



DELIVERY QUALITY INDICATOR IMPROVEMENT AND PICKING WAREHOUSE OPTIMIZATION:

THE CASE OF UNICER BEBIDAS, SA

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Internship Report
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BIOGRAPHIC NOTE

Ana Machado Rocha was born in November 1st 1994 in Porto, Portugal. Even though she studied “Science and Technology” during high school, she decided to study management in her bachelor. Ana enrolled in the bachelor in Management at School of Economics and Management, University of Porto (FEP) in 2012. Three years later, once she completed her graduation, she applied to the Master in Management, also at FEP.

During her master studies, Ana was part of the Double Degree Program, which conceded two diplomas: one from FEP and the other from KEDGE Business School (KBS). One of the requirements to obtain the diploma was one semester abroad and so she was in Marseille, France, studying in KBS.

In the last year of the master, Ana did a 6-month internship in Unicer Bebidas, SA, in the Logistics Department. During that period, Ana had the opportunity to be involved in several projects, which are described in this internship report.

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ABSTRACT

One of the issues that concerns logistics managers is the service level that the Third-Party Logistics (TPL) provide to the customers. Especially on transportation outsourcing, it is very difficult to control the product from the moment it leaves the company, until it reaches the customer

Other issues that concern managers are related with warehousing, since they play a vital role in the company's performance. The most expensive activity within a warehouse is the order picking. However, there are different ways of optimizing this activity, through the warehouse layout. Also, the loading activity plays an important role, not only in transportation economies but also in the warehouse operations.

The aim of this study aroused from a logistics internship in a beverage company in Portugal, Unicer Bebidas SA. The internship was conducted in two different areas within the department: "Transportation and Distribution" and "Logistic Platforms". In the first one, the goal was to improve the delivery indicator previously implemented by the company. In the second one, the projects were conducted over the picking warehouse in the company's headquarters. The mains goals in the Logistics Platforms area were to develop an algorithm which enabled a stacking classification and the development of a tool which allowed the understanding of the picking warehouse layout and storage allocation management. In order to achieve this goal, the case study methodology was followed and the data was collected through direct and participant observation, documents, archival records and interviews.

The delivery indicator tool and the algorithm developed are, nowadays, implemented in the company's operations. The goal of the delivery indicator was achieved, since the percentages started to increase rapidly. The algorithm showed reliable results, even though there is still no statistics for its impact in terms of time savings in the loading activity. Lastly, the storage location verification tool is not implemented yet, but the outcome was highly satisfactory and it will be implemented until the end of 2017.

Key-words: Supply chain, Transportation, Outsourcing, Delivery Control, Warehousing, Stack-Up, Storage Allocation Assignment, Beverages

JEL-codes: L66, L87, L91

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INDEX OF ACRONYMS

40 - 40 tons trucks (Exportation)
1D - Direct Distribution in 10 tons vehicles (Secondary Distribution)
2D - Direct Distribution in 20 tons vehicles (Secondary Distribution)
4D - Direct Distribution in 40 tons vehicles (Secondary Distribution)
ABC - Inventory categorization technique
C2 - 20 tons containers (Exportation)
C4 - 40 tons containers (Exportation)
CO2 - Carbon Dioxide
DC - Distribution Centre
DPLP - Distributor's Pallet Loading Problem
HO - HORECA Channel (Secondary Distribution)
HS - Hyper and Supermarkets (Secondary Distribution)
I/O - Input / Output point
KPI - Key Performance Indicator
L - Litre
LSP - Logistics Service Provider
LSP1 - Logistics Service Provider 1
LSP2 - Logistics Service Provider 2
LSP3 - Logistics Service Provider 3
LSP3.1 - LSP3 Primary Distribution
LSP3.2 - LSP3 Secondary Distribution
LSP4 - Logistics Service Provider 4
LSP5 - Logistics Service Provider 5
MCP14 - Scanner located in the left side of the picking warehouse
MPLP - Manufacturer's Pallet Loading Problem
OPS - Order Picking System
PBS - Pick by Store
PBL - Pick by Line
PET - Polyethylene Terephthalate (Type of packing)
POS - Point-of-sale
PP - Door-to-door Distribution (Capilar Distribution)

PR - Primary Distribution

S1 - SMS "Arrived and waits for unload"

S2 - SMS "Delivery with no incidents"

S3 - SMS "Delivery with incidents"

S4 - SMS "No delivery"

SAP - Unicer's Database

SC - Supply Chain

SCM - Supply Chain Management

SCP14 - Scanner located in the right side of the picking warehouse

SKU - Stock Keeping Unit

SL - Service Level

SLA - Service Level Agreements

SSCC - Serial Shipping Container Code

TPL - Third-Party Logistics

VHU - Verification Handling Unit

1. INTRODUCTION

Logistics and Supply Chains are being recognized in organizations as an important part of their strategies, due to the crucial role that they have in each company's competitiveness (Mellat-Parast and Spillan, 2014). It is also common that companies do not perform the entire activities essential to their business and, instead, they subcontract another company that is able to better perform that or those activities (Joong-Kun Cho et al., 2008). This process is called outsourcing and, nowadays, many companies begin to use it as a way to focus on other activities that they believe to perform best in their business. This usually happens with services such as outbound and inbound transportation, warehousing, freight bill auditing and freight distribution (Joong-Kun Cho et al., 2008). Companies that are engaged in outsourcing, sometimes face difficulties in terms of managing the subcontracted activities. Therefore, the challenges increase when the outsourcer attempts to control the service provided by the outsourcee (Jamwal and Meda, 2012).

Other issues that concern managers are related with warehousing, since they play a vital role in the company's performance. With more product variety, smaller orders and the need for shorter response times, efficiency and effectiveness become even more important. The most expensive activity within a warehouse is the order picking. However, there are different ways for optimizing this activity, through the warehouse layout. Also, the loading activity plays an important role, not only in transportation economies but also in the warehouse operations. This is another activity which can be optimized.

This research has arisen from an internship at Unicer Bebidas, SA (hereafter referred to as Unicer), the Portuguese leader company in the beverages market. As a consequence of *Prémio de Logística Moderna* 2015 Award, given annually by the *Logística Moderna* magazine and the APLOG (*Associação Portuguesa* Logistics), Unicer represents a great opportunity to do research in Logistics (Miebach, 2015). This award congratulates professionals and organization which contribute to the development of logistics in Portugal. The internship was conducted in two areas of the Logistics Department: "Transportation and Distribution" and "Logistic Platforms".

With this said, this research has two different topics, which give origin to three research questions:

1. *How to improve the delivery quality indicator in the outsourced transportation services at Unicer Bebidas, SA?*
2. *How to develop a stack-up decision algorithm for mixed pallets?*
3. *How to verify the current storage locations assignment within the picking warehouse?*

One of the research goals is to improve the delivery control system that Unicer is implementing, aside with its new self-service portal for transportation companies. Without its own transportation service, Unicer uses outsourcing to deliver its products, which makes it difficult to know the exact time that each delivery arrives to the customer. This system will allow the company to receive more feedback from its customers, through the development of a daily indicator that will evaluate the effective time of each daily delivery. Besides this daily indicator, the new control system should also include other monthly indicators that will enable Unicer to evaluate the number of deliveries scheduled in the portal and the successful delivery rate.

The second and third questions are related, since they were studied in the same environment: the picking warehouse of Unicer in *Leça do Balio*. The goal is to develop an algorithm which categorizes mixed pallets as “Good bases for stacking” or “Non-Good bases for stacking”. Finally, due to managers concerns, the last issue of this research will focus on the warehouse layout, with the aim of developing a tool which enables the verification of the storage locations.

An internship is commonly used by universities as a way to help students transiting from higher education to their professional lives (Silva *et al.*, 2016). This practical teaching gives students skills, knowledge and abilities that allow them to overcome the challenges they will face in their workplaces. In the end of an internship, students are said being more ambitious, having higher job satisfaction and being less shocked when they entry the real-world employment (Silva *et al.*, 2016). Besides that, students who do internships improve their work habits, have the possibility to receive an offer for employment and might receive higher starting salaries than students who don't (Silva *et al.*, 2016). An internship not only affects students but also employers and schools (Maertz and Marks,

2014). For employers, they receive high qualified, motivated and inexpensive labor. Besides that, they have reduced costs in the recruitment process through the relation between the company and the academic institution (Sanahuja Vélez and Ribes Giner, 2015). Finally, internships also have benefits for schools because they improve the schools' visibility in the job market. Schools which place their students in companies have the chance to provide them an experiential education and also demonstrate their success in preparing students for jobs (Maertz and Marks, 2014).

This internship and, in consequence, this study are important for the company since they will provide a clearer view over its delivery quality control system, guidelines to improve it, a functional stacking decision algorithm and a storage location verification tool. Outsourcing, performance measurement and order picking are topics which have been emerging their importance among researchers. Therefore, this study will be an addition to the existing literature.

This report is structured into 4 different chapters, besides this one. In Chapter 2, it is presented a literature review of the topics previously introduced: supply chain, transportation, outsourcing, performance measurement, deliveries, warehousing, order picking, stack-up problem, warehouse layout and similar studies. In Chapter 3, the methodology of the present and similar studies is described. Chapter 4 contains a description of the case study object: Unicer Bebidas, SA. Within this chapter, the company's history, values, mission, vision and structure are presented, but special focus is paid to the Logistic Department activities. The results of this research are described in Chapter 5 and Chapter 6. The first one regard the research conducted in the "Transportation and Distribution" area, which was the development of the delivery indicator existent in the company. Chapter 6, on the other hand, concerns the projects conducted in the "Logistic Platforms" area. In this chapter, a solution for a stacking decision algorithm will be presented as well as a storage location verification tool. Lastly, limitations, future implications and conclusions are presented in Chapter 7.

2. LITERATURE REVIEW

Within this section, the relevant topics for this study will be presented. As it was stated in the previous chapter, this research is a result of an internship conducted in two different areas of the Logistic Department of Unicer. This means that both areas are going to be subject of research.

In Section 2.1, the main topics related to supply chain that have relevance to this study are presented (supply chain, supply chain management, logistics, supply chain integration). In Section 2.2, “Transportation” is introduced and it is given a focus to the research issue, the delays. In Section 2.3, it is provided a description of outsourcing as well as its main advantages and disadvantages. Thereby, Section 2.4 deals with the main descriptions and characteristics of delivery performance measurement. After focusing on this topic, some literature review regarding warehousing and order picking is provided in Section 2.5. In this section, the fundamental literature review for the stack-up problem and warehouse layout is presented. Lastly, on Section 2.6., similar studies are summarized.

2.1. SUPPLY CHAIN

2.1.1. INTRODUCTION TO SUPPLY CHAIN, SUPPLY CHAIN MANAGEMENT AND LOGISTICS

Supply Chain (SC) and Supply Chain Management (SCM) have been increasing their role in company’s performance, which has led to an increase in academic research on this topic (Janvier-James, 2012). Supply Chain is being seen as an important part of a company’s strategy, by providing a competitive advantage (Ireland and Webb, 2007), that companies use to stand out in this emerging competitive environment (Lambert and Cooper, 2000). The competition is no longer between brands or stores but rather between supply chains (Lambert and Cooper, 2000).

Many authors have developed definitions for Supply Chain and Supply Chain Management. While Pienaar (2009) believes that Supply Chain can be described as the integration of all the activities and organizations that transform the raw materials into

finished goods and then deliver them to the final customer, Kukovič *et al.* (2016) and Aguezzoul (2014) believe that SC is not only about the goods flow, but it also concerns information and financial flows. At the same time, there are many definitions in academic literature for SCM, e.g. the examination and management of the supply chain networks (Janvier-James, 2012). A good SCM allows a company to achieve higher customer service levels, ensure the quality of its products and to reduce management costs (Armstrong and Kotler, 2009). Therefore, the definition given by the Global Supply Chain Forum, which is represented by academic researchers and non-competing firms, states that SCM is “the integration of key businesses processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders” (Lambert and Cooper, 2000, p.66). These key business processes that supply chain is in charge of are: customer relationship and service management, demand management, order fulfillment, manufacturing flow management, procurement, product development and commercialization and returns. To have a successful SCM, companies need to start managing their activities as part of the key business processes, instead of managing them as individual activities (Lambert and Cooper, 2000). The goal of SCM is to optimize the supply chain, by maximizing its efficiency, creating a competitive advantage and having firm focused tactics (Manzini *et al.*, 2005). This goal is common to every industry, since every company’s concern is to “provide customers with the right product/service, at the right time, in the right place, in a profitable way for the company” (Serdaris *et al.*, 2014, p. 485).

The importance of SCM has been increasing since the mid-1990s, due to the increase of supply chains’ complexity, cost and uncertainty. This is a consequence of globalization, which has driven companies to move out-boarders, and to source, produce and sell their distributed products in the global environment (König and Spinler, 2016). Until more recently, SCM was not considered any different from logistics, by most of the researchers and practitioners. In fact, Logistics Management is a part of SCM because it represents the process of planning, controlling and implementing efficiency and effective flows of information and goods, from the raw materials to the end-consumer (Serdaris *et al.*, 2014). SCM, on the other hand, can be seen has the integration of logistics with the rest of the business processes (Lambert and Cooper, 2000). Logistics activities are represented through transportation, warehousing and the integration of those activities in the entire

supply chain, while SCM focuses on merging those activities with the rest of the activities within the company, such as marketing, finance, operations, and with other businesses outside the company (Serdaris *et al.*, 2014). As Lambert and Cooper (2000) mentioned, marketing is a great example to understand the Logistics and SCM concepts. The goal of marketing is to fulfill customers' needs, but this concept does not apply only to the marketing department but rather to the entire company, because it is every department's responsibility to focus on customers' needs.

2.1.2. SUPPLY CHAIN INTEGRATION

In the past years, researchers have also focused their attention in understanding how company's performance can be affected through supply chain integration. Integration can be defined as different parties working together, in a cooperative way, to achieve common goals and outcomes. This cooperation should happen both inside and outside the company's boundaries since it can provide cost reductions and higher inventory turnovers (Jayaram and Tan, 2010). Although integration improves efficiency, by increasing the flow of goods and information across members, without a trustworthy method, managers might have difficulties in understanding the existing obstacles within the supply chain, which can later difficult that improvement (Janvier-James, 2012). With this said, there are two different types of integration: vertical and horizontal integration. While vertical integration refers to "the incorporation into a single corporate of several corporate involved in all aspects of a good's production from raw materials to distribution", horizontal integration "refers to the incorporation into a single corporate of several corporates involved in the similar level of production and sharing" (Janvier-James, 2012, p.199). Besides effectivity, supply chain integration can also provide agility to a supply chain (Panayides, 2006), which can have benefits such as greater flexibility to adapt to the constant changeable business environment and higher levels of customer satisfaction (Janvier-James, 2012).

