

These top two longest CT processes are not recurrent within the e-commerce fulfillment process: the manual label only happens 8% of the cases and the manual insertion of SOs occurs in 18.4% of the times. That being said, there are three shifting bottlenecks:

- When the manual label documentation process occurs:
- When the manual insertion of SOs occurs and the order does not require manual label;
- When none of the top two processes occurred, the packaging is the bottleneck process since it happens for all the orders.

5.1.5 Utilization Rate Analysis

Considering two workers for the e-commerce team – the e-commerce team-leader and an operator-, Figure 19 demonstrates the daily percentage of time each operator spends for each process. The working time considered is of 460 minutes per day: one eight-hour shift less two ten-minute breaks. The analysis shows that each operator takes 57% of the working time to actually work in the e-commerce fulfillment process, being packaging the procedure within that macro process that consumes a higher percentage of time per week. This can be explained by the 100% occurrence in the process (every order goes through the packaging process) and being the third most time-consuming procedure, taking more than 4 minutes per order.

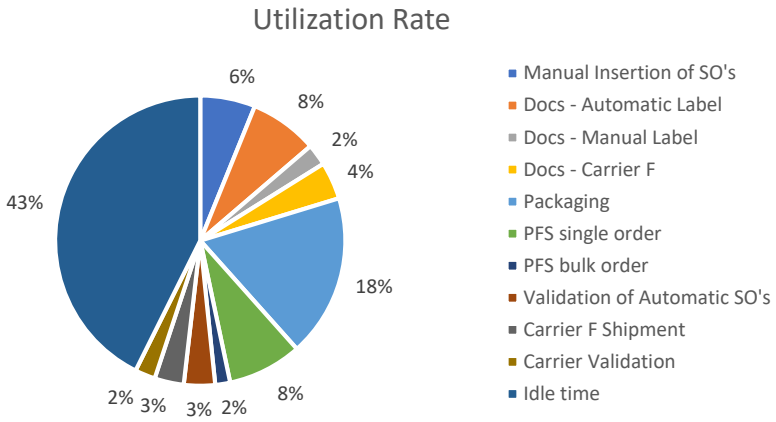


Figure 19 - Utilization rate per process

The other 43% of the working time represents idle time within the e-commerce process. In order to understand where this time is used, an individual analysis to the effective working time of each operator was conducted. Since there are processes which are exclusively allocated to the e-commerce responsible and others can be done by either of the two of them, Figure 20 represents the real occupation time of each operator. The division of processes can be seen in APPENDIX E.

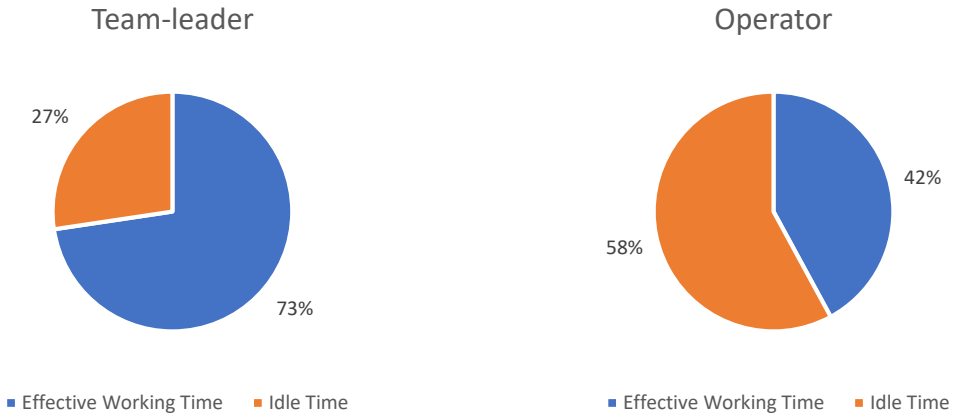


Figure 20 - Effective working time (%) per operator

It can be concluded that the team-leader spends more time in the e-commerce fulfillment process than the operator. In fact, the operator has a higher percentage of idle time than effective working time. Regarding the e-commerce team-leader, the idle time can be justified by a process which is represented in the VSM as the e-commerce management. This process involves the management and control of each individual process within the flow, assuring that only the authorized orders are fulfilled and that they are complete and have all the required documentation to be shipped. It is hard to quantify the time spent in this process, since it is an administrative position that involves almost constant communication with the AM team so that questions regarding orders issues can be immediately solved.

When it comes to the other operator, it is noticeable that more than half of the time is not spend in the e-commerce fulfillment process. So, assuming that the 27% idle time of the team-leader is actually occupied with the e-commerce management, 1,5 FTEs is enough to fulfill the 38-average number of orders per day. The idle time of the operator can be leveraged for other processes within the warehouse functioning due to the cross-training mindset of the company: every operator learns the basis to execute almost all tasks in the warehouse, especially the ones related to the wholesale flow since they are not so specific as the e-

commerce procedures. However, what can and usually happens is that the process is not executed at the desired pace, so, since the operator has more time, he executes the processes in a more relaxed way taking more than the average 15 minutes and 49 seconds to process an order.

5.1.6 Labor Cost Analysis

The labor cost each process brings is computed to show what is the costliest process for the company. A representative value of the company's cost for each FTE was provided and associated with the operator's working time to stablish a euro per minute cost. Then, the labor cost per order of each process can be determined using the equation (5.1).

$$Labor\ cost/order = \frac{Weekly\ FTE\ Cost}{Weekly\ Working\ Time} \times Cycle\ Time \times \#orders \qquad (5.1)$$

From that analysis, the process that entails greater cost for the company is the packaging one. By determining the cost of each process, it is possible to reach a value of the portion of cost revenue that each one entails by knowing the average value payed by the brands for each item shipped. Taking into account that are shipped about 3 products per order, in average, and the frequency of occurrence of each process, the cost revenue ratio that the company holds is presented in Figure 21, in which the packaging process is the most expensive process by carrying on a cost of 0.16€ per every euro of revenue earned per order. However, Figure 21 also shows that the idle time is actually what makes the company lose a higher percentage of revenue, accounting for 37%, leaving just 13% of margin in the e-commerce process.

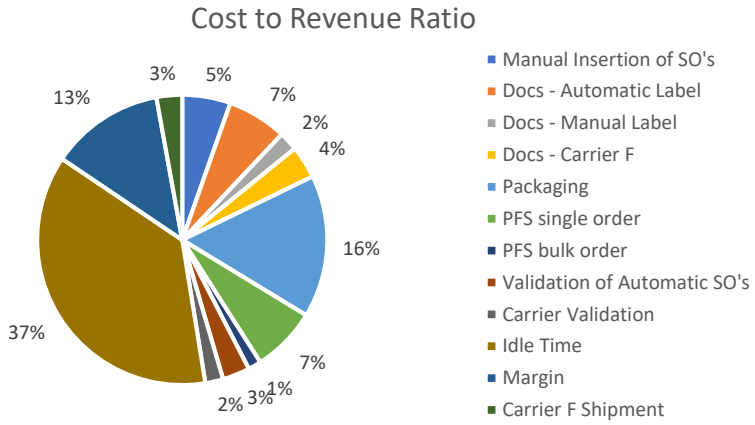


Figure 21 – Cost revenue ratio per process

5.1.7 Non-value-adding Activities Analysis

While HUUB's final costumers value speed and quality when it comes to the fulfillment and delivery of their sales orders, HUUB's clients – the brands – want the best possible service for their customers (speed and quality), aligned with a cost-effective operation. Taking that into account, the interpretation of value-adding and non-value-adding concepts in this context is present in Table 5.

Table 5 – Definition of value- and non-value-adding activities within e-commerce logistics operation

Type of activity	Definition
Value-adding activity (VA)	Activities that directly create value and which the customer is willing to pay, such as the packaging and the required documentation so that the SO successfully reaches its destination.
Necessary but non-value-adding activity (NNVA)	Activities that do not add value but are necessary for execution of VA activities (e.g. grab flyer, grab pocket, fill in the customs declaration).
Non-value-adding activity (NVA)	Wastes such as delays, extra movements/transport, search or insertion of information in Spoke or websites.

The characterization of each activity in VA, NNVA and NVA is demonstrated in APPENDIX B. By measuring the portion of time each process spends in each type of activity, it is possible to determine which are the processes that do not add value in the fulfillment process.

From the ten processes in study, there are four of them which add no value to the e-commerce process: the validation of automatic SOs, the manual insertion of SOs, the carrier validation and the carrier F shipment by the team-leader. This indicates that these processes should be eliminated since the time and money expended in their processing is not virtually being paid by the clients.

The manual insertion of SOs stands out among the other three processes because it is the second longest and costliest process within the e-commerce stream. This analysis was also conducted for the remaining possible flow bottlenecks, represented in Figure 22, from which it is possible to conclude that the packaging process is the one that delivers more value to the customers and the carrier F's documents process does not contemplate any value-adding activity. The manual label process consumes 83% of the time in NVA activities.