2.2. TRANSPORTATION

2.2.1. INTRODUCTION TO TRANSPORTATION

A SC has two different channels: the materials supply channel and the product or service distribution channel. As the name points itself, the materials supply channel represents all the organizations that provide materials to the manufacturing, while the distribution channel has the aim to provide the end-customer the final product/service. Therefore, transportation is one of the key activities in logistics (Ballou, 2004), because it is essential, in each company that the product is delivered where the demand took place (Binioris, 2008) (cited in Serdaris *et al.*, 2014). Through the years, transportation went from a simple scheme where the final product was directly delivered to the end consumer, to a more complex distribution that includes middlemen. This means that distribution channels can have intermediary stops, called commodity centers that allow companies to decentralize the distribution of loads (Serdaris *et al.*, 2014). With the advance of technology, other areas, such as supply chain, improved their operating processes. Transportation can go from simply collecting at the origin and delivering in the destination point, to additional functions like storage (Van Schijndel and Dinwoodie, 2000).

According to Serdaris *et al.* (2014), transportation services strategy is aligned with logistics management, meaning that quality, speed, cost reduction, technology access and risk management are essential factors. The choice of transportation should guarantee the company that the product is transferred without defects and damages and, at the same time, it should give the opportunity to easily enter in new markets as well as reducing inventory holdings, by having high transportation speed. Regarding cost reduction, transportation represents a big parcel in the logistics total costs, so decreasing transportation costs would allow companies to reduce this total cost. Besides this, when a company is determining the most suitable transportation service, attention should be paid to the risk that each mean of transportation and transportation service itself have, to be sure that the product is always available to the consumers. The most common means of transportation, according to Ballou (2004), Binioris (2008) (cited in Serdaris *et al.*, 2014) and Neeraja *et al.* (2014), are:

		Means of Transportation				
		Rail	Road	Water	Air	Pipelines
Characteristics	Accessibility	High	High	Medium	Medium	Low
	Reliability	Medium	High	High	High	High
	Flexibility	Low	High	Low	Low	Low
	Capacity	Medium	Medium	High	Medium	Low
	Distance	High	Medium	High	High	Low
	Cost	Low	Medium	Low	High	Low
	Speed	Medium	Medium	Low	High	Low

Table 1 - Means of transportation

Source: Author based on Ballou (2004), Binioris (2008) (cited in Serdaris et al., 2014) and Neeraja et al. (2014)

Nowadays, road transportation is the most common mean of transportation in Europe, since it can cover any shipping need (Sternberg *et al.*, 2013). Sternberg *et al.* (2013) mention that it is the most suitable form of continental transportation for its flexibility. However, there is the possibility to move a cargo using two or more different means of transportation, at the same rate. This process is called multimodal transport and its main goal is to transfer the freight within the entire transport chain, at the lowest possible cost and time. Regardless the use of one or more means of transportation to move a cargo, the choice of transportation mean is a trade-off between customer service and cost (Serdaris *et al.*, 2014).

2.2.2. TRANSPORTATION UNCERTAINTY AND DELAYS

According to Sanchez Rodrigues *et al.* (2008), uncertainty affects supply chains and, to overcome this barrier, companies try to track variations, which leads to cost increase, or even to be prepared for such events, by increasing their inventory, which leads to an increase in holding costs. Transportation managers must consider the uncertainty issue and have a flexible and responsive service that is able to fulfill the consumers' needs. There are situations that occur out of company's boundaries that managers must consider when planning the transportation, such as transit times, customers' delivery windows, volume and transportation mode (Sanchez Rodrigues *et al.*, 2008). Risk and uncertainty are different concepts that are many times confused. While risk is something that can be

predicted, as well as the impact that it might have on the supply chain, uncertainty is something that cannot be predicted, neither its impact on the company. Nevertheless, uncertainty increases with risk and risk is a consequence of uncertainty (Sanchez Rodrigues *et al.*, 2008). Therefore, flexibility of transportation can be used as a competitive advantage (Naim *et al.*, 2006) since it creates an efficient transportation strategy that can add value to the service offered to consumers (Villarreal *et al.*, 2016). Flexibility doesn't mean that companies should be able to cover all the possibilities, since is it very expensive but, instead, businesses should have a strategy that enables them to fulfill all the customers' needs and minimize costs.

The transportation uncertainty is a consequence of the increasing outsourcing within the supply chain network, since it increases the supply chain complexity by making more difficult the information visibility and the communication among the members (Sanchez Rodrigues *et al.*, 2008). Therefore, the integration of the supply chain becomes essential to have an effective supply chain. The transportation services can be provided by the company itself, by a third-party logistics or by a combination of both (Tracey, 2004).

2.3. OUTSOURCING

2.3.1. INTRODUCTION TO OUTSOURCING

Companies are becoming more aware that a good management of logistics activities can add value to the product or service distributed. They have three different ways to handle those activities, in an effective and efficiency way (Abdur Razzaque and Chen Sheng, 1998; Juga and Grant, 2010): making the service and have it in-house; own a logistics subsidiary or buying a logistics company; outsource the function and buy the service.

According to Sloper (2004, p.34), outsourcing is “one of the fastest growing and evolving business activities worldwide”. Outsourcing, third-party logistics and contract logistics represent, in general terms, the same concept (Lieb *et al.*, 1993, cited in Lambert *et al.*, 1999) which has been increasing over the years (Abdur Razzaque and Chen Sheng, 1998; Berglund *et al.*, 1999; Hertz and Alfredsson, 2003; Lambert *et al.*, 1999), as well as the research on this topic (Marasco, 2008; Berglund *et al.*, 1999). Recently, there has been paid more attention to this topic, among researchers and academics, and it led to an increase in the number of definitions presented in scholarly journals, trade publications and magazines (Marasco, 2008). While Skjoett-Larsen (2000) defines outsourcing as being the use of external companies to perform some or all the logistics activities of a company, Van Laarhoven *et al.* (2000) and Berglund *et al.* (1999) defend that the logistics activities being outsourced are, at least, warehousing and transportation management and execution, and other activities, such as inventory management, can be added. Nevertheless, in this report, the concept of outsourcing will be considered as the use of a logistics service provider to perform some or all logistics activities (the definition presented by Lambert *et al.*, 1999).

There are several reasons behind the growth of outsourcing but the most mentioned cause in papers is globalization (Abdur Razzaque and Chen Sheng, 1998). With the increase of supply chains' complexity, companies do not have enough knowledge to enter into different geographic markets, because they don't have information and experience in performing in such places. Therefore, the need to use an external company to perform some or all logistics activities increases and many companies nowadays outsource the activities that they used to perform by themselves (Kremic *et al.*, 2006). Nevertheless, logistics managers should keep the company's core activities in-house and considering

the possibility of outsourcing in the remaining activities (Lieb, 1992; Sheffi, 1990). According to Damme and Amstel (1996) and Marchet *et al.* (2017), this decision should involve the entire organization, since it represents a strategic choice and it will affect the entire business for a long period of time. The “make-or-buy” decision should be taken having some considerations in mind: the cost differences between having the activity in-house or outsourcing, the demand fluctuations, the flexibility in responding to customers’ needs, the availability of personnel and equipment and the level of dependence on the activity (Damme and Amstel, 1996; Zhu *et al.*, 2017). There is a need to look at the company’s plans and evaluate if the goal is to be a service leader or a cost leader. Eventually, if the decision is to outsource a certain activity, the third-party logistics chosen should complement the company’s weaknesses (Abdur Razzaque and Chen Sheng, 1998).

Eventually, when the company takes the decision to outsource, a long-term relationship is established between the outsourcer, the buyer of the service, and the outsourcee, the company providing the service (Lambert *et al.*, 1999). This relation is usually called a partnership since, when successful, can bring competitive advantage to both companies by increasing profits, efficiency and customers service. On the other hand, not all relationships are successful, due to the unrealistic expectations that on or both parties might have over the agreement. Therefore, there is a lack in literature regarding the type of relationship to adopt according to different outsourcing situations. Lambert *et al.* (1999) developed a model that not only helps to decide if outsourcing should be integrated in the company’s strategy, but also to understand which type of relationship should be established. The success of outsourcing depends on the relationship established between the company and the logistics service provider. It should be based on faith and trust, without jeopardizing the control that the company must have over the activity or activities performed by the third-party logistics (Abdur Razzaque and Chen Sheng, 1998; Núñez-Carballosa and Guitart-Tarrés, 2011).

Although outsourcing is available for all logistics activities, transportation is the most outsourced service (Ashenbaum *et al.*, 2015; ModusLink, 2016; Wilding and Juriado, 2004), while manufacturing, product design and assembly are in the bottom of the list (ModusLink, 2016). According to 66% of the respondents of the study conducted by

ModusLink Global Solution (2016), transportation seems to fit the criteria for logistics activities that can be outsourced because, usually, it is not a core-competence of the company and, therefore, a third-party logistics is able to reduce costs as well as to increase the service flexibility, due to the market knowledge. Rahman and Jim Wu (2011) summarized five recent academic works and concluded that transportation and distribution related activities were the outsourced logistics services with the higher percentage of use.

2.3.2. ADVANTAGES AND DISADVANTAGES OF OUTSOURCING

According to Lambert *et al.* (1999), when companies take the decision to outsource a logistics service, their expectations are efficiency, profitability and customer service improvement. The TPL provider is able to offer more efficiency, due to the possibility of benefiting from economies of scale and, after adopting an outsourcing strategy, human resources, maintenance of equipment, licenses and regulations related to the logistics service, are no longer shipper's responsibilities or concerns (Damme and Amstel, 1996; Zailani *et al.*, 2017). Moreover, this business is recognized for lowering logistics costs, by many authors (Abdur Razzaque and Chen Sheng, 1998; Batarlienė and Jarašūnienė, 2017; Kremic *et al.*, 2006). However, previously, in some cases, outsourcing might not have brought reduction of costs (Lacity *et al.*, 1995; Loh and Venkatraman, 1992). According to a study conducted on different states in USA (Yusuf and O'Connell, 2013, p. 488), most of the respondents believe that outsourcing is "more likely to improve quality than reduce costs".

There are many papers mentioning the benefits of outsourcing, but the risks are not so well known (Kremic *et al.*, 2006; Lambert *et al.*, 1999). Still, some disadvantages have already been identified (Batarlienė and Jarašūnienė, 2017; Damme and Amstel, 1996). Regarding transportation, the buying company no longer has the same direct customer contact as it used to have and, therefore, the feedback received takes longer to reach the logistics managers, affecting the response capability of the company. Without underestimating the previous risks, the lack of control (Damme and Amstel, 1996; Zailani *et al.*, 2017) is one of the disadvantages that most concerns managers (Lieb and Randall, 1996). Likewise, the service level and the true cost of outsourcing are seen as uncertainties that can affect the company's performance. Lastly, the dependence on the

TPL is also a disadvantage and, to minimize this issue, companies should have more than one supplier for that service (Damme and Amstel, 1996).

2.4. DELIVERY PERFORMANCE MEASUREMENT

2.4.1. SERVICE QUALITY DEFINITION

Over the last three decades, quality management research has been increasing among academics (Cheng *et al.*, 2005). Ghobadian *et al.* (1994) mentioned that, in many manufacturing industries, service quality can be more important than product quality, in terms of long-term relationships and profitability. Therefore, in order to pursue this research, it is important to understand the definition of “service quality”. According to Parasuraman *et al.* (1988), service quality represents the difference between customers’ perceptions and expectations, through the impression of superiority they have over a service provider and its services (Bitner and Hubbert, 1994). In a service organization, quality is “a measure of the extent to which the service delivered meets the customer’s expectations” (Ghobadian *et al.*, 1994, p.49). Parasuraman *et al.* (1988) developed a perceived quality model, SERVQUAL, which many researchers tried to replicate to different situations. The research conducted by Bienstock *et al.* (1996) concluded that SERVQUAL is not suitable for physical distribution. The service quality measurement needs to be adapted to each business, since the type of service, situation, need and other factors vary (Seth *et al.*, 2005).

According to Gunasekaran *et al.* (2004), the link between the supply chain and the customer is the service/product delivery. Consequently and in order to increase the competitive advantage, there is a need to measure and improve this process (Gunasekaran *et al.*, 2004). Many companies have been relying on Logistics Service Providers (LSPs) to perform logistics activities, since outsourcing has been recognized for cost reduction and performance improvement (Aguzezoul, 2014). Van Iwaarden and van der Valk (2013) classify quality as being essential among service triads, since the purchased service is directly delivered to the customer by the service provider. The buying organization is highly dependent on the service provider’s performance, which is reflected in the organization’s performance as well.

The topic of service quality has already been studied in different areas, such as marketing, operations management, purchasing and supply chain but it doesn't seem to quite address the issue of triads (van Iwaarden and van der Valk, 2013).

2.4.2. PERFORMANCE MEASUREMENT

According to Fawcett and Cooper (1998), Performance Measurement is essential to every company's success. The results of this research showed that many leading companies invest on performance measurement, which is later reflected on functional excellence. This evaluation is essential, especially in relationships with logistics service providers, since it enables the company to measure the variation of service, cost and quality with outsourcing (Wilding and Juriado, 2004). Therefore, it has been increasing its relevance among researchers and academics (Folan and Browne, 2005)

The service quality assessment can be performed in three different levels, inside an organization: organizational, operational and task levels (van Iwaarden and van der Valk, 2013). However, when considering service triads, some logistics processes are no longer managed inside the organization's boundaries. At this point, other departments of the organization can have impact on this evaluation. For example, the purchasing department is responsible for selecting the service providers and they can, from the start, apply measures for supplier quality management. Besides, instead of only considering ex-post evaluation measures in the suppliers' performance assessment, ex-ante measures should also be applied (van Iwaarden and van der Valk, 2013). The study conducted by Ellram *et al.* (2007) suggested that the control of service delivery, within triads, should have in consideration the Service Level Agreements (SLA), since they enable such evaluation. Furthermore, incentives and involvement activities also provide control, as well as more motivation and trust from service providers.

Distribution has been recognized as an essential activity, among supply chains, in delivering customer service. Besides, contrarily to production activities, which have been mechanized or automated and its costs have been decreasing, distribution costs have actually increased. This has led managers to pay special attention to distribution performance (Ploos van Amstel & D'hert, 1996; Sanchez Rodrigues *et al.*, 2014).

Performance measurement in distribution involves the shippers and the customers, on the input and output sides, respectively. This enables a deeper analysis, which is very important to create higher efficiency and effectiveness than the competitors (Lai *et al.*, 2002).

2.4.3. KEY PERFORMANCE INDICATORS (KPIs)

According to Krauth *et al.* (2005), Key Performance Indicators (KPIs) are typically used to analyze a significant amount of data, in order to evaluate the past performance of the company. KPIs differ from metrics, because they evaluate the company's performance in comparison to an established goal (Eckerson, 2009). Even so, managers should not see KPIs as an end-measure but rather as a tool to improve service quality (Krakovics *et al.*, 2008). Even though performance measurement has been stated, by many researchers, as an essential process, the KPIs that should be used in this process are not so well defined (Wilding and Juriado, 2004). This happens because the definition of the KPIs depends on every company's strategy, goals and state (Krauth *et al.*, 2005).

The most common attributes of transportation, also mentioned as freight forwarding by Jothimani and Sarmah (2014), are reliability, responsiveness, flexibility, cost measures and asset management efficiency. Within these categories, these authors defined KPIs, which are summarized in Table 2. Besides, according to Kayakutlu and Buyukozkan (2011), the performance attributes regarding this logistic activity are: fleet, distance travelled, driver force, loss of goods and relocation rate. Fawcett and Cooper (1998) also defined KPIs, within the categories termed by traditional measurement systems (asset management, cost, customer service, productivity and quality). These KPIs are summarized in Table 2, as well.

Author(s)	Performance Attribute(s)	Key Performance Indicators (KPIs)
Fawcett and Cooper (1998)	Customer service	Average transit time, Transit time variability
	Productivity	Orders delivered per vehicle, Full versus partial loads
	Quality	Damage in transit, Documentation accuracy
Jothimani and Sarmah (2014)	Reliability	Carrier reliability, Geographical coverage, Service failure, Cargo damage rate, Customer referral value
	Responsiveness	Response delay index, Number of shipments responded to on time
	Flexibility	Route flexibility, Payload flexibility, Split house handled, Capacity utilization
	Cost measures	Freight cost per km, Accessorial charge index, Claims as percent of payable
	Asset management efficiency	Cash-to-cash cycle time, Outstanding payable, Utilization of specific purpose equipment

Table 2 - Transportation KPIs

Source: Author based on Fawcett and Cooper (1998) and Jothimani and Sarmah (2014)

According to the study conducted by Wilding and Juriado (2004) over European companies, performance measurement is common among triads and companies are considering the continuous development of KPIs. In the KPIs' definition, organizations should assure that they are "sparse, drillable, simple, actionable, owned, referenced, correlated, balanced, aligned and validated", in order to translate significant results (Eckerson, 2009, p.18).

Delivery performance can be measured through on-time delivery (Gunasekaran *et al.*, 2001; Krauth *et al.*, 2005) and through delivery-to-request rate, delivery to commit date, order fill lead-time and goods in transit (Stewart, 1995). In fact, it can act as a measure for customer service level (Gunasekaran *et al.*, 2001; Krauth *et al.*, 2005). The quality and quantity of information across the entire supply chain is very important, not only in the delivery, but also in the other activities as well. It plays an essential role for performance measurement and improvement (Gunasekaran *et al.*, 2001).

2.5. WAREHOUSING

2.5.1. INTRODUCTION TO WAREHOUSING

Warehouses are used to store products, which not only include finished goods but also raw materials, components and goods in process (Min, 2015). According to Frazelle (2002) and Ghiani *et al.* (2013), warehouses are playing a crucial and determinant role in companies' performances.

The increasing demand for more product variety, smaller orders and shorter response times has been affecting the way managers handle logistics operations (Rouwenhorst *et al.*, 2000). Due to these situations, warehouses are now “executing more and smaller transactions, handling and storing more items, providing more product and service customization, offering more value-added services, processing more returns and receiving and shipping more international orders” (Frazelle, 2002, p. 224). The wider variety of stock keeping units (SKUs) has led companies to centralize their distribution centers (DCs), moving from many small DCs to fewer large DCs (van den Berg and Zijm, 1999).

Achieving transportation and production economies, through combined shipment, full-truck loads and make-to-stock production policies, are some of the main warehousing advantages (De Koster *et al.*, 2007). Besides, warehouses are also useful for storage, trans-shipments (cross docking activities), product consolidation, overcome market conditions and uncertainties and purchase discount advantages (De Koster *et al.*, 2007).

Since warehousing is an expensive part of the supply chain, its ownership needs a careful consideration (Ballou, 2004). Managers can decide to have their own facilities – private warehouse – or opt by using rented spaces (Waters, 2009). The last ones can either be public warehouses or services offered by logistic service providers (Ballou, 2004). Private warehouses require a high initial investment in both space and material handling equipment (Waters, 2009) but, at the same time, offer advantages such as greater control over warehousing operations, possibility of tax advantages, possibility of using the space for different future needs, increase operations reliability by having those activities inside the company's boundaries, facilitate communications across the entire supply chain and lower costs by not having another entity that requires profit (Ballou, 2004).

There are several types of warehouses, which vary according to their functionality and position within the logistics system (Ghiani *et al.*, 2013); they have impact on costs and flexibility (Min, 2015). While private warehouses have infinite layouts, due to each company's needs, public warehouses are more standardize because they need to meet different requirement within the same space (Ballou, 2004). These publics' warehouses can be commodity warehouses, bulk storage warehouses, temperature-controlled warehouses, household goods warehouses, general merchandising warehouses or miniwarehouses. The decision underneath the warehouse holding represents a “make-or-buy” decision: comparing to public warehouses, in private warehouses the initial cost is higher but the additional cost per unit is lower (Waters, 2009).

The most common activities within a warehouse are described in Figure 1. In some situations, warehouses are also used for prepackaging, packaging and/or pricing (Frazelle, 2002).

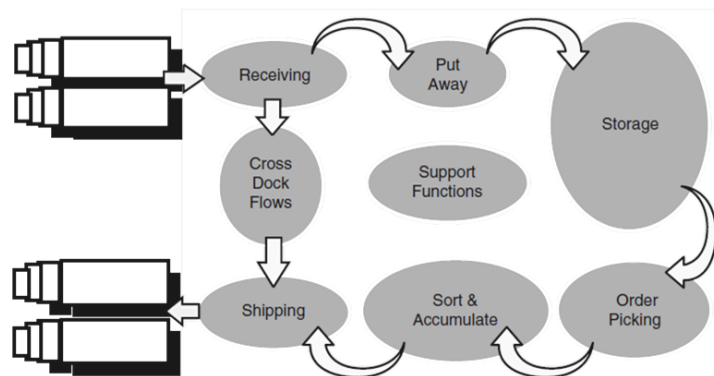


Figure 1 - Common Activities in Warehouses

Source: Frazelle (2002)

The flow of materials inside the warehouse starts with the receiving activity. Once the goods are unloaded at the receiving docks, a quality and quantity inspection is performed as well as an inventory update (De Koster *et al.*, 2007; Frazelle, 2002; Rouwenhorst *et. al.*, 2000; van den Berg and Zijm, 1999). In case the incoming storage modules are not the required, the load can be subjected to reassembly to meet the storage-cube requirements (Frazelle, 2002; van den Berg and Zijm, 1999). Then, the products are transferred to the storage locations. Once the order is placed, the order picking process begins. An order represents the right products and quantities requested by a set of customers or other workstations (De Koster *et al.*, 2007; van den Berg and Zijm, 1999). This process can be

manual or partially automated (Rouwenhorst *et al.*, 2000). In case products are assembled for a more convenient use, they must be repackaged. Delaying this process can have advantages such as higher flexibility in the inventory use (Frazelle, 2002). The products need to be sorted and accumulated if that task is not done during the order picking. Finally, the order is ready, it is stacked (in pallets, for example), if possible, and loaded in trucks, containers or other carriers (De Koster *et al.*, 2007; Rouwenhorst *et al.*, 2000). The receiving and shipping activities are the connection between the material flow and the warehouse, which require schedules for loading and unloading. The storage goal is to “achieve high space utilization and facilitate efficient material handling” (Gu *et al.*, 2007, pp. 3).

According to Frazelle (2002), after applying a survey to the members of the Warehousing Education and Research Council, order picking is the prior warehouse activity in terms of productivity improvement.

2.5.2. ORDER PICKING AND PICKING POLICIES

Order picking is a warehouse activity, which consists in the retrieving items from storage to meet customers’ specific orders (De Koster *et al.*, 2007; Henn and Wäscher, 2012; Petersen, C. G., & Aase, G., 2004; Roodbergen *et al.*, 2008). According to Dallari *et al.* (2009), this process is increasing its importance within supply chains, not only in production, by supplying other production stations with the necessary kits, but also in physical distribution, through customer order fulfilment. This process is usually followed by pickup and delivery operations (Hwang and Cho, 2006). The increasing order variety and volume (Rouwenhorst *et al.*, 2000) has been an important contribution to the order picking activity development (Henn and Wäscher, 2012). More importantly, order picking is being recognized as the most labor-intensive and costly activity within almost every warehouse, representing around 55% of the overall warehousing costs (De Koster *et al.*, 2007).

There are many order picking systems (OPSs) and it is possible to see more than one OPS within the same warehouse (De Koster *et al.*, 2007). These systems have been studied by many researchers, among them Dallari *et al.* (2009), who proposed an OPSs classification, as demonstrated in Figure 2.

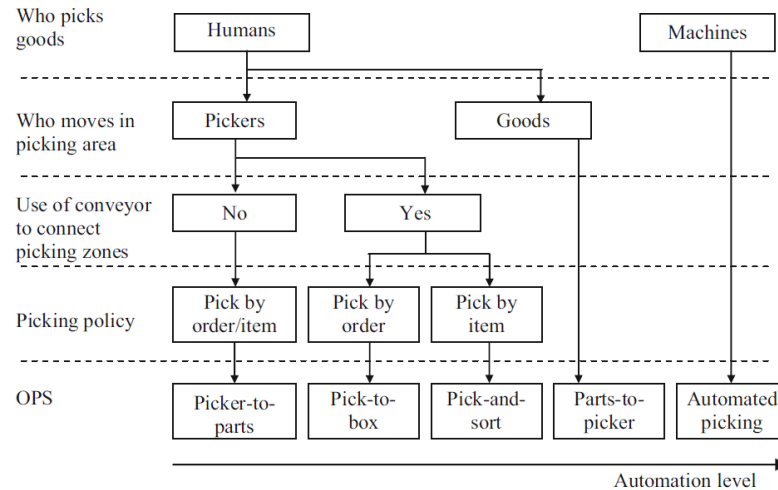


Figure 2 - Order picking systems

Source: Dallari *et al.* (2009)

Dallari *et al.* (2009) classified OPSs according to four main topics: the picking performer, the picking mover, the use of conveyors in the picking zone and the picking policy (order or item). The level of automation increases from “picker-to-parts” to “automated picking” and the most common OPSs are performed by humans.

In the first, “picker-to-parts”, pickers walk or drive through the aisles to retrieve items for simple or multiple orders, depending on the picking policy. The main policies are picking by order – discrete picking – and picking by article – batch picking (De Koster *et al.*, 2007). In the first (discrete picking), it is very common to have a “sort-while-picking” system, which means the picker sorts the items during the order picking. In other cases, the sorting process only takes place after the picking is finished – “pick-and-sort” (De Koster *et al.*, 2007). This OPS has many space for improvement, since it depends on routes, products allocation and picking device operations.

The “pick-to-box” system can be distinguished from the previous OPS, since the warehouse is divided into different picking zones, which are assigned to different pickers. These areas are connected through conveyors, which are used to place partial or completed orders. This OPS is characterized by the reduction of travel times but, on the other hand, there are some disadvantages regarding the amount of work between picking zones.

The “pick-and-sort” order picking system is like the “picker-to-box”, excluding the fact that the picker is responsible for picking a single item, in the amount ordered.

The only OPS which is characterized by the movement of goods, is the “parts-to-picker”. In this case, an automated device retrieves unit loads (for example, pallets) from the storage and brings them to the picking bay/position, a depot, where the picker selects the amount required in the order (De Koster *et al.*, 2007). The remaining items are returned to the storage. It enables labor and space cost reductions. On the other hand, the picker needs to wait for the items to be retrieved, which might cause delays in his performance, leading to a decrease in productivity, usually measured by number of items picked per hour (Caron *et al.*, 2000).

Lastly, the automated picking is performed by robots or dispensers.

2.5.3. STACK-UP PROBLEM

The order picking process is essential to fulfill customers’ orders (Dallari *et al.*, 2009) but, at the same time, it represents a problem to the delivery industry, when loading and transporting such unit loads, since customers order many SKUs (Rethmann and Wanke, 2001). According to Terno *et al.* (2000), this problem has been emerging in distribution centers, due to the need to reduce the number of pallets used, to decrease transportation costs.

Contrarily to the Manufacturer’s Pallet Loading Problem (MPLP), which objective is to maximize the pallet utilization, by placing as many identical items as possible (Bhattacharya *et al.*, 1998), the Stack-Up Problem, also known as Distributor’s Pallet Loading Problem (DPLP) (Terno *et al.*, 2000), deals with several non-identical items (Rethmann and Wanke, 2001). Yaman and Şen, 2008 report the case of a Turkish beverage company that was pressed by its customer to create mixed pallets, forcing employees to break-up full pallets, pick products and mix them in a different pallet. Although this process leads to costs increase, it also allowed company to sell its products to smaller size retailers. Customers no longer have to order a full pallet of each product, which means they have higher flexibility to order the desired quantities. According to Yaman and Şen (2008), there are two different types of warehouses, concerning the capability to design mixed pallets: warehouses which can easily design and create mixed pallets and warehouses without that capability. In the first case, the decision of how many products and which quantity is placed in the pallet is taken by each order requirement. In

case the warehouse is not capable of creating a different pallet for each order, the most common solution is the creation of standardized pallets, which are previously studied by managers to be able to meet most of the order requirements. Nevertheless, the design of a mixed pallet is a challenge for logistics, due to product dimension and weight differences (Yaman and Şen, 2008). There are many considerations that need to be assessed when loading a pallet with different SKUs, as it is showed in Table 3.

Condition	Description
Weight	There is a weight limit for the total of items in a pallet
Placement	The density of each product varies, so there are some products which cannot be under other products
Splitting	If an order of a certain SKU is large enough to complete one uniform pallet, then it should be done. On the other hand, if it is not, all SKUs should be kept together to make loading and unloading activities easier. The only exception to this condition is if the number of pallets being used can be reduced by dividing the same SKU in different unit loads.
Connectivity	During the pallet loading, it is not allowed that the person who is performing such activity needs to go to the storage several times.
Stability	The pallet should be stable enough to be transported to the customer.

Table 3 - Loading Conditions

Source: Author based on Terno *et al.* (2000)

The literature regarding the packing problem has been evolving over the years and researchers are now paying attention to other factors, such as stability and weight (Bischoff, 2006). This means that managers are now concerned with different aspects in pallet loading, such as weight distribution: the heavier product should be in the bottom, while the lighter should be placed on top. According to Bischoff (1991) and Bortfeldt and Wäscher (2013), pallet stability is important, not only from a transportation point of view, but also for storage optimization. The first author also emphasis that “in pallet based distribution systems even small relative improvements in the palletization efficiency of a product can often represent significant overall savings in absolute terms” (Bischoff, 1991, p.190).