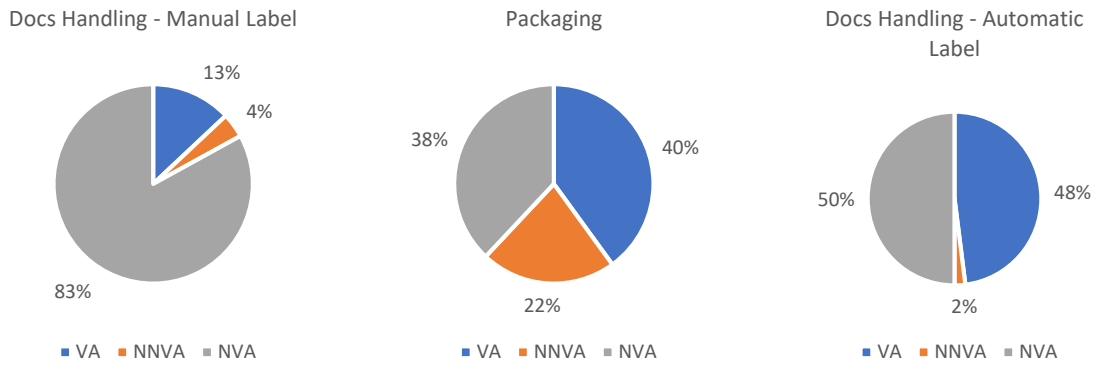


Figure 22 - Portion of time spent in VA, NNVA and NVA activities in the manual label, carrier F's documentation and packaging processes, respectively

Within the other processes, the carrier F documentation and both shipment records are the ones that do not contemplate any value-adding activity: the carrier F documents handling involves 64% of the time in NNVA activities and 36% in NVA activities, the shipment record I has 22% of the time spent in NNVA activities and 78% of the time spent in NVA tasks, while the shipment record II is only composed by NVA activities.

5.1.8 Efficiency Analysis

In order to assess the efficiency of each process, the equation (3.6) can be adapted to a ratio between the standard time and the real processing time. The standard time corresponds to the process time without inefficiencies, meaning the non-value-adding activities. That way, Figure 23 demonstrates that the higher efficiency within the e-commerce flow refers to the manual label process with 54%, meaning that the most efficient process within the stream still has 46% of margin to improve its performance. Moreover, half of the processes are inefficient, because they do not add value to the e-commerce fulfillment process (in this analysis, the NNVA activities are considered as NVA activities since, despite necessary, they do not add value to the customer).

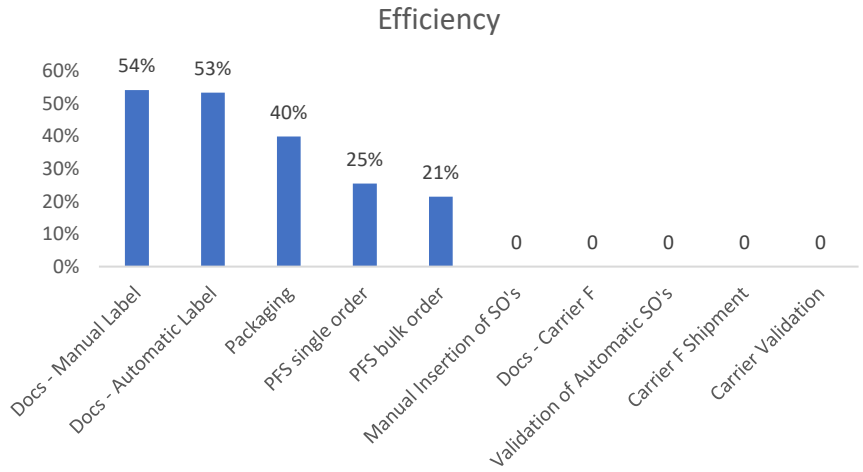


Figure 23 - Efficiency per process

The global efficiency of the e-commerce flow can be estimated by the ratio between the standard and real average full processing time of an order. To reach these values, the cycle time was weight according to the number of SOs that go through of each process in order to determine the average working time of mutually exclusive processes (e.g. manual insertion of SOs and validation of automatic SOs). The values result in an average processing time of 15 minutes and 49 seconds. By removing the process inefficiencies, this value can decrease 65%, reaching an average of 5 minutes and 32 seconds and, consequently, decreasing the cost per order in 65% as well. This means that the current e-commerce process has 35% of efficiency in its performance.

5.1.9 Sensitivity Analysis

The expected growth of the e-commerce segment in the company makes it relevant to analyze how would the fulfillment process behave. Hence, a sensitivity analysis is conducted to analyze if the current e-commerce flow can sustain an increase of 100%, 300% and 600% of the number of SOs. The increment was conducted to a steady daily average number of orders of 38 and a basis of two people for the e-commerce team. In addition, it is considered that the revenue is a measure of the value paid for the average number of items shipped and it is constant.

For 100% increase

The increase of 38 to 76 daily orders makes it unfeasible for two people to fulfill all the SOs within the 460 minutes of daily working time. With an AS-IS operation, the team-leader and the operator are occupied 100% of time and there is still missing 13% of the time so that the 76 orders can be completed. That way, it would be needed to allocate a third operator to the e-

commerce process for about 60 minutes, increasing the labor cost per order in 10%. However, form the cost revenue ratio analysis, the allocation of 0.13 FTE to the process would present 44% of margin in the e-commerce fulfillment process, with an increase of 31%.

For 300% increase

The transition of 38 to 152 daily SOs, which is the expected growth of the company for the following year, would require the presence of two more members in the e-commerce team: one full time member and the other one would just need to assign 23% of his time to this process, so 3.23 FTEs. The labor cost per order represents 86% of the current labor cost, having a 24% margin on the revenue provided by each order. Despite being a higher percentage than the one achieved with the current demand, the allocation of an extra full-time FTE for this process and other operator to perform almost 2 hours of work decreases its margin related to the previous two scenarios.

For 600% increase

When it comes to the 600% increase of the e-commerce business in the company for 2020, which translates into 266 daily SOs, there is a need of 4.54 FTEs to accommodate this growth. The labor cost per order is 13% less than the present one, having a 0% margin increase of the revenue received. The analysis for this scenario is similar to the 300% increase one, with the progressively number of FTEs assigned to the process having a higher impact in the labor cost per order than the revenue earned per each order.

Figure 24 presents an overview of the three scenarios comparing the percentage of labor cost and margin related to the current fulfillment process dimensioned for 38 daily orders.

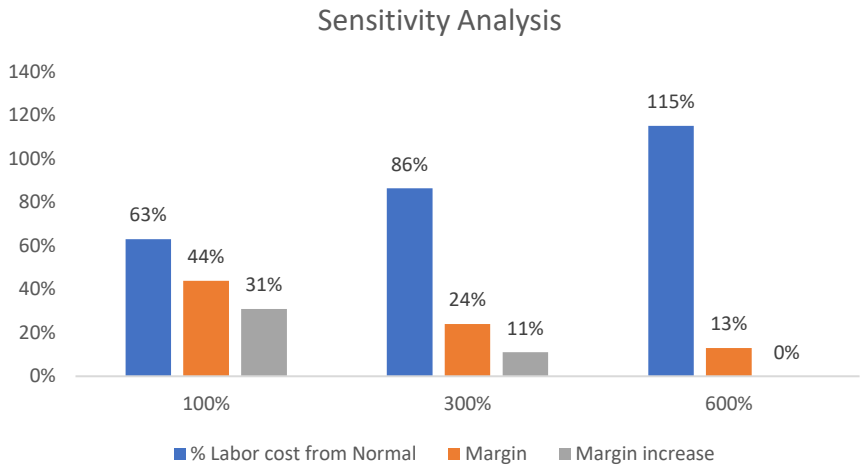


Figure 24 - Comparison of labor cost/order, absolute margin and margin increase of the 100%, 300% and 600% increase scenarios compared to the AS-IS e-commerce process for 38 orders/day

5.1.10 Effectiveness Analysis

Effectiveness relates to the concept of doing things right at the first time, relating to the occurrence of errors in a process. A sample of 41 operational mistakes was collected in collaboration with the AM team within a universe of 6556 orders between September of 2017 and March of 2018, which gives a 0.6% of error occurrence. Despite seeming an insignificant percentage, it is expected that this value is actually bigger since there is not an incident record culture within the company. Most part of these errors were not properly described at the time of its occurrence and the main concern of the AM team and the other stakeholders involved was to solve the problem in order to minimize the impact in both clients (brands) and final customers, instead of conducting a deeper analysis to truly understand what led to that incident. For this reason, the process of gathering all the required information to create a

complete report on these incidents was laborious and time-consuming due to the dispersion of information in the several IT platforms and services used by stakeholders and even the non-existence of information at all.

The 41 errors collected were characterized by type of error, cause of error, the process in which they occurred and the team responsible for that incident. For that, each incident was analyzed resorting to the 5 Whys technique to understand the best way to characterize the incidents according to the mentioned parameters and standardize them. Bear in mind that there are type of errors which occur in processes outside the e-commerce fulfillment process, however, they impact the e-commerce service-level and are of the team-leader responsibility.

By analyzing the pareto chart represented in Figure 26 there is evidence that the 20% of types of errors that account for 80% of incidents occurrence are exchange of labels, incomplete orders, labeling error, delay on processing the orders, duplicated orders and wrong insertion of items quantity by descending order. Besides the labeling error, which is related to the labeling process and outside the e-commerce spectrum, the other types of errors concern to three e-commerce processes: e-commerce management (incomplete orders and delay on processing them), manual insertion of SOs (duplicated orders and wrong insertion of items quantity) and documents handling (exchange of labels), which are validated by as the most error-prone processes.

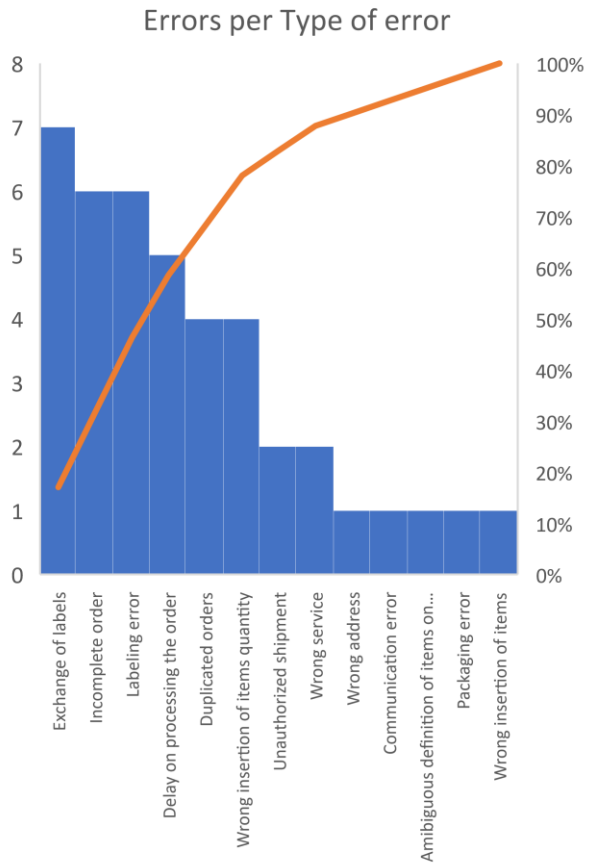


Figure 26 - Pareto chart of errors per process

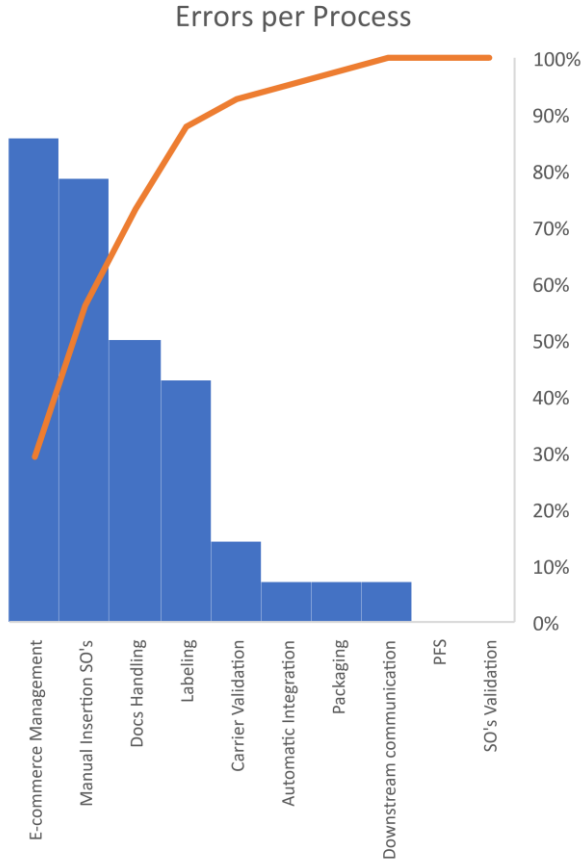


Figure 25 - Pareto chart of errors per type of error

The causes for these 41 errors were difficult to determine because the stakeholders did not remember the specific context of each one of them due to the time that has passed since the event. Despite this obstacle, it can be concluded that 93% of the error causes are due to process errors, meaning that it is a consequence of the lack of knowledge of the process or the disregard for the process procedures by the operator.

Even though the assessment of the frequency of errors per type of error and process is important, the impact these errors have must also be evaluated. For that, two measures are calculated: the extra cost the company incurs due to the occurrence of an incident, and the delay of arrival of the order to the final customer. Figure 27 shows the aggregated and averaged percentage of extra cost each type of error involves. The first one evaluates the impact that all the occurrences of each type of error have in the company's extra costs, while the second one displays the cost of an individual occurrence per type of error. In these terms, the labeling error is the type of error that has had a higher impact in the company's extra costs with additional 514% of cost, although the ambiguous definition of items in Spoke represents the most expensive type of error per occurrence, with 196% of extra cost per error.

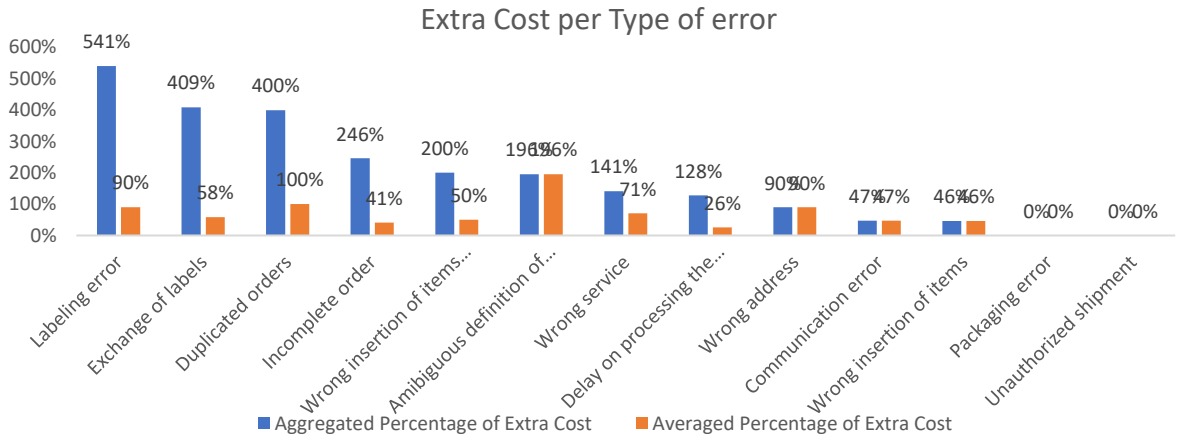


Figure 27 - Aggregated and averaged percentage of extra cost per type of error

The impact of each type of error in the service-level can be spotted in Figure 28, which evidences that the type of error that had a higher impact in the delayed arrival of the order to the final consumer is the communication error, both taking into account the total number of occurrences and its individual frequency, with 64 days of delay. Although it happened only once, this type of error had a huge impact in the delivery of the order to the final consumer, which makes it a more sensitive incident and important to understand the causes for this delay. Since it was an error in the downstream communication process, meaning the connection between the AM team and the warehouse, it is possible that the error was only noticed much later, and its resolution was delayed.

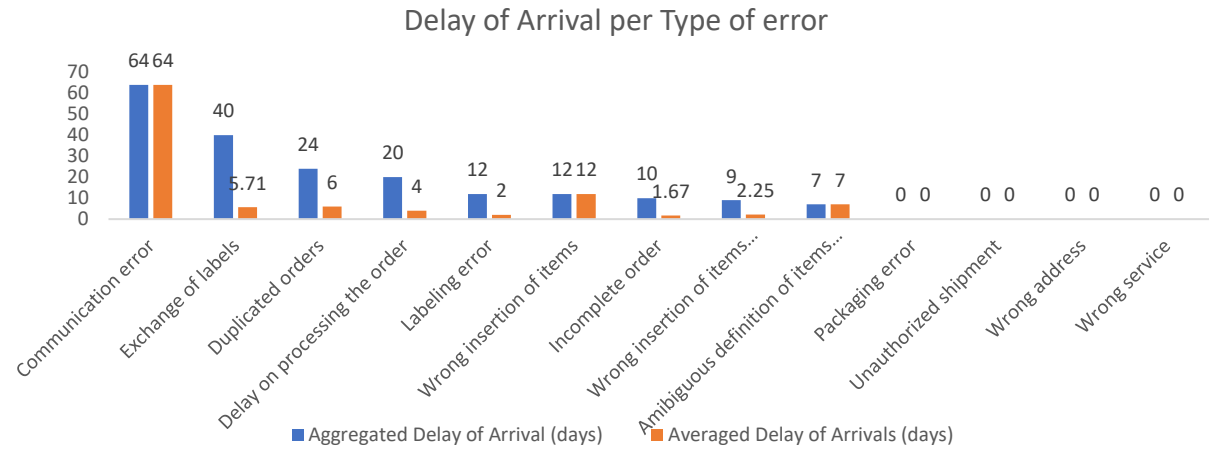


Figure 28 - Aggregated and averaged delay of arrival per type of error

To wrap up, the main conclusions of the effectiveness analysis are:

- The most error-prone process is the e-commerce management with the special contribution of types of errors such as incomplete orders and delay on processing the order;
- The most expensive process for the company, regarding the errors extra cost for the company, is the manual insertion of SOs and the one that has the most significant impact for the customers is the downstream communication;
- The most frequent type of error is the exchange of labels which belongs to the documents handling process, the third most error-prone one;
- Labeling error has been the type of error that has had a higher impact in the company's extra cost so far. However, the most expensive type of error is the ambiguous definition of items in Spoke. Note that, in both situations, the top three errors which contribute to the extra cost are incidents which usually involve a resend and/or a return, so types of errors with shipment consequences;
- Communication error is the one that has higher negative impact in the customers' service-level. Still, the following types or errors that have a bad impact on the service delivery process are errors which also imply a resend and/or a return to solve the situation.