2.5.4. WAREHOUSE DESIGN AND STORAGE ASSIGNMENT

The warehouse design is a strategic decision, to be taken by the company, to reduce the overall costs of investment, management, risk and operation (Ghiani *et al.*, 2013). Therefore, the warehouse layout optimization is fundamental to achieve this goal and it has been discussed by researchers during the last few decades. (Rakesh and Adil, 2015). According to Min (2015), this process begins with space planning and optimization, which should meet storage and material handling requirements like, for example, the types of racks and the equipment (Roodbergen *et al.*, 2008). This choice is highly associated with the products' characteristics and demand frequency (Roodbergen *et al.*, 2015). For example, fast moving products tend to be stored on flow racks, meaning they have a quick replenishment, while smaller and low-demand products tend to be kept in shelving racks, which are less expensive. Therefore, the outcome must assure that the chosen layout meets the necessary requirements and optimizes the warehouse performance (Roodbergen *et al.*, 2015).

The following figure describes a simple order picking warehouse. It contains pick aisles, cross aisles and sub-aisles. The pick aisles are where the product is picked from, the cross aisles are used to move between pick aisles and the sub-aisles form blocks (Roodbergen *et al.*, 2015).

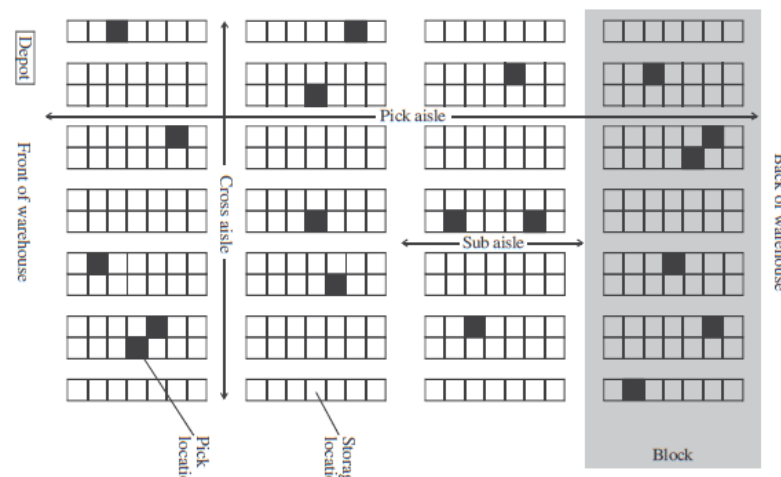


Figure 3 - Order Picking Area Example

Source: Roodbergen *et al.* (2015)

Besides the layout choice, there are three other strategic and operational decisions that need to be taken, when designing a new warehouse or reorganizing existing facilities (Chan and Chan, 2011). They are picking, routing and storage assignment policies. As it was mentioned in Section 2.5.2., the picking policies depend on who performs the actions and the way the items are picked. The routing policies are usually solved through heuristics, which define the route from the starting point, where the picker receives the picking list, until the end (Chan and Chan, 2011). Regarding the storage assignment policies, this decision is affected by the remaining choices, meaning that it depends on the size and layout of the warehouse, product characteristics, among others. This is one of the most difficult decisions faced by managers when designing the warehouse (Chan and Chan, 2011).

During the storage process, previously mentioned, the products are allocated to storage locations (Rouwenhorst *et al.*, 2000). The storage assignment categories defined by Hausman *et al.* (1976), are still a reference for managers: dedicated storage, random storage and class-based storage. The first two represent extreme cases of the class-based assignment storage strategy (Fontana and Cavalcante, 2014). The dedicated storage has specific storage locations for each product, which means that each product is a separate class (Li *et al.*, 2008). On the other hand, the random storage incorporates all products within the same class, so the products' location might vary through the entire storage area. The class-based storage, as the name points itself, is the division of all SKUs in several classes. Then, these classes are allocated to specific zones in the warehouse. More recently, Rouwenhorst *et al.* (2000) have identified other class, correlated storage or family grouping, which strategy is to storage nearby products that are commonly order together.

The most common storage location rule, known by Cube-per-Order Index (COI), was proposed by Heskett, in 1963 (cited in Fontana and Cavalcante, 2014, p. 1616). It expressed “the ratio of storage space required (cube) per SKU and the order frequency of the SKU”. The SKU with the lowest ratio would be placed in the nearest position to the input/output point. This strategy allowed cost reduction in the order picking process, by minimizing the travel distances.

2.6. SIMILAR STUDIES

As it was already mentioned, outsourcing is a new topic of discussion among researchers and the increasing use of service logistic providers has been the main reason for this development. Nevertheless, there are many studies discussing the quality control among companies, but few of them focus on triads. The main goal of those studies (presented in Table 4) was to understand how companies can measure the logistics service providers' service quality. In conclusion, it is possible to do this assessment but, most of the models already developed, need to be restructured, if they are going to be applied to a different context. Besides, the service quality of logistics service providers should not only be assessed in the final stage of the process. In the selection of those parties, performance measures should be, from the beginning, applied, in order to facilitate this evaluation in the future.

The stack-up problem is another issue which concerns managers and that is related with the topic under study. Not only it affects the manufacturers but also the distributors. Therefore, many algorithms have already been proposed to optimize the stack-up process, which can lead to transportation cost savings. However, most of those algorithms refer to the manufacturer pallet loading problem (MPLP). In other cases, the algorithms do not take into account all the restrictions necessary to consider the possibility of stacking. Table 5 synthetises the characteristics of some of the similar studies related to this subject.

Delivery Performance Measurement			
Author(s)	Aim of the study	Main Conclusions	Limitations
Van der Valk and van Iwaarden (2011)	Understanding how agency theory can be applied in a buyer-subcontractor-end customer triad in order to better understand the monitoring activities in the business service triads.	Outsourced services can be monitored through the “right combination of contracts and monitoring activities”. The presence of a legal agreement between parties doesn’t necessarily imply an appropriate subcontractor behavior.	• The data was not collected for this study. • Does not consider supplier opportunism.
Srivastava et al. (2012)	Understanding which factors influence service quality in the outsourcing of high-end services.	It presents a conceptual model for supervisory control. Therefore, it should be easy to create a system to supervise quality on the lines of this model.	• In order to apply this model to a different context, it needs to be evaluated and submitted to additional studies. • Requires different sets of rules for different types of data.
Jamwal and Meda (2012)	How we can ensure that the outsourced business service is designed-in or engineered-in to deliver quality service outcomes.	There are some challenges when defining quality control methods: “absence of precise specification models for quality of service; and services with unique deliverables which are either not explicated or are poorly understood” (p.99). Provides clear specification of quality and gives a finer level control over the quality of service outcomes.	• Built based on Document Processing service and cannot be applied to all business services. • For situation where the outlines are not well defined, the implementation of this model can be difficult. • Regarding time change, if the quality requirement changes over time, this model will need a future analysis to be adapted to the new changes.
Van der Valk and van Iwaarden (2013)	Understand how buying organizations can control outsourced services deliveries	Organizations can measure the quality in other phases than the service delivery to control the service delivery (ex: pre-order measures).	• Assumes that an increase in service delivery represents an increase in service quality. • It is needed to understand if a better delivery service has impact on the service quality perceived by customers.

Table 4 - Relevant similar studies (1)

Source: Author based on the referenced papers

Stack-Up Problem / Distributor's Pallet Loading Problem (DPLP)			
Author(s)	Aim of the study	Main Conclusions	Limitations / Future Applications
Morabito et al. (2000)	Application of an optimization model for product loading on pallets and pallets loading on trucks.	The model was already implemented in randomly generated examples but, in this research, it was applied to 2 case studies. Different pallet sizes were used and P1 demonstrated to be the pallet size which maximized the loading of palletized products on trucks.	
Terno et al. (2000)	Understand how to load the optimal number of small rectangular boxes on the minimal number of pallets.	It is unlikely to find an algorithm which optimally solves the Manufacturer's Pallet Loading Problem, so some considerations were taken over that model. This approach provided better results, on average, than the previous researches on this topic.	• In some situations, the algorithm developed allowed to load the pieces in a "somewhat overhanging position". • It only concerns rectangular-sized pieces. • Further research on stability conditions is required.
Rethmann, and Wanke (2001)	Understanding the stack-up problem in the delivery industry through the application of several basic stack-up algorithms.	The worst-case performance of the Most-Frequently algorithm is the best that can be achieved by on-line stack-up algorithms.	• Further research over the Most-Frequently algorithm to discover if it can be optimized through randomization.
Schuster et al. (2010)	Provide a new algorithm that solves Distributor's Pallet Loading Problem, by optimizing stack stability and volume.	The result of this research has showed guarantees of constraints and stability. This algorithm was tested through the comparison to other planners and by using a real robot.	• More algorithms should be developed in order to compare the results and try to improve the performance and efficiency of the existent solutions.

Table 5 - Relevant similar studies (2)

Source: Author based on the referenced papers

3. METHODOLOGY

This chapter states the methodology used to conduct this research. Besides, a review of the methodological considerations of the similar studies is presented, followed by the steps conducted in the case study methodology, provided by Yin (2009). Lastly, the data collection methods used for this research are described.

3.1. METHODOLOGICAL ASPECTS OF SIMILAR STUDIES

Similar studies were selected to better understand the topics in analysis. The tables below, Table 6 and Table 7, present the methodological aspects of each study, in terms of data sources and methodological analysis, first for the Delivery Performance Measurement topic and then for the Stack-Up Problem / Distributor's Pallet Loading Problem.

Delivery Performance Measurement				
Author(s)	Country	Industrial Sector	Methodological Analysis	Data Sources
Van der Valk and van Iwaarden (2011)	Netherlands	Exhibition Center	Case Study	• Interviews • Documents • Participant Observation
Srivastava <i>et al.</i> (2012)	India	High-end services providers	Multiple Case Study (7 organizations)	• Questionnaires • Interviews
Jamwal and Meda (2012, December)	India	Document Processing Services	Case Study	• Documents • Observation
Van der Valk and van Iwaarden (2013)	Netherlands	Exhibition Center	Case Study	• Interviews • Document studies • Observation

Table 6 - Methodological Aspects of Similar Studies (1)

Source: Author based on referenced papers

According to Table 6, the studies over the delivery performance measurement have similar methodologies, since they all used the case study method. In fact, one of the selected studies used a multiple case study methodology, which means that the data collection was made among 7 different organizations. Besides, multiple data sources were

used in each study, which enabled the researcher to collect different types of information and eliminate some biases. Even so, those data sources are similar among all studies.

Stack-Up Problem / Distributor's Pallet Loading Problem (DPLP)				
Author(s)	Country	Industrial Sector	Methodological Analysis	Data Sources
Morabito <i>et al.</i> (2000)	Brazil	Food Distribution and Wholesalers	2 Brazilian case studies	• Direct observation • Documents
Terno <i>et al.</i> (2000)	Germany	Distribution Industry	Computational Experiments	
Rethmann, and Wanke (2001)	Germany	Delivery Industry	Computational Experiments	• Company documents
Schuster <i>et al.</i> (2010)	Taiwan	Distribution Industry	Two Experiments (Real world and synthetically created datasets)	• Companies' documents

Table 7 - Methodological Aspects of Similar Studies (2)

Source: Author based on referenced papers

Within this topic, the similar studies focus the same industry, the Distribution Industry, once this is a problem that frequently appears in the Distribution process. Nevertheless, most of the similar studies are experiments and attempts to create new algorithms which can provide better solutions to the Stack-Up Problem and to the DPLP.

3.2. METHODOLOGY SELECTION

In order to select the methodology that best fits this research, the framework provided by Yin (2009) was followed. There are three main conditions to be assessed, when selecting the most suitable method. Table 8 presents the Yin's framework:

METHOD	Form of research question	Requires Control of Behavioural Events	Focuses on Contemporary Events
Experiment	How, Why?	Yes	Yes
Survey	Who, What, Where, How many, How much?	No	Yes
Archival Analysis	Who, What, Where, How many, How much?	No	Yes/ No
History	How, Why?	No	No
Case Study	How, Why?	No	Yes

Table 8 – Methodology Selection

Source: Yin (2009)

As it was mentioned before, in order to understand the methodology that should be used in this research, these three variables need to be assessed:

- **Form of the research question** – the research questions “*How to improve the delivery quality indicator in the outsourced transportation services at Unicer Bebidas, SA?*”, “*How to develop a stack-up decision algorithm for mixed pallets?*” and “*How to verify the current layout within the picking warehouse?*” belong to the “how” series. According to Yin (2009), these types of questions are more explanatory, since they need to be traced over time, instead of being mere frequencies or incidences.
- **Requires Control of Behavioural Events?** No. This study will be conducted without the researcher control over the behavioural events.
- **Focuses on Contemporary Events?** One of the aims of this study is to understand how Unicer can control its deliveries and, therefore, it will consider the current deliveries and stakeholders. The other topic approached in this research is focused on the current picking warehouse layout and pallets. This means that it will also include current events and products.

The case study methodology was many times considered as an “exploratory stage of some other type of research strategy”, according to Yin (2009, p.17). Thereby, there is a need to define “case study”. Case study has been described by Yin (2009, p. 18-19) as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident. (...) there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, (...)”. This type of methodology has been, many times, confused with experiments but, in fact, they differ from each other, since in the last one, the context is established in the laboratory environment (Yin, 2009). Besides, since the difference between phenomenon and context is not always perceived, data collection and data analysis strategies need to be defined.

The case study methodology includes both single-case studies and multiple-case studies, known as comparative case method (Yin, 2009). According to Pope *et al.* (2007), the comparative case method was developed by Agranoff and Radin, in 1991, with the aim of contracting cases to develop theories. In the present case study, there will be only one case study element: Unicer Bebidas, SA and, therefore, it is a single-case study. However, this research includes more than one project, once it concerns more than one problem presented to the intern, during the internship.

3.3. STEPS OF THE CASE STUDY METHODOLOGY

According to Yin (2009), the case study methodology is divided into the following steps:

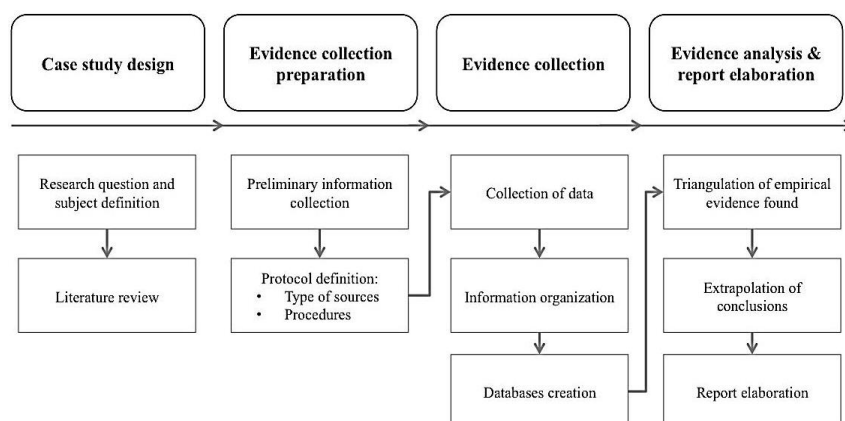


Figure 4 - Steps of the Case Study

Source: Yin (2009)

Firstly, in the case study design, the research question and subject are defined and the literature review is made. Secondly, in the evidence collection preparation, the need to collect preliminary information emerges, in order to be able to understand the type of data required to the case study. With this, it is possible to establish the type of sources that will be used, as well as the procedures to collect the data. In the following step, the evidence collection, the researcher needs to organize the data and create a database. Finally, after analyzing the data, it is possible to extrapolate conclusions and elaborate the final report.