5.2 Improvement Opportunities

After conducting all the analyses, it is possible to gather all the improvement opportunities idealized during the AS-IS model analysis process and begin the PDCA cycle by planning them. These suggestions are displayed in Table 6, where it is also presented their impact in qualitative and quantitative terms. The values for related to the efficiency and the error frequency were assessed taking into account the improved cycle times and the impact of their reduction in the total fulfillment process time, and the elimination of errors that each improvement opportunity mitigates.

Table 6 - Improvement Opportunities designed for each e-commerce process

VSM Position	Improvement Opportunity	Impact
Validation of Automatic SOs	Eliminate the process by presenting the list of orders in Spoke by carrier and by brand.	Provide a full picture of the daily work with a prioritization logic, while eliminating the use of Trello to manage the orders' fulfillment process. 11.4% efficiency increase
Manual Insertion of SOs	Eliminate manual insertion of SOs by integrating all the brands in Spoke.	Eliminate errors such as: duplicated orders, wrong address, wrong insertion of items and items quantity, ambiguous definition of items at Spoke. 8.9% efficiency increase 25% error occurrence decrease
PFS single order	Switch the most used picking procedure to the PFS bulk order, stipulating a 2% of occurrence for PFS single order for rare occasions.	Increase picking efficiency by eliminating excessive transport movement associated to PFS single order. 0.7% efficiency increase
PFS bulk order	Introduce picking carts and boxes with compartments to pick the orders, and a vehicle routing optimization algorithm.	Increase picking efficiency by increasing picking capacity and minimizing time and distance traveled. 16% efficiency increase

PFS	Alert mechanism that informs the operator that the order is on delay to be processed (2 days after entering in Spoke, not counting the weekend).	Eliminate errors by delay on processing the order. 12% error occurrence decrease
Packaging	Reorganize e-commerce fulfillment area and provide increased visibility on the merchandise and standardization of packaging procedures.	Increase packaging efficiency by standardizing procedures and increasing space utilization.
Carrier Validation	Carrier and service automatically integrated.	Eliminate errors by wrong carrier and/or service. 6% efficiency increase 5% error occurrence decrease
Documents Handling – Automatic label	Eliminate Dropbox as the place where labels are saved and from which they can be printed, by having that information in Spoke.	Eliminate the use of the Dropbox in the process.
Documents Handling – Manual label	Integration of all carriers in Spoke.	Increase documents handling process efficiency by eliminating manual label. Eliminate errors by wrong address and carrier and/or service. 3.5% efficiency increase 7% error occurrence decrease
Shipment Record I	Pick the order to be shipped right after the documents handling process and introduce cages for each carrier so that orders can be placed there according to the carrier.	Eliminate errors by exchange of labels and the use of Excel as the tool where the shipped orders are registered. Increase efficiency in the outbound flow. 17% error occurrence decrease
Shipment Record II	Update Cost and Charged tables and integrate them in Spoke.	Eliminate uncertainty regarding costs and charged values in Spoke and the use of Excel as a reference tool.

Although it is a process that does not encompass any value-adding activity, the carrier F documents handling process is hard to improve since it is an intrinsic and mandatory procedure of the carrier.

5.3 TO-BE Model

Based on the improvement suggestions approached in the previous subchapter, the VSM of the TO-BE model for the e-commerce fulfillment process can be seen in Figure 29. By comparing the AS-IS and the TO-BE models, it is evident that the TO-be model is simpler, contemplating just half of the initial processes. There is no need for a *Kanban* to begin the fulfillment process since all the management of the orders' processing will be integrated in Spoke and automatically available for processing. The presence of mutually exclusive processes is limited to the documents handling process, in which the SOs can go through carriers A to E (58%) – automatic label -, or carrier F. Despite having two possible processes for the picking, the PFS bulk order is supposed to be the core one, being the PFS single order

only used in extraordinary situations, that is why a 2% of occurrence is associated to this process. Furthermore, the introduction of a picking cart able to carry two boxes with five compartments each enables a reduction on the PFS bulk order cycle time in 17%, minimizing, as well, the waiting time associated to each order in this process.

The integration of all the necessary information from the several platforms in Spoke removes the excessive amount of IT services and platforms used in the current e-commerce process, eliminating waiting times and the waste of searching for information in disperse systems. This also eliminates the break of the flow due to no invoice orders, remaining the incomplete orders situation, which always depends on the communication with the brand.

Regarding the ownership of the processes, only the carrier F shipment is exclusively owned by the e-commerce responsible; the other processes can be conducted by any worker that belongs to the e-commerce team.

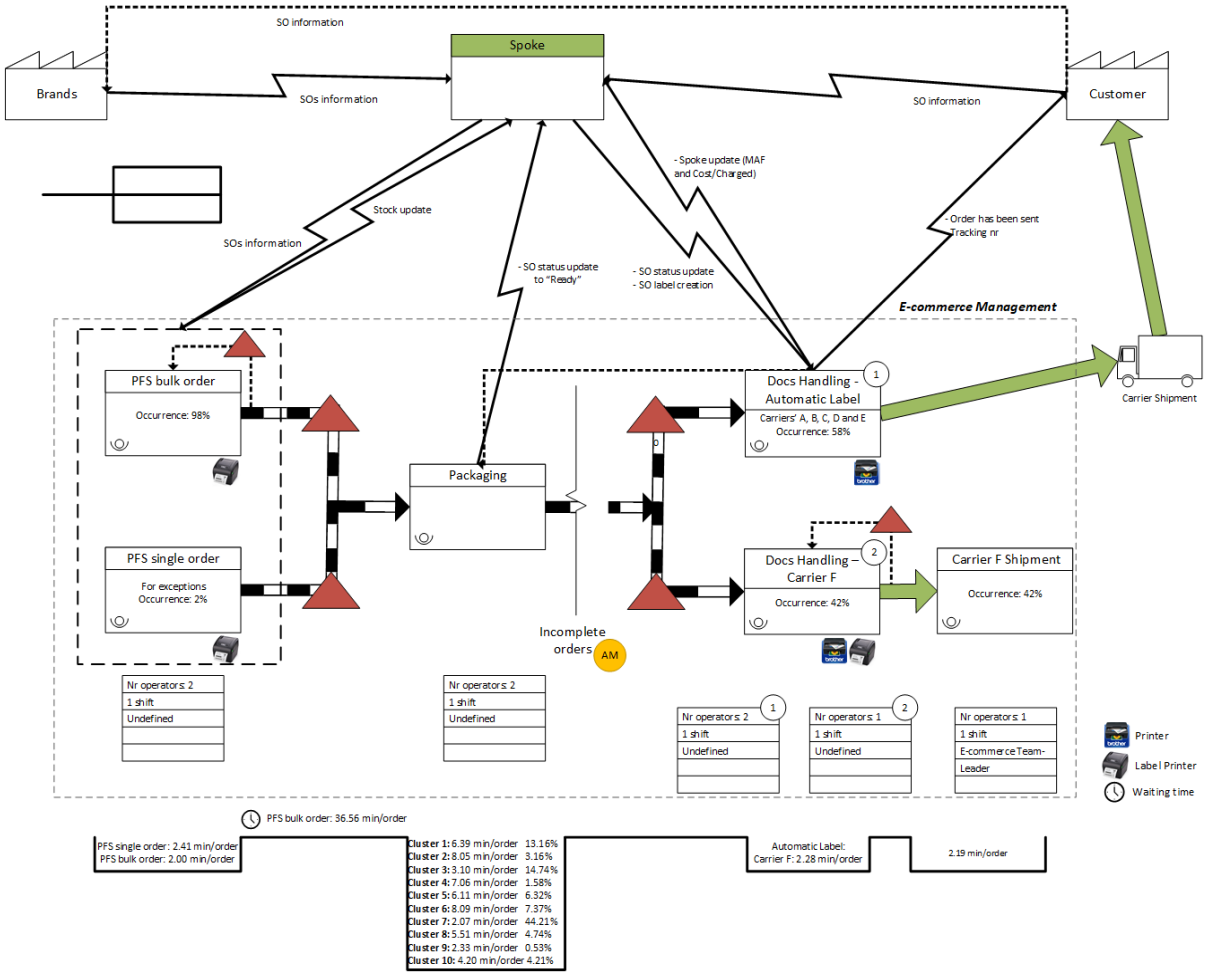


Figure 29 - Value Stream Map of the TO-BE model of e-commerce flow

Quantitatively speaking, the e-commerce flow presents improvements regarding its efficiency and the error rate occurrence. The new processing time for each order is estimated as 9 minutes and 40 seconds, representing an efficiency of 61% and, consequently, an increase of 26% regarding the current e-commerce process. When it comes to the error occurrence, the improvement suggestions described in 5.2 can provide a 69% reduction in error occurrence.

Within the new e-commerce flow, there is the existence of a new recurrent bottleneck, which is the packaging process with an average cycle time of 4 minutes and 19 seconds. Furthermore, this model would support an extra 14 orders per day.

5.4 Implementation

The implementation is the *Do* stage in the PDCA cycle, following the planning delineated with the improvement opportunities. Since there are several changes suggested to the e-commerce process, a prioritization method must be assessed in order to sort the most important suggestions to implement. The combined results from all the conducted analyses presented in Table 7 provided the basis for this prioritization process.

Table 7 - Rank of the top 3 processes per analysis conducted

Analysis	Top 3 processes
Bottleneck	1. Documents handling – manual label 2. Manual insertion of SOs 3. Packaging
Utilization rate	1. Packaging 2. Documents handling – automatic label & PFS single order 3. Manual insertion of SOs
Cost revenue ratio	1. Packaging 2. Documents handling – automatic label & PFS single order 3. Manual insertion of SOs
Efficiency	Carrier validation, documents handling – carrier F, carrier F shipment, validation of automatic SOs, manual insertion of SOs – all with 0% of efficiency
Errors occurrence	1. E-commerce management 2. Manual insertion of SOs 3. Documents handling
Errors extra cost impact	1. Manual insertion of SOs 2. Labeling 3. Documents handling
Errors delay of arrival impact	1. Downstream communication 2. Documents handling 3. Manual insertion of SOs

By analyzing the Table 7, it is possible to conclude at first sight that the manual insertion of SOs is the process that arises the most within the several studies, being in the top three of every analysis conducted. It is the second process with the highest cycle time, the fourth most used and costliest process and one of the five inefficient processes of the e-commerce stream. When it comes to the effectiveness analysis, manual insertion of SOs is the second most error-prone process and the one that originates the errors that incur a higher extra cost for the company due to their interrelationship with extraordinary shipments. Furthermore, it is also one of the processes that impacts the service level the most. Hence, the integration of all the brands in Spoke is a priority for the company in order to eliminate the process that negatively impacts the e-commerce process in all scopes of analysis.

Regarding the most process-oriented analysis, the packaging procedure is emphasized by being the third highest cycle time and the one with a highest utilization rate and cost revenue ratio. The documents handling process also shows up in the top 3 of all the analyses but within its several variants. For this reason, it is not yet considered for the focus of this first implementation stage.

When it comes to the effectiveness analysis, the documents handling process, which contemplates both automatic and manual labels and the carrier F's documentation, is the second one that stands out by showing up in the top 3 of the three analyses. Exchange of labels is the most frequent type of error and it comes from the documents handling process. Additionally, it is also one of the third and second process that originates errors with the

highest impact in the extra cost for the company and the delay of arrival to the customer, respectively.

That way, the top 3 targeted processes to the first implementation phase are the manual insertion of SOs, the documents handling and the packaging processes. Since the improvement opportunities for the first two processes involve technological developments regarding Spoke, their implementation is currently in the IT pipeline for future work. Regarding the packaging process, the focus was on standardizing the packaging procedures so that the variability between operators can be minimized. For that, the creation of OPLs for the packaging of each brand must be physically and virtually available – in the e-commerce station and Dropbox, respectively –, so that every operator can consult and have access to the required information. In these OPLs, each step of the packaging procedure is detailed and supported by images that visual demonstrate how to execute the procedure itself.

In order to enhance the packaging process and the e-commerce fulfillment process in general, a reorganization of the e-commerce area in the warehouse is conducted. The chosen technique to support this rearrangement is the 5S since, before inducing changes in the area, the necessary resources must be sorted from the unnecessary ones, arrange predefined places for each resource and stimulate the sense of cleanliness in the warehouse. The criteria used to sort the material and resources is based on the needs of the operators, gathered by asking them on what material they need to perform their job, and the utilization rate of each resource in order to understand the amount of material needed. Afterwards, all the encountered waste is eliminated, and the second step begins. To set in order all the different packs and merchandise required for the packaging process, labels are used to identify each card box where the respective resource is placed. Furthermore, solutions to better organize the different silk papers used for packaging are introduced.

An idea to reorganize the e-commerce area regards on the division of the packaging station into two sides, each one specialized per type of packaging. This would allow to separate the required resources and merchandise for brands, allocating them to specific partitions on the correspondent side of the station. To set up this segmentation, an analysis is conducted in order to join the predefined packaging clusters, according to the similarities within the packaging procedures, and balance the work between the two stations. For that, it is assessed the average daily working time each brand consumes to operators, by considering the average number of orders per brand and the respective cycle time per packaging procedure. The result of this analysis reveals that one side of the station must contemplate 58% of the brands, which are mainly characterized by having silk paper to wrap the products that are subsequently inserted into flyers to be shipped, while the other one must address the remaining 42% of the brands, whose orders are packed into card boxes. The created OPLs for the packaging procedures can then be segmented according to the brands that are packed in each side of the station, so that each operator has access to the standardize procedures.

Despite only happening in 0.6% of the orders fulfilled within the period of study, the lack of a platform to register the operational incidents makes it unfeasible to assess their real impact in the company. That way, in order to tackle that gap and enable the desired analysis, the creation of an incidents data base where all the information of each event is recorded and available for analysis is conducted, in addition to a platform to manage the resolution of those incidents. In order to develop this project, there is the need to clearly understand the current error resolution process within the company and the existing mechanisms to collect and save information about them. So, interviews were conducted with every team-leader of the teams that have a role in this process in order to create a file that answers to all the teams' needs. By collecting that information, it is possible to create an Excel file that contemplates all the required fields to fully register and assess an incident and from which the Financial team, for instances, has access to the required information to process that incident. Regarding the management platform for the incidents, Trello is the chosen tool since it is an already applied

platform in the company that stakeholders know how to work with. The purpose of this platform is to provide a place in which the team members can create a card that represents an incident that is further analyzed by a pivot – the member responsible for the incidents' management – and allocated to the team responsible to solve the ticket. When notified to solve the ticket, the stakeholder must analyze the incident and provide further feedback related to its resolution. The incidents management flow can be visualized in Figure 30. The pivot has the role to allocate responsibilities to the team that must solve the incident and assure that all the information is provided, not only to fully characterize and assess an incident, but also to enable the best resolution possible on behalf of the teams.

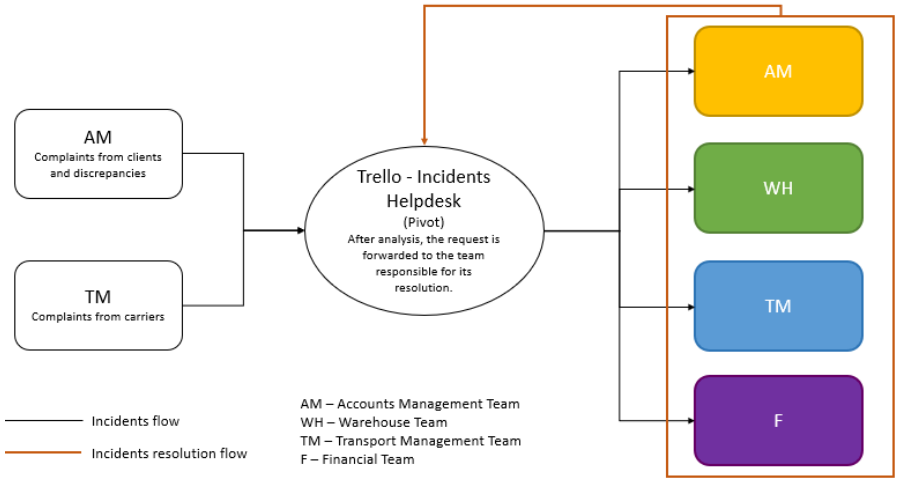


Figure 30 - Incidents management flow

5.5 Monitoring and Control

Since most of the improvement suggestions could not be implemented or are being implement at the current moment, the comparison between the expected and the real results could not be assessed, inhibiting the execution of the steps *Check* and *Act* of the PDCA cycle. However, there are still some procedures that must be considered to monitor the processes, such as the existence of monthly audits in which the e-commerce process is closely followed at the *Gemba* so that updates regarding cycle times, value-adding-time activities and the compliance with the stipulated procedures is conducted. The continuous upgrade of these type of metrics helps to rectify some and identify further improvement opportunities. In addition, whenever a new brand is integrated, the fulfillment process of its orders should be carefully monitored in the first week of execution, following the proposed framework to measure and analyze the process.

6 Conclusions and Future Work

Supply chain management (SCM) has increasingly become an important way to enhance competitive advantage amongst organizations. However, managing the supply chain and the logistics within the supply chain, regarding the coordination of material and information flows is a complicated and challenging task. Additionally, factors such as internationalization and mobility are contributing for the consumers shift towards online business, which is affecting the retail structures as they are known. Logistics facilities are gradually performing more functions of a store, requiring flexibility to adapt to the increasing customer demand and adding complexity to the operation. Therefore, the present study develops a conceptual framework to improve the logistical performance of an e-commerce process.

The framework developed presents five main sequential steps, starting with the creation of the AS-IS model. It is probably the most important stage since the ability to improve an operational flow is highly influenced by the construction and analysis of the current state of the operation. This phase involves four steps: 1) process identification, 2) gathering information, which involves process description and work measurement, 3) process mapping, using the VSM tool, and 4) analysis, involving metrics such as the determination of the bottleneck, efficiency and error rate of the process. Secondly, there is the gathering of all the improvement opportunities idealized while understanding the AS-IS model, resulting in the TO-BE model presented in the subsequent stage. Afterwards, there is the implementation of the most breakthrough improvement opportunities, since it is not always possible to implement all of them. Finally, there is a monitor and control phase which aims to assess the compliance of the real and expected performance of the new design.

In order to implement the proposed methodology, this dissertation is conducted in the business environment of HUUB, a logistics start-up, that provides a real case study for analysis. For that, the framework must be adapted to the operational characteristics of the company.