3.4. DATA COLLECTION

Regarding the data collection, in the case study methodology, data is more commonly collected through six different procedures: documents, archival records, interviews, direct observation, participant-observation and physical artefacts. All sources have advantages and disadvantages, which means that a good case study should incorporate as many sources as possible (Yin, 2009). In this research, data will be collected through documents, archival records, interviews, direct observation and participant-observation.

According to Yin (2009), documents play an important role in case study data collection, since they allow the researcher to corroborate and augment information from other sources. On the other hand, it needs to be kept in mind that all documents were written with a specific purpose that is not the same as the present case study.

The documents that are used in this case study are the source of data concerning the company characteristics, the topic and the methods already used to assess this matter.

The archival records differ from documents, since they don't play an essential role in every research (Yin, 2009). This means that, depending on the study being conducted, archival records' importance varies. When using archival records, researchers must assure a certain level of accuracy of this data.

In the "Transportation and Distribution" area, archival records are important, since they represent the evolution of the system implemented to control the delivery quality and, therefore, the service level. The data was collected through the company's database (SAP). In the Logistics Platforms area, data from SAP was also collected, in order to study the past storage allocation assignment.

Regarding the interviews, they are an essential source in every case study data collection, since most of the researches being conducted are about human affairs (Yin, 2009). This methodology allows the researcher to collect data and, at the same time, to have a visual interpretation. Besides, the interviewees can help to identify other relevant sources of data that weren't addressed yet. On the other hand, as it was mentioned before, every evidence collection method has disadvantages. Interviews are submitted to problems like biases, poor recalls and poor or inaccurate articulation. The information collected should also be crossed with the rest of the information collected from other sources, in order to minimize these problems. The interviewees in this study are the "Transportation and Distribution" manager and the "Logistic Platforms" manager, who has followed the projects covered during the internship.

Lastly, the direct and participant observations differ one from another, in the sense that the first one refers to "field observation" while the second describes the situations when the observer participates in the events being studied, assuming different roles (Yin, 2009). In the internship, the data was collected through both methods: direct and participant observations. Concerning the first one, the fact that the internship took place inside the company's physical boundaries, allowed daily data collection, especially, during the integration time. Regarding the participant observation, since part of the internship responsibilities involved the contact with some of the supplier representatives and Unicer's employees, information was also collected through that method. The remaining responsibilities, which concern the "Logistic Platforms" area, where the development of the algorithm, which required the interaction with the partner company in this project development as well as the analysis of the data collected.

The data collection was performed from October, 2017, the beginning of the internship, until June, 2017. Most of the data was collected during the internship through direct and participant observation, documents and archival records. The interviews were conducted in May, to the "Transportation and Distribution" manager, and in June, to one of the "Logistics Platforms" managers.

4. CASE STUDY OBJECT DESCRIPTION –UNICER BEBIDAS, SA

Within this section, a description of the case study object will be provided. Firstly, the description of the organisation and special attention to the Logistics department will be paid.

The description of Unicer Bebidas, SA will cover 5 topics: history, products, business strategy, market position and company's organisation. Therefore, the focus will be on the Logistics department, providing information regarding the number of employees, areas and activities performed within the department.

The information presented in this chapter was collected through direct observation, during the internship conducted in the Logistics department of the company.

4.1. UNICER BEBIDAS, SA: HISTORY AND BUSINESS AREAS

Unicer Bebidas, SA is the largest beer producer in the Portuguese beverage industry (Bouckley, 2014). Its business is mainly focused on bottled water and beer, but Unicer also produces soft drinks and wines (Unicer, 2015). Besides being a manufacturing company, it is also present in the tourism industry, with two different recreational and SPA parks in *Vidago* and *Pedras Salgadas*, both places in *Trás-os-Montes*, Portugal (Unicer, 2015). According to the company's 2015 Annual Report, 25% and 30% of the *Vidago* Place Hotel and the *Pedras Salgadas* SPA and Nature Park' customers are foreign customers.

This company's origins date from 1890, the beginning of industrialization in the beverage industry (Unicer's website, 2015), and it was called CUFP (*Companhia União Fabril Portuense das Fábricas de Cerveja e Bebidas Refrigerantes*). Its main products were beer and soft drinks but they also sold other alcoholic drinks, such as liqueurs, cognac, brandy, wine and gin. Counting only with 13 employees, this family-sized company was managed by its shareholders, who were elected with that purpose. The initial beer production was around 360,000 litres and the facilities were located in the centre of *Porto*, Portugal. In 1964, the company moved to *Leça do Balio*, *Porto*, Portugal. At that time, the production capacity was 25,000,000 litres and the company had three different bottling lines, with a

unit capacity of filling 20,000 bottles/ hour, and a canning line with the capacity of filling 16,000 cans/ hour (Unicer's website, 2015).

Nowadays, this company is mainly owned by a Portuguese group named *Viacer* (56%), which is composed by three Portuguese groups: *Violas*, *Arsopi* and *BPI* (Unicer's website, 2015). The remaining 44% are held by *Carlsberg*. It has 13 activity centers located in Portugal (see Annexe 1), with headquarters located in *Leça do Balio*, and the current beer production reaches 450,000,000 litres. Exportation plays an important role in the company's performance, since Unicer exports a large volume of beer to 50 different countries: 200,000,000 out of 600,000,000 litres of beer sold in 2014 were exported to other countries. In 2015, the sales volume was 557,000,000 litres of beer, which was a consequence of the exportation decrease in Angola. Nevertheless, this decline could be worse if the company hadn't improved its performance in Portugal and in other countries.

Unicer Bebidas, SA's vision is "Wherever we are, Unicer and our brands are always the first choice". This company believes that the employees are the ones that guarantee the commitment fulfilment and will make Unicer the market leader in Portugal and in its other targets. In order to work at Unicer, people need "to be direct and transparent, to be audacious and entrepreneuring, to be responsible and learn from mistakes, to know how to and appreciate to work in a Team, to be open and outward looking" (Unicer's website). Unicer believes that by conquering the consumers preferences for its brands, being customers' favourite partner, obtaining the community and market recognition and guarantying the remuneration and confidence of its shareholder, it will be consumers' first choice.

Unicer's strategy is based on a selected and focused continued investment on its brands, which has resulted in an increase in the competitive position as well as in the popularity among customers and consumers. In 2015, the company maintained its leadership in the beer Portuguese market, with a market share over 50% (Unicer 2015 Annual Report). The same happened in the sparkling water Portuguese market, where Unicer had a 51.5% market share. In the African market, the company was able to reinforce its position, having a 92% of market share in Angola and 75% in the remaining African countries, where Unicer operates, regarding the Portuguese beers in that international market (Unicer 2015 Annual Report). The Portuguese beverage market is duopoly between

Unicer Bebidas, SA and *Sociedade Central de Cervejas* (SCC). These two company's together hold around 90% of this market. SCC also sells beer, water and soft drinks and it has a similar strategy to Unicer. The remaining 10% are owned by smaller companies.

4.2. GOVERNANCE STRUCTURE

Unicer's structure is simple, allowing the company to focus on their customers, consumers and employees. Besides, it also allows effectiveness improvement, since they are able to "follow each activity, product and brand" (Unicer 2015 Annual Report). The internship that gave origin to this research topic was taken in the Supply Chain division of this company and, therefore, the description of the Logistics department will be provided in more detail.

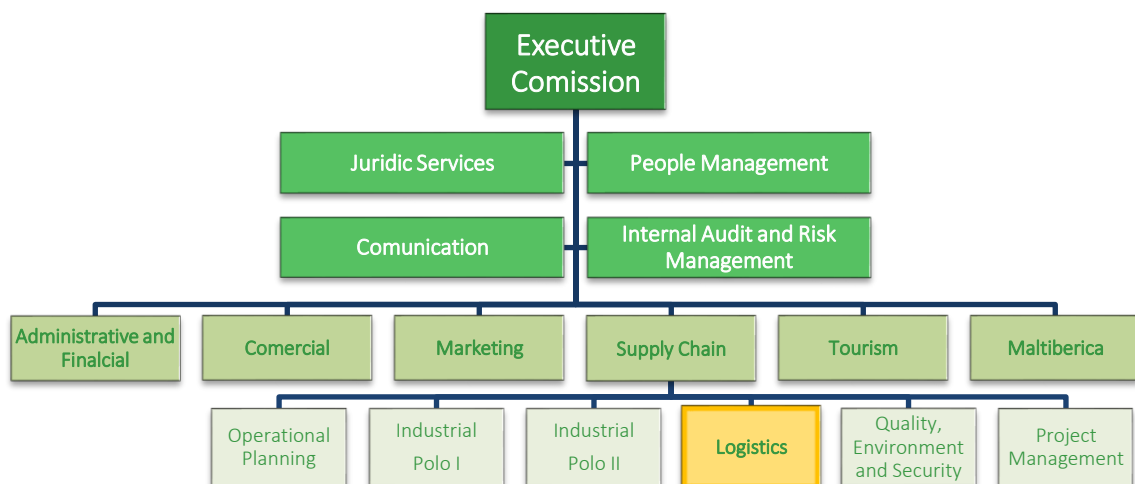


Figure 5 - Unicer Bebidas, SA structure

Source: Author based on Unicer Bebidas, SA data

The Logistics Department of Unicer is integrated in the Supply Chain area. This department counts on 123 people and it is divided in four main areas: Transportation and Distribution, Logistic Platforms, Back Office and Projects and Processes. The Direction is composed by the Logistics director and the secretary. The objective of this department is to manage and develop projects to the optimization of the supply chain. Each sub-department plays an essential role to achieve this goal.

The internship was conducted in the "Transportation and Distribution" and "Logistic Platforms" areas of the company. Therefore, the focus of this report and the activities performed will be on these two areas. However, additional information regarding the main activities performed by each area is provided.



Figure 6 - Logistics Department

Source: Author based on Unicer Bebidas, SA data

Transports and Distribution

The Transports and Distribution area has 39 employees and its main activity is to assure the product's transportation and distribution to each customer of all distribution channels, as well as the movement of the goods between Unicer's platforms. In order to be successful, they need to ensure that the distribution fleet and the respective equipment are being correctly and adequately managed. Besides that, it is also Transports and Distribution area's responsibility to invigorate and lead the negotiation of transportation, logistics operators, infrastructures and logistics equipment, together with the Purchasing Department.

Logistic Platforms

The Logistic Platforms area has 58 employees and its main activity is to assure an effective management of the operations and a correct handling of the finished product, raw materials, bottles, packing material and other materials, in Unicer production and distribution logistic platforms. In order to achieve a high level of effectiveness, the execution of the procedures and processes in goods flows needs to be assessed and controlled by this department, since there are logistic operation services (such as internal/external operations and external logistic platforms) which are provided by third part logistics.

Back Office Assistance Services

The Back Office Assistance Services (BOAS) area has 23 employees and its main responsibility is to ensure a quality customer service, by assuring efficiency in the ordering processes and in the after selling services. In order to do that, each client file (which contains the sales conditions: table prices and discounts) needs to be kept and updated.

Projects and Processes

The Projects and Processes area has only 1 person and its main activity is to assure that every employee in this department follows the quality, safety and hygiene work norms, as well as the implementation of improvement processes, through the implementation of a permanent learning and development system that supports a continuous improvement culture in the logistic processes.

5. DELIVERY INDICATOR: TOOLS' DEVELOPMENT AND IMPLEMENTATION

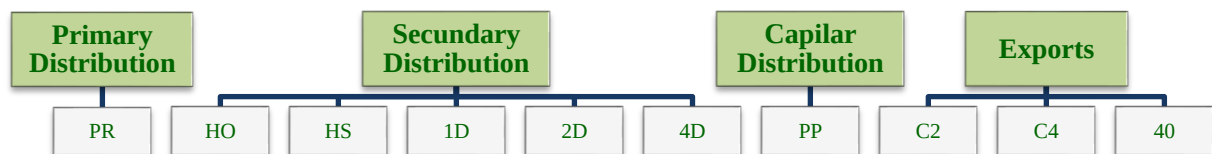
This chapter aims to answer the question “*How to improve the delivery quality indicator in the outsourced transportation services in Unicer Bebidas, SA?*”.

By launching this challenge, Unicer Bebidas, SA aimed to improve its delivery indicator through the improvement of the entire process. Next, a description of the activities conducted, as well as the difficulties faced, are presented within this chapter.

This chapter is divided in 3 main topics. Firstly, the different types of distribution are presented, as well as the explanation of the distribution types chosen to implement the delivery indicator. Secondly, in order to understand how the systems was installed, an introduction to the shipment and order creations is provided. Lastly, this tool is described as well as the process and the improvements inherent to it.

5.1. TRANSPORTATION AND DISTRIBUTION IN UNICER BEBIDAS, SA

Unicer's distribution is divided in 4 different types, as presented in Figure 7: Primary Distribution, Secondary Distribution, Capital Distribution and Exports.



PR: Primary Distribution; HO: Horeca Channel; HS: Hyper and Supers; 1D: 10 tons Direct Distribution; 2D: 20 tons Direct Distribution; 4D: 40 tons Direct Distribution; PP: door-to-door Distribution; C2: 20 tons containers; C4: 40 tons containers; 40: 40 tons trucks

Figure 7 - Types of Distribution in Unicer Bebidas, SA

Source: Author based on the semi-structured interview presented in Annexe 3

The Primary Distribution (PR) can be described as the freight distribution, in 40 tons vehicles, of full load (equivalent to 33 pallets) without picking. This type of distribution is usually performed to intercenters, which are transfers between factories, and to large distribution customers.

The Secondary Distribution has five different types of shipment. HO and HS stand for “Horeca” (hotels, restaurants and coffees) and “Hyper and Supers”, respectively. These

vehicles supply small customers across the entire country, through a cross-docking operation and they are called cross-docking vehicles. They leave Unicer Bebidas, SA to an intermediary warehouse of the LSP in charge of the distribution. Then, Unicer's products are mixed with other company's products in another vehicle to be delivered in a common area (for example, Beja city). The remaining Secondary Distribution types (1D, 2D and 4D) are smaller size vehicles: 10, 20 and 40 tons vehicles. The letter "D" means "direct", since the distribution is performed directly to the customer, without an intermediary. The difference between the Primary Distribution and the 4D is the existence of picking in the Secondary Distribution type.