The application of the framework to the e-commerce operational context of the company raised some obstacles regarding the work measurement and the information to conduct the effectiveness analysis. When it comes to the first one, since the cycle times of the e-commerce processes are small (all below 10 minutes per order), the number of cycles to observe each process ranges from a 15 to 40 times. Since there are 20 processes being considered in the analysis, the time measurement becomes an exhaustive and time-consuming method.

Regarding the effectiveness analysis, the main obstacle relies on the absence of all the relevant information to assess the impact of each incident for the company (extra cost) and the customer (delay of the SO arrival). For this reason, that information had to be searched in the carriers' websites, several Excel files, different stakeholders' mailboxes and chats in Slack, some Trello boards and in Spoke itself, revealing to be also a time-consuming process. Furthermore, the 0.6% of collected incidents mentioned in 5.1.10 for the seven-month study is probably higher, since that percentage results in the agglomeration of an inconstant record of the incidents on behalf of the AM team members during that time, not contemplating all that

occurred. The lack of a continuous record of the operational incidents also hindered their characterization process, especially regarding the cause of the error.

6.1 Results

From the AS-IS model analysis, it is possible to assess which are the most critical processes of the e-commerce flow for each type of metric calculated. Taking into account the improvement opportunities developed and the prioritization conducted, the proposed model section shows the achievements of the improvements developed.

6.1.1 AS-IS Model

The bottleneck of the e-commerce is not static. The top two longest cycle times, manual label and manual insertion of SOs, do not occur in the fulfillment process of every order, so the bottleneck can be one of these two processes and, when neither of them occur, the packaging procedure reveals to be the bottleneck.

The utilization rate analysis shows that the most part of the operators working time is not spent in the e-commerce fulfillment process since 43% of the working time is idled. However, within the 57% of the time they actually work, packaging is the process in which they spend more time. By analyzing the operators effective working time, it is concluded that 1.5 FTEs are enough to fulfill the current average demand of the e-commerce flow. The cost to revenue ratio has a similar analysis to the utilization rate one, demonstrating that the idle time is what makes the company lose the higher percentage of revenue, accounting for 37% of the revenue. The costliest process for the company is the packaging one, representing a 6% cost of the revenue earned.

The NNVA activities analysis and efficiency have the same results regarding the least efficient processes because they are the ones which do not add any value to the customer. They are the manual insertion of SOs, the carrier F's documentation process, the validation of automatic SOs, the carrier F shipment and the carrier validation. The whole e-commerce process presents 35% of efficiency.

With the current operational processes, the e-commerce flow would only be able to accommodate the expected growth of the company by hiring more people. In the case of the 300% growth, additional 1.23 FTEs are needed, and for the 600% increase, it is required an increase of 2.54 FTEs to the 2 FTEs already assigned.

The effectiveness analysis provided the desired visibility on the incidents occurrence and their impact on the company, demonstrating 80% of the e-commerce operational incidents are concentrated in the e-commerce management, manual insertion of SOs and documents handling processes. Furthermore, the most expensive errors for the company are the ones that originate extra shipments such as resends or returns, emphasizing the ambiguous definition of items in Spoke as the most expensive individual error and the labeling errors as the ones that originated a greater cost for the company so far. When it comes to the impact on the customers, communication error is the one that induced a higher delay on the SO arrival.

From the combined analysis of all these measurements (which can be consulted in 5.3), the manual insertion of SOs can be titled as the most critical process in the e-commerce flow due to the constant appearance in the top 3 every metric. The other two critical processes are the packaging and the documents handling processes.

6.1.2 Proposed model

Regarding the manual insertion of SOs, the goal is to cut off this process from the e-commerce flow by integrating all the brands in Spoke. This would induce a 11.4% efficiency

increase in the process. For the documents handling process, the improvement opportunities are focused on the automatic and manual labels variants. For the first one, it is intended to eliminate the Dropbox as the place where labels are saved and from which they can be printed, by having that information in Spoke. When it comes to the manual label, the purpose is to integrate all the carriers in Spoke so that this process can be eliminated. This would enable a 3.5% efficiency increase in the e-commerce process, as long as a 7% error occurence decrease. However, since the improvement opportunities for these two processes involve technological developments on Spoke, their implementation is currently in the IT pipeline for future work, not being implemented for now.

For the packaging process, the e-commerce work area was reorganized, and the packaging procedures were standardized. To balance the packaging process, the e-commerce packaging station was divided into two segments, according to the type of packaging: one is allocated to 58% of the brands and the other one to the remaining 42%. This also allows more clear division and control of the packaging resources. To promote the standardization of the packaging procedures, OPLs were created and divided according to the brands segmentation so they can be physically displayed in each side of the working station. To support this reorganization process and further improvement actions, it was also implemented the 5S framework.

Although it cannot be quantitatively measured, the implementation of the 5S methodology brought a cultural change in the working floor. Now, the waste was reduced, and the workplace is more organized and cleaner, indicating a perceptible improvement from the old operators' mindset. This was an important result since 5S acts as a prerequisite for the implementation of other improvement actions.

Focusing on the incidents, the development of the platform and record file to manage them and record their information presents advantages such as the visibility on the status of each period over time and the centralization of all the incidents in one file. This would allow to assess each incidents impact and, by assigning them to the already identified types of errors, causes of errors and processes that originated the incident, and the development of reports showing important KPIs such as the most error-prone processes and the costliest errors for the company.

Despite not being able to measure the improvements results, in this particular case, due to the still ongoing implementation, the framework allowed to understand the main disabilities of the e-commerce process revealed to be useful in providing guidelines for designing and implementing improvement opportunities. Furthermore, this framework reveals to be dynamic in the sense of always updated according to the current operational context, meaning that, after measuring, analyzing and improving, the methodology returns to the initial stage of measurement, contemplating possible influences of the implemented improvement suggestions that would change the first analysis of the studied process.

6.2 Future Work

Although it can be adapted to several logistics contexts, the conceptual framework introduced does not consider some relevant KPIs to evaluate the performance of a logistics warehouse, especially regarding inventory metrics such as inventory turnover and inventory carrying cost, and others like order picking accuracy and back order ratio. Therefore, more relevant metrics must be added to the analysis step of the AS-IS model in order to retrieve more information about the individual processes and the e-commerce flow.

Most of the improvement opportunities identified in the e-commerce fulfillment process involve technological developments in Spoke, the company's information system. For this reason, their implementation is dependent on the IT team availability, which is scarce due to

the several ongoing projects within the company and the entrance of new brands that require integration mechanisms to accommodate all the required data in Spoke. Therefore, a follow-up program must be conducted in order to ensure that these suggestions enter the pipeline of work of the IT team to be seamlessly implemented. This monitoring job can be eased by the integration of the continuous improvement responsible in the company in the weekly IT meetings.

At the moment, the picking process does not consider a logic of minimizing the operator travelled distance and time. Hence, the development of a vehicle routing optimization algorithm would enable to minimize that distance and time, and increase the picking efficiency, consequently improving the e-commerce process. In this context, the algorithm should consider the schedule of the carriers as the first criteria to pick a product and the most time-consuming orders to fulfill, according to the packaging procedures, as the second criteria to prioritize the picking sequence of the SOs.

When it comes to the incidents management flow and record, the developed solution using the Trello and the Excel presents several limitations. It demands the pivot to copy all the incidents information from the Trello to the respective fields in the Excel file in order to assess their impact. Therefore, the presented solution must be only temporary and evolve for a more integrated system. A possible future solution is to use Zendesk, a customer service software and support ticket system, which has the same principles as Trello, but in a more integrated way and presenting some functionalities which ease its use. Additionally, Zendesk allows to extract the data from the cloud to an external file, allowing to assess all the required analysis. Besides this possible solution for a near future, the ideal is to integrate the logic of managing and reporting the incidents in Spoke, so that the information can be intrinsically linked to each SO.

Looking towards the major stream in which the e-commerce process is inserted – the outbound stream -, the implementation of electronic and technological solutions, such as radio frequency identification (RFID) structures would eliminate the occurrence of errors such as exchange of labels, which represent 17% of the identified incidents and one of the most expensive for the company, and the shipment record I process that has high degree of uncertainty associated with. However, a more in-depth study must be conducted to assess the feasibility of the implementation, balancing the costs and the expected benefits offered by this new technology.

References

Aguilar-Savén, Ruth Sara. 2004. "Business process modelling: Review and framework". *International Journal of Production Economics* no. 90 (2):129-149.

Beamon, Benita M. 1998. "Supply chain design and analysis: Models and methods". *International Journal of Production Economics* no. 55:281-294.

Bhuiyan, Nadia and Baghel, Amit. 2005. "An overview of continuous improvement: from the past to the present". *Management Decision* no. 43 (5):761-771.

Borsos, G., Iacob, C. C. and Calefariu, G. 2016. "The use KPI's to determine the waste in production process". *IOP Conference Series: Materials Science and Engineering* no. 161:012102.

Caton, Chris. "Prologis: Your Next Store May be a Warehouse". Accessed 29/05/2018. https://www.prologis.com/ecommerce-logistics.

Chase, Jacobs and Aquilano. 2005. "Operations Management for Competitive Advantage".190-199.

Chorfi, Z., Berrado, A. and Benabbou, L. 2015. "Selection of Key Performance Indicators for Supply Chain Monitoring using MCDA".

Christopher, Martin. 2011. "Logistics & Supply Chain Management". *Pearson UK* no. 4th edition.

Coimbra, E. A. 2013. "Kaizen in Logistics & Supply Chains". *McGraw-Hill Education*.

Foundation, E-commerce. 2017. "Global E-commerce Report 2017".

Gapp, Rod, Fisher, Ron and Kobayashi, Kaoru. 2008. "Implementing 5S within a Japanese context: an integrated management system". *Management Decision* no. 46 (4):565-579.

Goldratt, E. M. 1990. "Theory of Constraints".

Guedes, A., P, P and P. 2010. "Logística e Gestão da Cadeia de Abastecimento". *Lisboa: Edições Sílabo, Lda*.

Harrison, Alan and Hoek, Remko van. 2008. "Logistics Management and Strategy: Competing Through the Supply Chain". no. 3rd edition.

Hines, Peter, Holweg, Matthias and Rich, Nick. 2004. "Learning to evolve". *International Journal of Operations & Production Management* no. 24 (10):994-1011.

Hines, Peter and Rich, Nick. 1997. "The seven value stream mapping tools". *International Journal of Operations & Production Management* no. 17 (1):46-64.

Hübner, Alexander, Holzapfel, Andreas and Kuhn, Heinrich. 2015. "Operations management in multi-channel retailing: an exploratory study". *Operations Management Research* no. 8 (3-4):84-100.

Hunt, V. D. 1996. "Process Mapping: How to Reengineer Your Business Processes". *Technology Research Corporation*.

Imai, M. 2012. "*Gemba* Kaizen: A commonsense Approach to a Continuous Improvement Strategy". *McGraw-Hill Companies* no. 2nd edition.

Jaca, Carmen, Viles, Elisabeth, Paipa-Galeano, Luis, Santos, Javier and Mateo, Ricardo. 2014. "Learning 5S principles from Japanese best practitioners: case studies of five manufacturing companies". *International Journal of Production Research* no. 52 (15):4574-4586.

Jacka, J. M. and Keller, P. J. 2009. "Business Process Mapping: Improving Customer Satisfaction". *Wiley* no. 2nd edition.

Jacobs, F. R. and Chase, R. B. 2011. "Operations and Supply Chain Management". *McGraw-Hill Education* no. 14th Global edition.

Jeyaraj, A. and Sauter, V. L. . 2014. "Validation of business process models using swimlane diagrams". *Journal of Information Technology Management* no. XXV (4).

Jothimani, Dhanya and Sarmah, S. P. 2014. "Supply chain performance measurement for third party logistics". *Benchmarking: An International Journal* no. 21 (6):944-963.

Košturiak, J. and Frolík, Z. 2006. "Lean and innovative company". *Alfa Publishing*.

Krauth, Elfriede, Moonen, Hans, Popova, Viara and Schut, Martijn. 2005. "Performance Measurement and Control in Logistics Service Providing". *ICEIS*:239-247.

Lambert, D. M., Cooper, M. C. and Pagh, J. D. 1998. "Supply Chain Management: Implementation Issues and Research Opportunities". *The International Journal of Logistics Management* no. 9 (2):1-19.

LeMay, Steve, Helms, Marilyn M., Kimball, Bob and McMahon, Dave. 2017. "Supply chain management: the elusive concept and definition". *The International Journal of Logistics Management* no. 28 (4):1425-1453.

Lodgaard, Eirin, Ingvaldsen, Jonas A., Aschehoug, Silje and Gamme, Inger. 2016. "Barriers to Continuous Improvement: Perceptions of Top Managers, Middle Managers and Workers". *Procedia CIRP* no. 41:1119-1124.

Magu, Poonam, Khanna, Kumud and Seetharaman, Premavathy. 2015. "Path Process Chart – A Technique for Conducting Time and Motion Study". *Procedia Manufacturing* no. 3:6475-6482.

Meyr, Herbert, Wagner, Michael and Rohde, Jens. 2002. "Supply Chain Management and Advanced Planning". *Springer*:86-87.

MÍkva, Miroslava, Prajová, Vanessa, Yakimovich, Boris, Korshunov, Alexander and Tyurin, Ivan. 2016. "Standardization – One of the Tools of Continuous Improvement". *Procedia Engineering* no. 149:329-332.

Pentina, Iryna and Hasty, Ronald W. 2009. "Effects of Multichannel Coordination and E-Commerce Outsourcing on Online Retail Performance". *Journal of Marketing Channels* no. 16 (4):359-374.

Randhawa, Jugraj Singh and Ahuja, Inderpreet Singh. 2017a. "5S – a quality improvement tool for sustainable performance: literature review and directions". *International Journal of Quality & Reliability Management* no. 34 (3):334-361.

———. 2017b. "Evaluating impact of 5S implementation on business performance". *International Journal of Productivity and Performance Management* no. 66 (7):948-978.

Rushton, Alan, Croucher, Phil and Baker, Peter. 2010. "The Handbook of Logistics & Distribution Management". *The Chartered Institute of Logistics and Transport (UK)* no. 4th edition.

Savelsbergh, Martin and Woensel, Tom Van. 2016. "City Logistics: Challenges and Opportunities".

Schmidt, M. T. , Elezi, F., Tommelein, I. D. and Lindemann, U. . 2014. "Towards recursive Plan-Do-Check-Act Cycles for Continuous Improvement". *IEEE IEEM*:1486-1490.

Shah, Satya R. and Naghi Ganji, Elmira. 2017. "Lean production and supply chain innovation in baked foods supplier to improve performance". *British Food Journal* no. 119 (11):2421-2447.

Sharp, A. and McDermott, P. 2008. "Workflow Modeling: Tools for Process Improvement and Application Development". *Artech House Publishers* no. 2nd edition.

Shou, Wenchi, Wang, Jun, Wu, Peng, Wang, Xiangyu and Chong, Heap-Yih. 2017. "A cross-sector review on the use of value stream mapping". *International Journal of Production Research* no. 55 (13):3906-3928.

Slack, N., Chambers, S. and Johnston, R. 2007. "Operations Management ". *Pearson Education* no. 5th edition.

Sokovic, M., Pavletic, D. and Kern Pipan, K. 2010. "Quality Improvement Methodologies - PDCA Cycle, RADAR Matrix, DMAIC and DFSS". *Journal of Achievements in Materials and Manufacturing Engineering* no. 43 (1):476-483.

Statista. 2018a. "E-commerce share of total global retail sales from 2015 to 2021”". Accessed 28/05/2018. https://www.statista.com/statistics/534123/e-commerce-share-of-retail-sales-worldwide/.

———. 2018b. "Retail e-commerce sales worldwide from 2014 to 2021 (in billion U.S. dollars)". Accessed 29/05/2018. https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/.

Toivonen, Teemu and Siitonen, Juha. 2016. "Value Stream Analysis for Complex Processes and Systems". *Procedia CIRP* no. 39:9-15.

Womack, J. P. and Jones, D. T. 2003. "Lean thinking: Banish waste and create wealth in your corporation". *FREE PRESS*.

Yang, L. and Wu, S. 2010. "Study of Logistics Management Model Based on E-commerce". *International Conference on Advanced Computer Theory and Engineering (ICACTE)* no. 6:10-13.

Zhang, Qing Ying, Sun, Xiao Fang and Wang, Chuan. 2012. "The Quality Management of Food Cold Chain Logistics Based on PDCA Cycle". *Advanced Materials Research* no. 424-425:1338-1341.

APPENDIX A. Guide to Number of Cycles to be observed in a Time Study

When Time per Cycle Is More than	Minimum Number of Cycles of Study (Activity)		
	Over 10,000 per Year	1,000–10,000	Under 1,000
8 hours	2	1	1
3	3	2	1
2	4	2	1
1	5	3	2
48 minutes	6	3	2
30	8	4	3
20	10	5	4
12	12	6	5
8	15	8	6
5	20	10	8
3	25	12	10
2	30	15	12
1	40	20	15
.7	50	25	20
.5	60	30	25
.3	80	40	30
.2	100	50	40
.1	120	60	50
Under .1	140	80	60

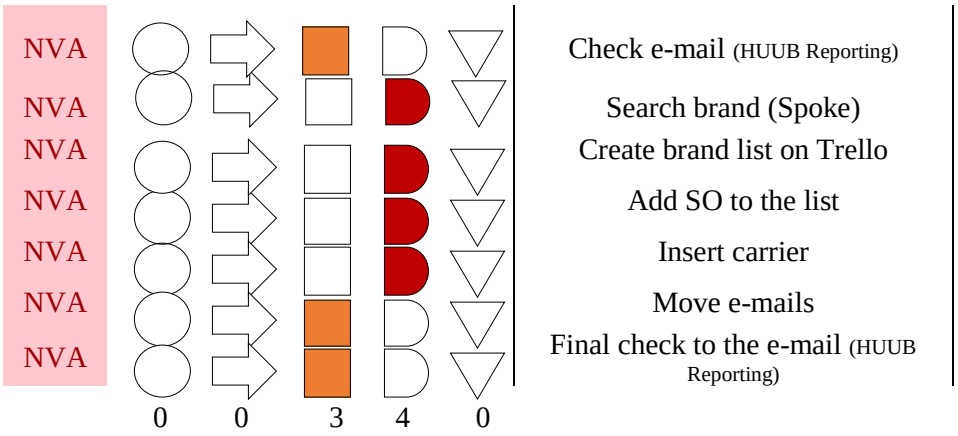
Source: B. W. Niebel, *Motion and Time Study*, 9th ed. (Burr Ridge, IL: Richard D. Irwin, 1993), p. 390. The McGraw-Hill Companies, Inc. Used with Permission.