The Capilar Distribution is the freight distribution in Porto and Lisbon metropolitan areas. This distribution is performed through small vehicles, 10 to 12 tons, which leave Unicer with high levels of picking. PP refers to *porta-a-porta* in Portuguese, which means door-to-door.

The Exports are performed in 20 and 40 tons containers (C2 and C4) and 40 tons trucks (40). This type of distribution is distinguished from the Primary Distribution due to the rates charged to foreign customers. These vehicles can include picking but it is unusual.

5.2. ORDER, OUTBOUND DELIVERY, SHIPMENT AND INVOICE

In order to understand the following sections, it is essential to analyse how a shipment is created and what and who it involves. As it is displayed in Figure 8, the Shipment Creation Process has several intervenients. Within one single shipment, it is possible to have one or more outbound deliveries to the same or different customers. An outbound delivery is the company's denomination for the order placed by the customer after being managed by the Back-Office Assistance Services.

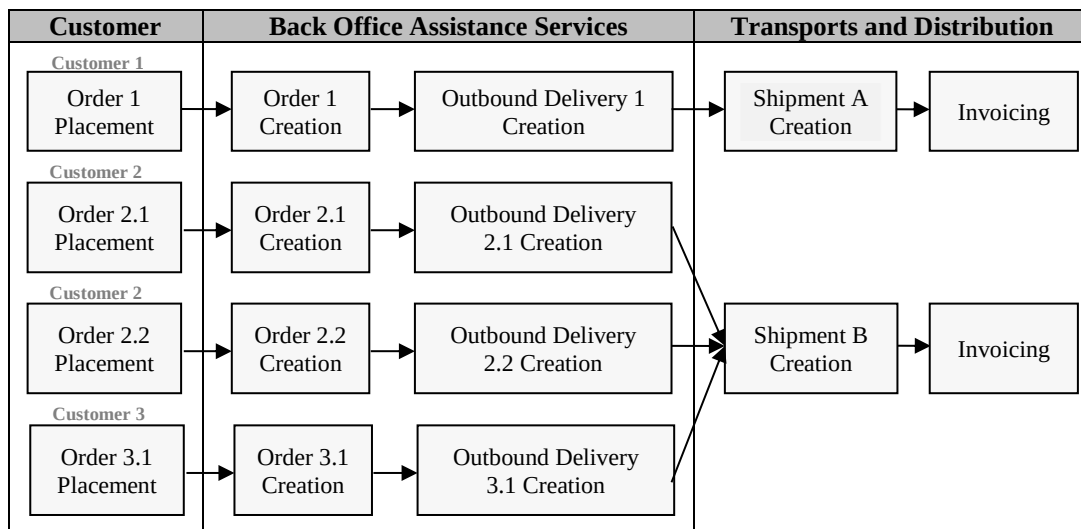


Figure 8 - Shipment Creation Process

Source: Author based on observation during the internship

5.3. DELIVERY INDICATOR (DI)

Unicer's Service Level (SL), in the Logistics department, measures the stock availability in the shipment day. In other words, it measures if the order was loaded into the vehicle. No one is able to know, inside the company, if that order was effectively delivered in the required day and within the customer's delivery window.

The following sections describe the indicator as well as the methods and procedures undertaken to implement and develop this tool.

5.3.1. DELIVERY INDICATOR DESCRIPTION

In order to control its deliveries, Unicer developed an indicator that enables the company to obtain information about the quality and time of deliveries. This project was putted into practice in April 2016 and its main goal was to provide an additional dimension to the Service Level and Unicer's delivery quality. The service level would not only concern the stock availability but also the time and status of the delivery.

This indicator consists in an SMS (a telephone text message), sent by the drivers of the LSPs, in two different moments of time: the arrival to the customer and the delivery itself. The SMSs are standardized and the information is contained in the document carried by drivers. The SMS regarding the moment of the arrival is unique and each driver needs to send that message every time they do a delivery in a different customer. Regarding the

delivery moment, there are 3 different SMSs that can be sent: “delivery with no incidents” (S2), “delivery with incidents” (S3) or “No delivery” (S4). This SMS is sent to a 5 digits number and it is a free service. From the beginning, the company was expecting a large number of SMSs sent by the LSP’s drivers.

In 2016, when the new SLA contract was put in practice, this indicator was inserted in the requirements list. Unicer provided a 3-month experimental period. So, starting in April, the lack of the SMSs was charged to the LSPs in the following way:

- A small amount¹ for each status SMS non-sent (status SMS are S2, S3 and S4);
- A large amount² for each attempt to cheat the system and send the SMSs far away from the customers’ locations.

All LSP’s drivers have phones, since they use them in other situations on their daily activities. In the company’s headquarters, in *Leça do Balio*, the drivers receive an SMS with information regarding the loading/unloading dock. They have the necessary technologies to perform this new activity.

This process involves both collaborators from Unicer as well as from the LSPs, on data creation, collection and analysis. The drivers are responsible for the initial part of the process, which includes the load, the transportation, the unload and the SMSs’ sending. The analysis of the SMSs received is an activity performed by Unicer staff.

This information allows the company to know at what time the LSP arrived at the customer and the state of the delivery. It is incorporated in Unicer’s information system and is automatically associated with one of the outbound deliveries contained in the shipment performed by that driver. This means that it is easy to find the information for each service.

5.3.2. DELIVERY INDICATOR IMPLEMENTATION

The awareness of the delivery performance was considered by Unicer an essential indicator. Not only to be aware of the percentage of shipments delayed, but also to use that information to improve its service level. This implementation was undertaken in a

^{1,2} Confidential value

continuous improvement optic and it was meant to include all types of distribution. However, the company faced some difficulties which did not allow such implementation in the Exports Distribution. On other hand, that process did not make sense in the Capilar Distribution, since the company already has that information through the system implemented in PP.

In order to implement the process and the indicator in Exports, the company needed a nine-digit number. The existent system was built to Portuguese phones, since it was a five-digit number. This modification was necessary in order to be able to obtain feedback from the Exports Distribution. Once that upgrade was done, the company faced some difficulties in implementing this indicator because the SMS were paid. Unicer is still dealing with this situation in order to try to find a solution.

Regarding the Capilar Distribution, as it was mentioned before, the system implemented in this type of distribution already provided information regarding the quality and time of the delivery. Each driver has his/her own tablet, where he/she is able to report different information, including the delivery status.

The remaining distribution types are the Primary and Secondary Distributions. The Secondary Distribution belongs to one exclusive LSP, which is not totally engaged with the indicator, since it is not included in the Service Level Agreements (SLA). With this said, it is difficult for the company to impose the development of this indicator in the Secondary Distribution. Even so, Unicer asked the LSP to commit to this project. Concerning the Primary Distribution, the indicator was implemented with success.

This implementation was performed differently accordingly to the distribution type, as it can be consulted in the following figure (Figure 9). This process started with the LSPs which have the larger volume of shipments of the Primary Distribution (LSP1, LSP2 and LSP3), followed by a smaller supplier (LSP4) and the Secondary Distribution performed by the LSP3. The indicator was lastly implemented in the LSP5, since it started its activity in January.

The LSPs' willingness not only to incorporate this activity into their daily operations but also to be subjected to fees was the desire to get the business deal. Unicer was clear, from the beginning, towards the fees collection when introducing that requirement in the SLAs.

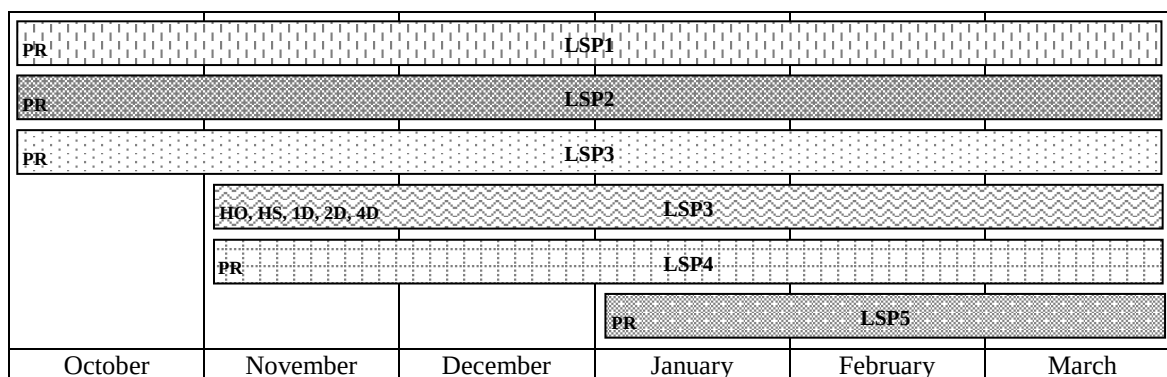


Figure 9 - Scheduling of Feedback by LSP

Source: Author based on internship

In order to decide the amount of shipments that each LSP will have, the company initiates the Shipments Allocation Process (Table 9). Firstly, Unicer sends an email to the eligible LSP, inviting them to be part of the contest and to know their availability and desire to join Unicer's network. Once the initial stage is completed, the Service Level Agreements are structured, for the LSP to know what they are being asked to do. That document can contain information such as the number of shipments annually required from one activity centre to another: from *Leça do Balio* to *Santarém*, for example (see Annexe 1). Besides the quantitative part, it also describes the requirements to perform such activities. Unicer has requirements for security (the forklift driver license and the use of a helmet in loading and unloading operations), service (Unicer hires the shipments 48h in advance, expecting the LSP appear in the company's facilities to load 24h before the time for delivery), documentation (the LSP employees need to return the documents correctly signed) and, in the current year, the information requirement was added (the SMSs). From this moment forward, the LSP were required to send information regarding the time and quality of the delivery.

Shipment Allocation Process
1. <u>Address a request</u> to the relevant LSPs asking if they want to be part of the contest. 2. Wait for LSPs <u>confirmation</u>. 3. <u>Development of the SLAs</u>. 4. <u>Allocation of shipments</u> through the different suppliers.

Table 9 - Shipments Allocation Process

Source: Author based semi-structured interview presented in Annexes 3

5.3.3. DELIVERY INDICATOR DEVELOPMENT

Initially, the analysis was done at the end of each month, by the “Transports and Distribution” manager, as it can be seen in the Initial Process Mapping (Figure 10).

After collecting the data from the company’s database, the manager from Transports and Distribution (T&D) would calculate the number of shipments performed by each LSP, the number of SMSs sent and, through the following formula, the percentage of SMSs sent:

$$\text{Percentage of SMSs sent}_i = \frac{\text{Number of SMSs sent by the LSP}_i}{\text{Number of transports performed by the LSP}_i}$$

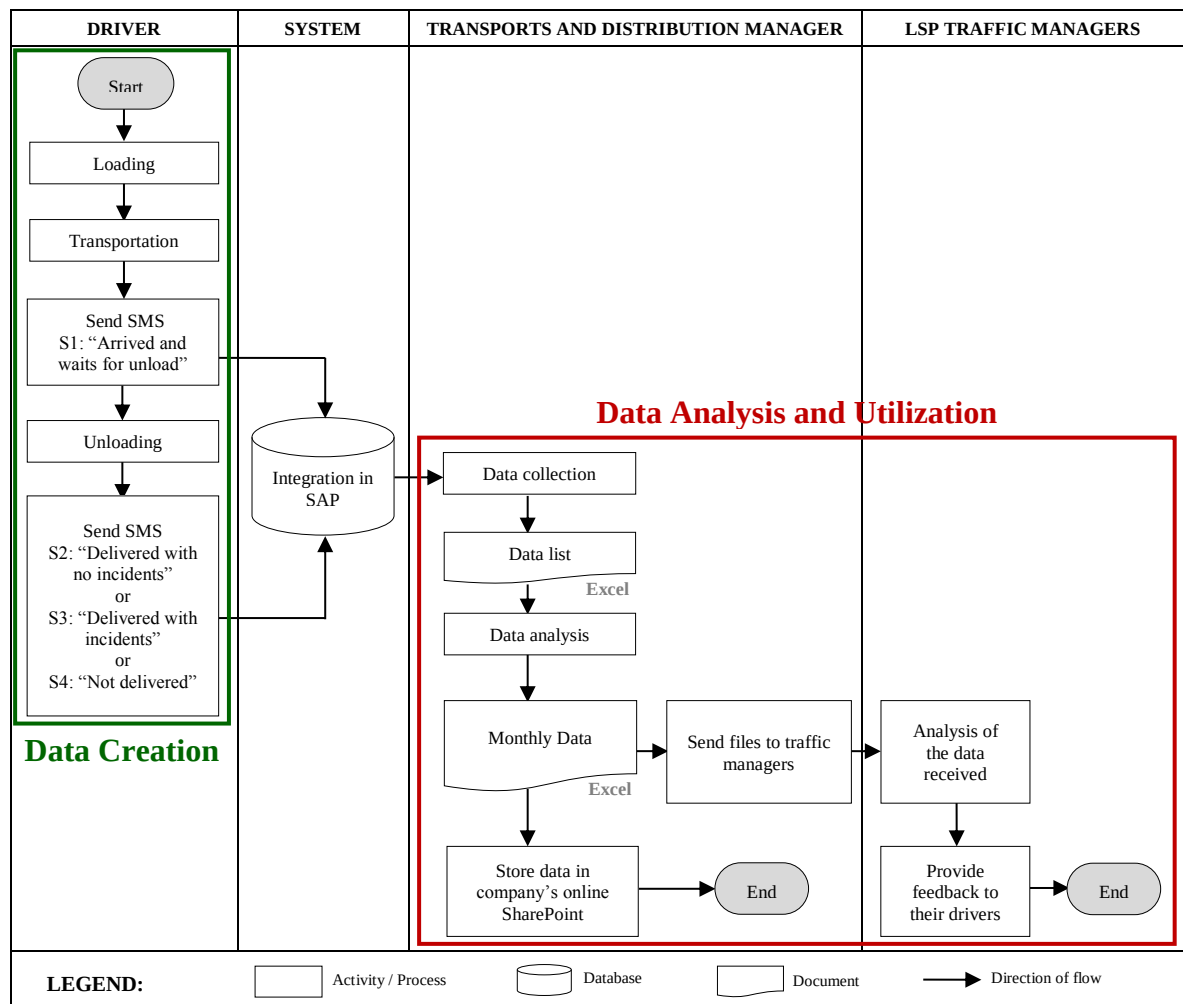


Figure 10 - Initial Process Mapping

Source: Author based on internship participation and observation

From April to September, this evaluation was done monthly, decreasing the chances for improvement. The need for more frequent feedback emerged from both sides: Unicer and the LSPs. Due to the lack of regular and rich feedback, the LSP's traffic managers faced difficulties, towards this indicator development, in instructing their drivers and improving their performance. The fact that the information was being sent at the end of each month compromised the improvement opportunities, since it was something being performed daily and, therefore, required more feedback. Besides, the analysis was poor and the LSP's traffic managers didn't have enough information to work on.