Figure A.1 - Guide to number of cycles to be observed in a Time Study

in (Chase *et al.* 2005)

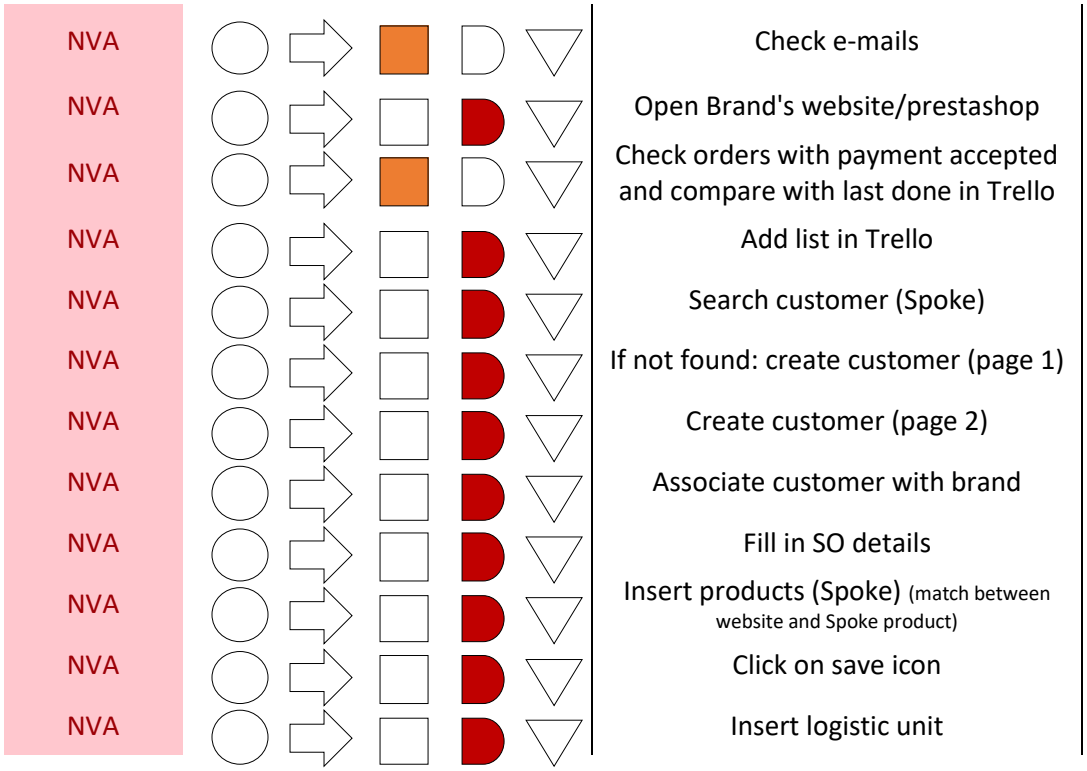
APPENDIX B. Process Charts for E-commerce Processes

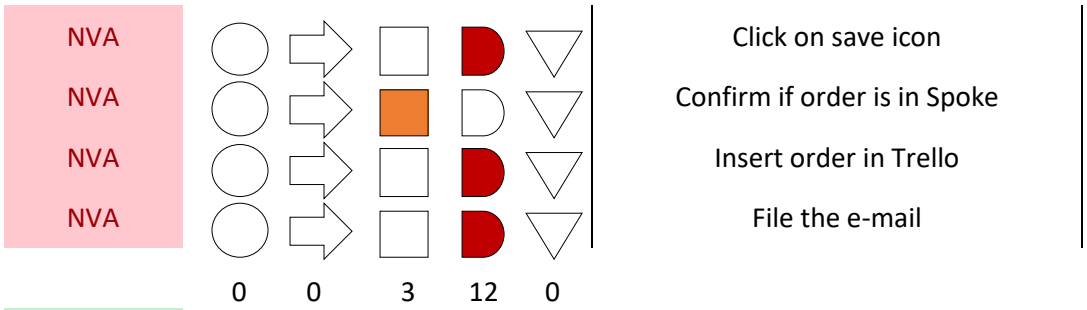
Table B.1 - Process Chart: Validation of Automatic SOs



VA	0
NNVA	0
NVA	7

Table B.2 - Process chart: Manual Insertion of SOs





VA	0
NNVA	0
NVA	15

APPENDIX C. Documents Handling Process Flow

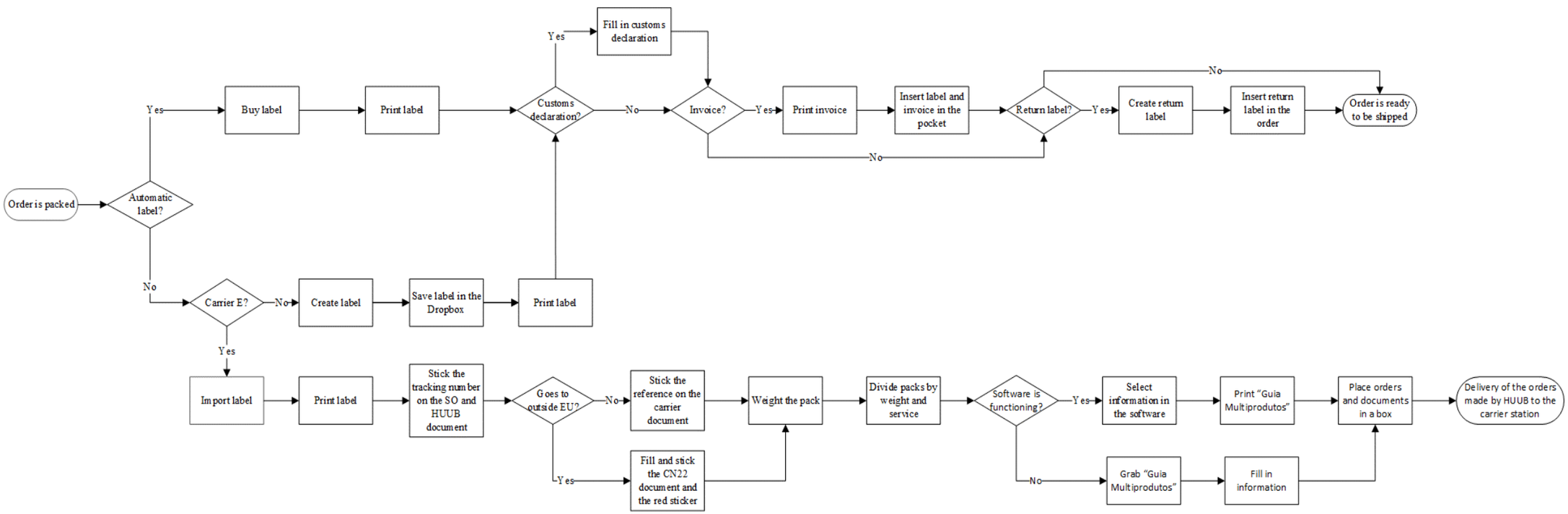


Figure C.2 - Documents Handling process flow

APPENDIX D. Normal Time, Average Nr. Of SOs per day and Nr. Of operators per process

Table D.3 - Normal time, average number of SOs per day and number of operators per process

Process	NT (min/order)	Number of SOs/day	Number of operators
Validation of automatic SOs	1.03	31	1
Manual insertion of SOs	8.07	7	1
PFS single order	2.41	32	2
PFS bulk order	2.38	6	2
Packaging: Cluster 1	6.39	5	2
Packaging: Cluster 2	8.05	1	2
Packaging: Cluster 3	3.10	6	2
Packaging: Cluster 4	7.06	1	2
Packaging: Cluster 5	6.11	2	2
Packaging: Cluster 6	8.09	3	2
Packaging: Cluster 7	2.17	17	2
Packaging: Cluster 8	5.51	2	2
Packaging: Cluster 9	2.33	0	2
Packaging: Cluster 10	4.20	2	2
Carrier Validation	0.55	38	2
Documents Handling: Automatic label	4.25	19	2
Documents Handling: Manual label – Carrier B	8.50	2	1
Documents Handling: Manual label – Carrier C	9.27	0	1
Documents Handling: Manual label – Carrier D	9.27	1	1
Documents Handling: Manual label – Carrier E	8.16	0	1
Documents Handling: Manual label – Carrier F	2.28	16	1
Shipment Record I	1.13	38	1
Shipment Record II	1.13	38	1

APPENDIX E. Division of Operators per Process

Table E.4 - Division of operators per process

Process	Operator		Time	
	Team-Leader	A	Team-Leader	A
Manual Insertion of SOs	x		282,45	
Docs - Automatic Label	x	x	174,28	174,28
Docs - Manual Label	x		110,51	
Docs - Carrier F	-	-	95,76	95,76
Packaging	x	x	416,81	416,81
PFS single order	x	x	190,56	190,56
PFS bulk order	x	x	38,15	38,15
Validation of Automatic SOs	x		159,88	
Carrier Validation	x	x	52,20	52,20
Carrier F Shipment	x		150	
Total			1671	968