Since distribution is an essential process that affects customer service (De Marco and Mangano, 2011; Ploos van Amstel & D'hert, 1996), the need to understand and measure the LSP performance increased. This was a consequence of the logistics department concern to improve its service and not a pressure made by the Sales department due to customers complains. Therefore, this section describes the process undertaken and the inconsistencies found during this indicator development.

The process of data creation was already developed and implemented since April 2016. The main question resided in the analysis and utilization of such information. Consequently, the actions undertaken to improve this process focused on the second part of the process identified in Figure 10 as "Data Analysis and Utilization".

The first step was considering a more frequent analysis of the data and, instead of providing feedback at the end of the month, this information started to be sent daily. This action allowed the LSPs to understand what type of information was the company receiving and, therefore, improving their performance by training their drivers. Instead of sending an Excel file with the shipments performed and the percentage of SMSs sent by each LSP, the information started to be sent in a report structure format - PDF file (see Annex 4).

With these improvements on the information management, the process structure has changed, as well as its intervenients (Figure 11).

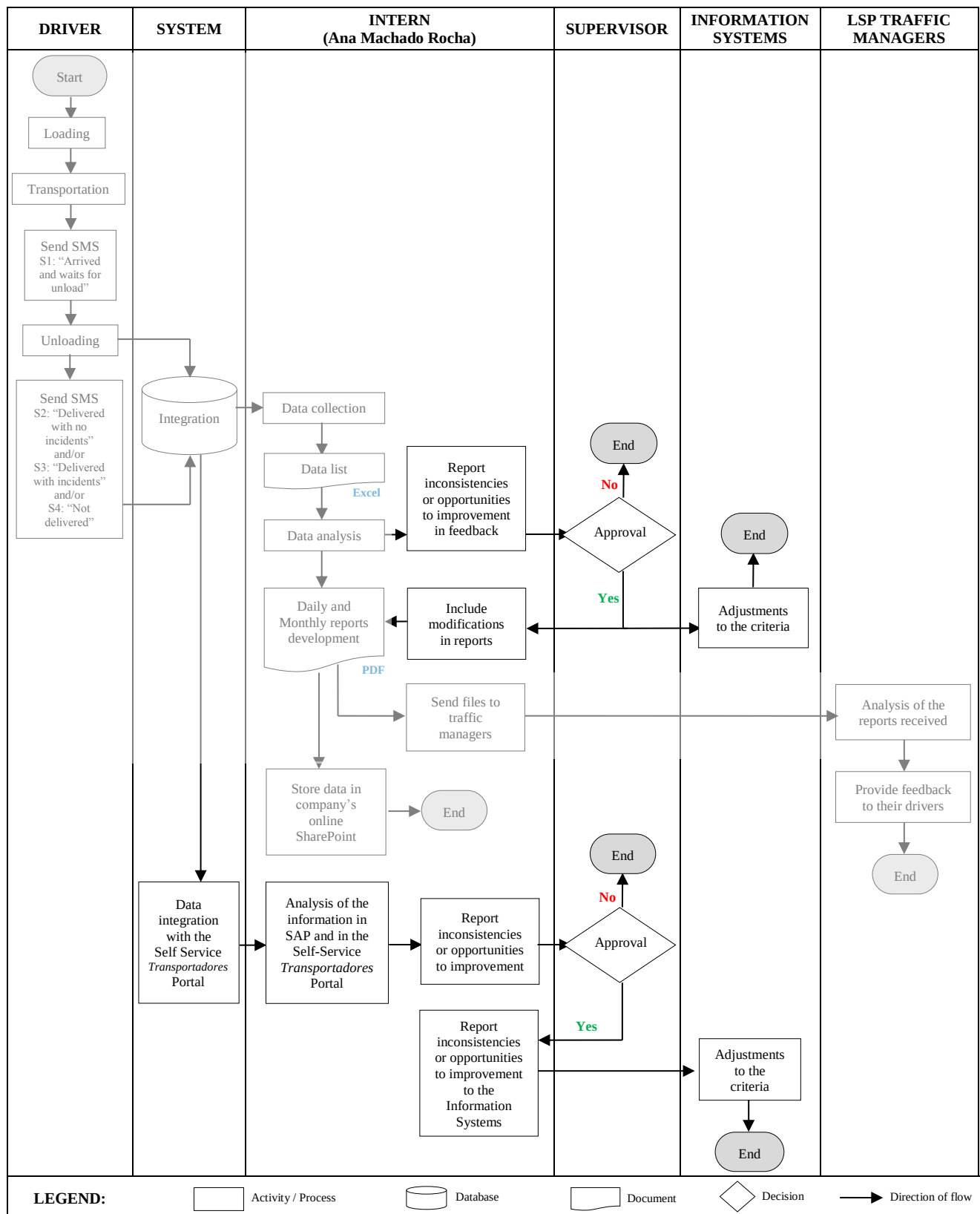


Figure 11 - Process Mapping during internship

Source: Author based on internship participation and observation

In order to create those reports, an Excel tool that enabled the report development was produced. This file was divided in 4 main parts: the data insertion, the data list, the Primary Distribution models and the Secondary Distribution models. The first two parts were common to both types of distribution but the report models were different, thence the distinction between these transportation categories. Since the number of customers visited per day, as well as the number of sub-distribution types (PR, 1D, 2D, 4D, HO and HS) were different, there was a need to distinguish those two reports.

After collecting the data from SAP, the information was analysed in this tool. If the data being considered concerned the primary distribution, then the analysis should be performed in the respective worksheets, as demonstrated in Figure 12.

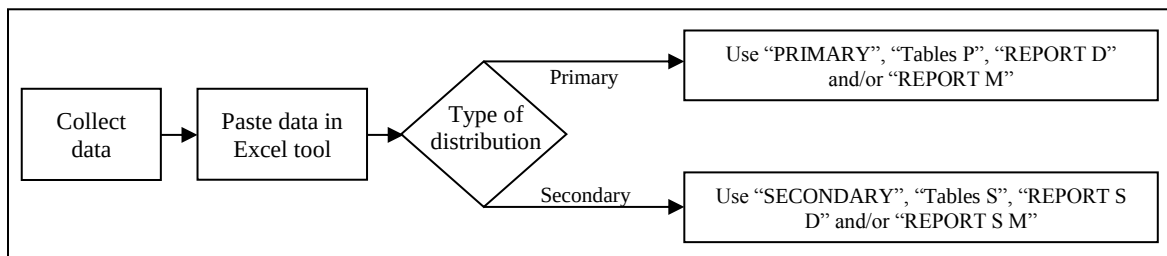
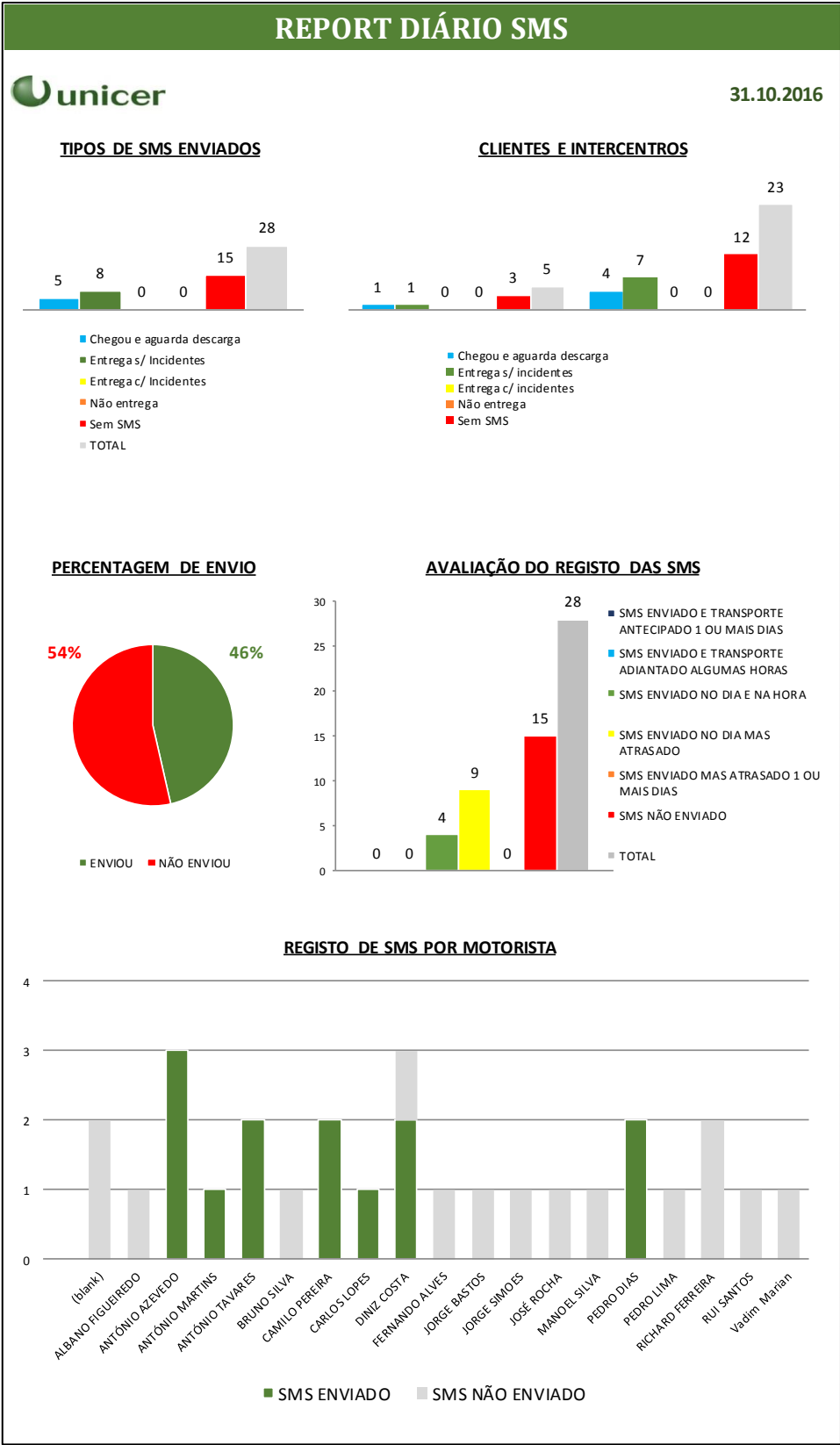


Figure 12 - Excel Tool Utilization

Source: Author based on internship participation and observation

This new tool brought a more detailed analysis and feedback provided to the LSP. The report model contained information such as the number of SMSs sent (by type of customer and type of SMS), the number of SMSs missing, the percentage of SMSs sent, the evaluation of the time of the SMSs and the SMSs sent by each driver (Figure 13).

These reports started to be sent daily (Figure 13) and monthly (Figure 14). As previously mentioned, this gave origin to a different feedback process (Figure 11). This analysis required more time but, due to the deepness with which this issue was addressed, some improvement opportunities were found.



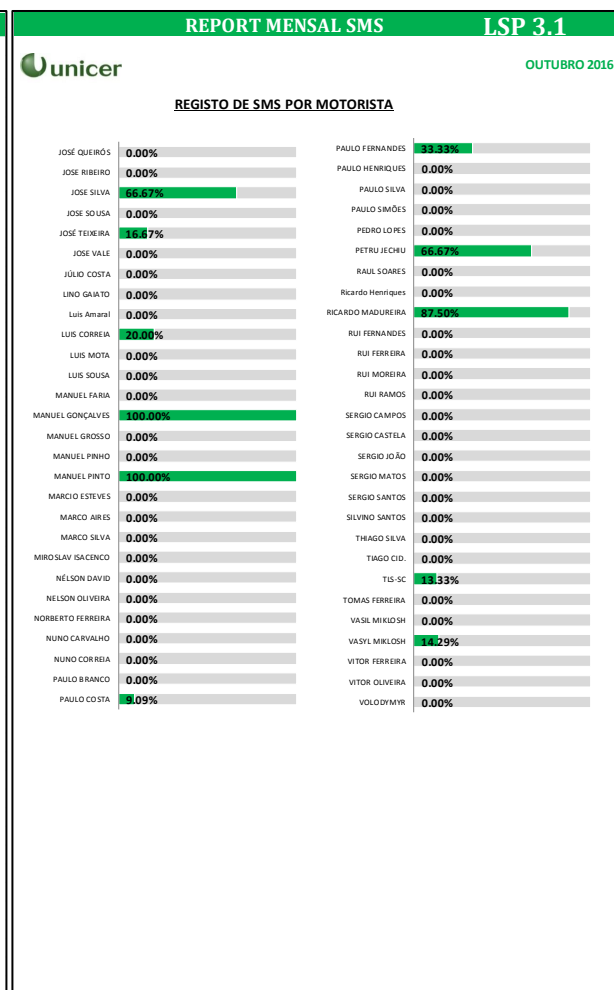
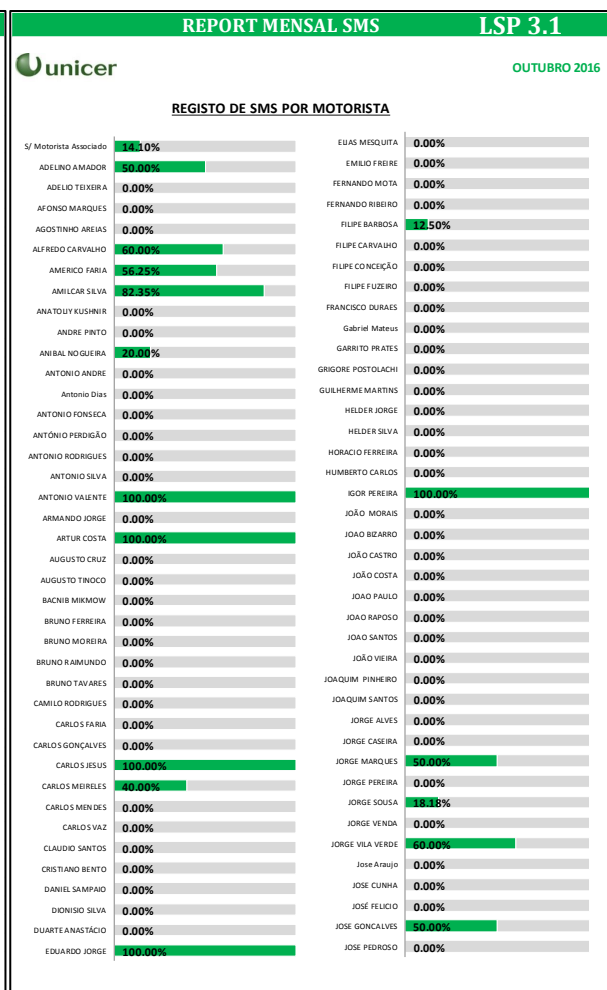
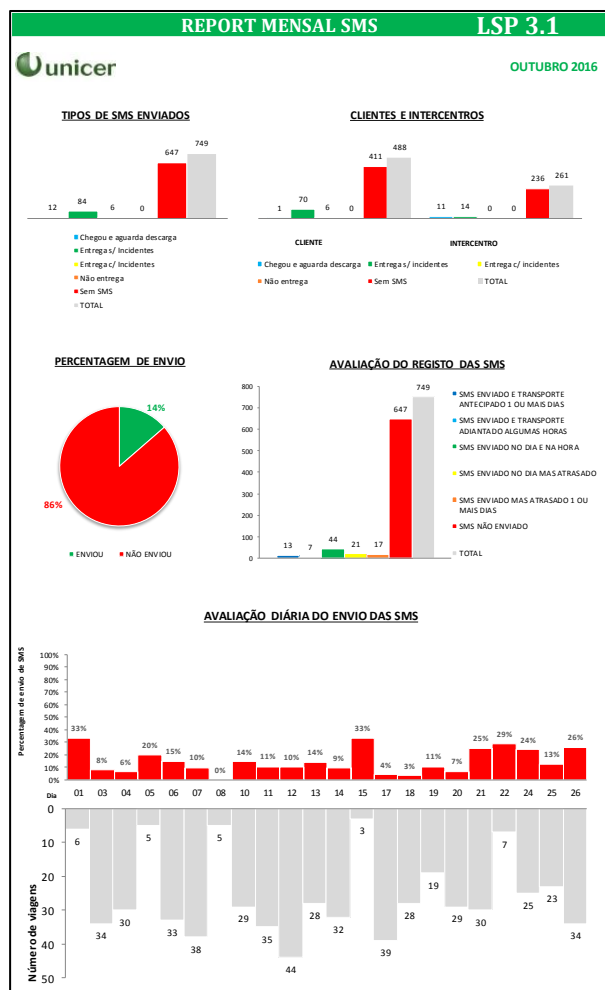


Figure 14 - 1st Mensal Report Model (legible data in Annex 4)

Source: Author during internship

After several weeks analysing the data collected from the company's system, some inconsistencies were found. Mostly in Secondary Distribution, information regarding customers' delivery windows was missing (Figure 15). This situation was detected through the classification of the hour the SMS was sent. Since the hour to which it was compared was 00:00:00, those SMSs were being considered as sent with delay. Once that inconsistency was found, more attention started to be paid to those cases in order to address that issue. This observation was performed from December until the end of March. In Secondary Distribution, from a total of 1686 customers, 141 were found with no information regarding the delivery windows (8%). From those customers, 41 were solved (29%). The same happened in the Primary Distribution, but in a lower scale (Figure 15). From a total of 211 customers, 13 were found without the delivery window information (6%). Within this total, 11 got solved (84,6%). The remaining 2 were customers in which the delivery is scheduled individually, meaning that it was not possible to define a certain delivery window. For those situations, the suggestion was to insert a field in the SAP transaction with the hour scheduled.

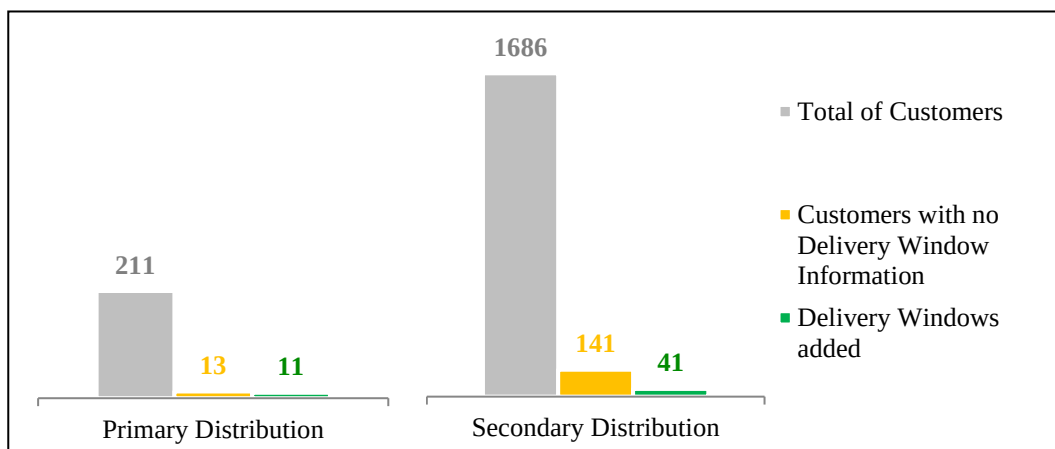


Figure 15 - Delivery Window Information

Source: Author based on internship participation and observation

Other inconsistencies were found regarding the way the system was managing the information. This indicator was created so that the drivers needed to send the SMSs per customer. Most of the times a shipment contains more than one outbound delivery per customer (see Section 5.2.) and, as it was mentioned before, the SMS gets associated with one of those outbound deliveries. When the indicator was

implemented, Unicer required that each driver sent, at least, two SMSs per customer, despite the number of outbound deliveries. Such information would be copied, automatically, to the remaining outbound deliveries of the same customer and same shipment. However, the system was not processing the information correctly. Most of those cases were fixed by the Information Systems department, except the cases in which the outbound deliveries are being managed/added at the time the SMSs is received. In this situation, the SMS might be sent to a specific outbound delivery which is not immediately associated to a specific shipment, meaning that the information is not spread to the remaining outbound deliveries.

Once the increase in feedback started to have positive and relevant results, the level of exigency increased as well. Initially, the number of SMSs expected by Unicer was being considered as the number of customers plus the number of SMSs regarding the arrival sent. This means that the last one was not considered mandatory, since the initial concern was to have delivery status information associated with every shipment and customer. The percentage of SMSs sent started to be calculated with the following formula:

$$\text{Percentage of SMSs sent}_i = \frac{\text{Number of SMSs sent by the LSP}_i - \text{Number of repeated SMSs sent by the LSP}_i}{\text{Number of customers visited by the LSP}_i * 2 + \text{Number of specific SMSs needed}}$$

According to the previous formula, the percentage of SMSs sent was now considering the repeated SMSs as well as the cases in which the delivery had incidents or there was no delivery. The number of SMSs expected was no longer calculated based on the number of shipment but based on the number of customers instead. Besides, status of “Delivery with incidents” or “No Delivery” should be additionally reported, meaning that an extra SMSs should be sent for the specific outbound delivery with that status.

This implementation was put into practice in January, leading to a decrease on the overall SMSs sent percentage, since the company was now expecting more SMSs. Figure 16 represents the evolution of the SMSs sent from the implementation moment, April, until June, 3 months after the end of the internship. As it was mentioned in Section 5.3.2., this process started with LSP1, LSP2 and LSP3 and it was followed by LSP4 and LSP5. The LSP3 performs two types of distribution – Primary (3.1.) and Secondary (3.2.) – which were introduced in different moments of time.

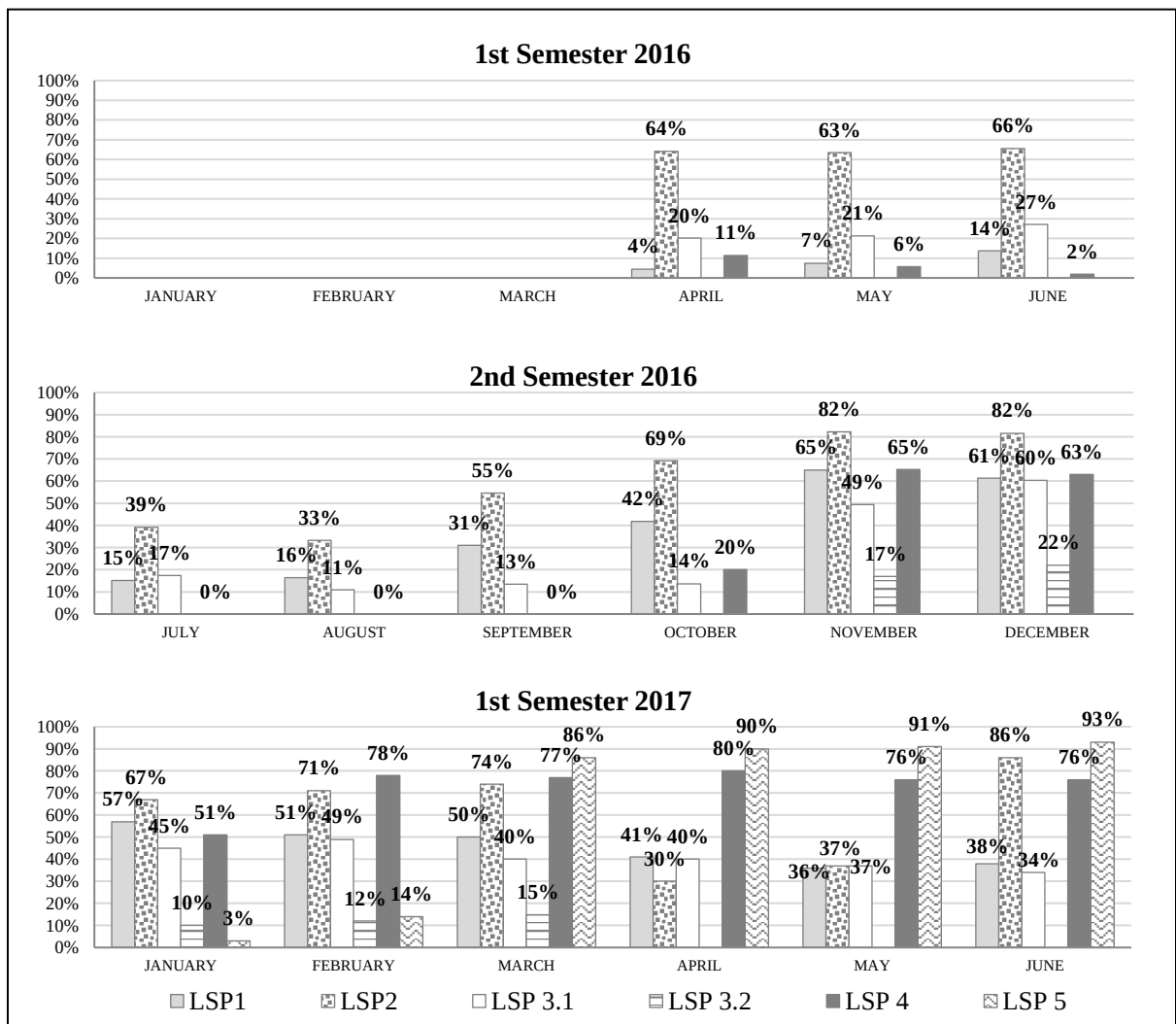


Figure 16 - Evolution of the SMSs sent

Source: Author based on internship participation and interviews

As previously stated, the lack of SMSs sent would involve a fee payment from the LSPs. This information started to be incorporated on the reports, in order to make the LSPs aware of their performance in monetary terms. They were in debt with the quantity of status SMSs not sent. The layout of the reports changed several times, during the internship, but this was the last modification implemented. The current layout report is the one showed in Figure 17 and Figure 18.



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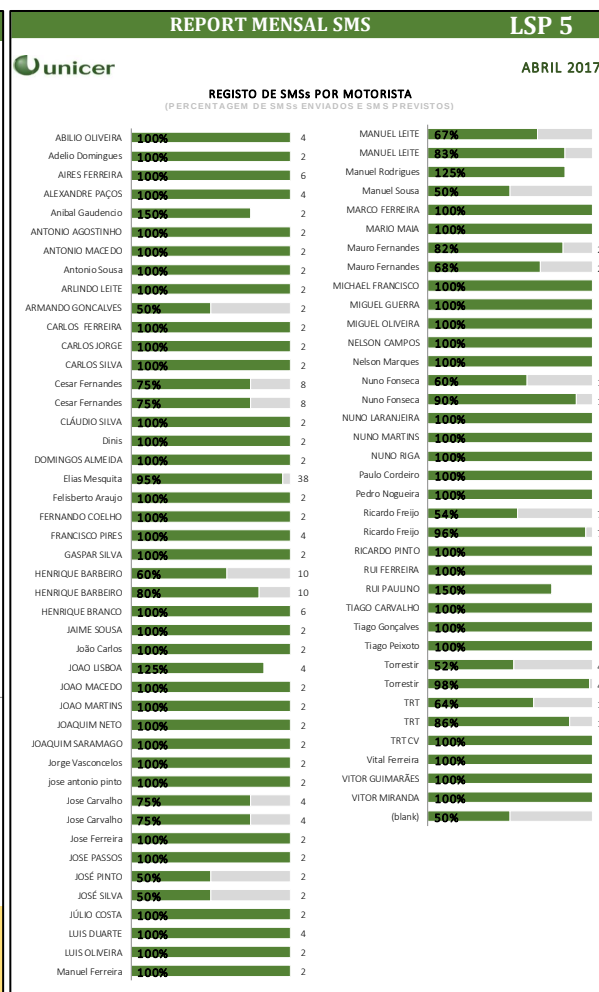
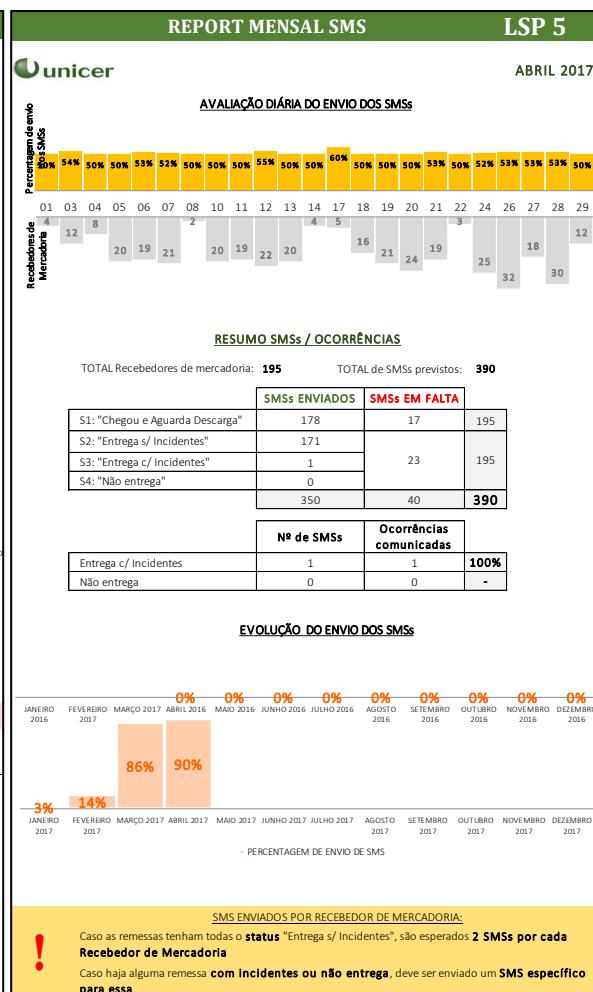
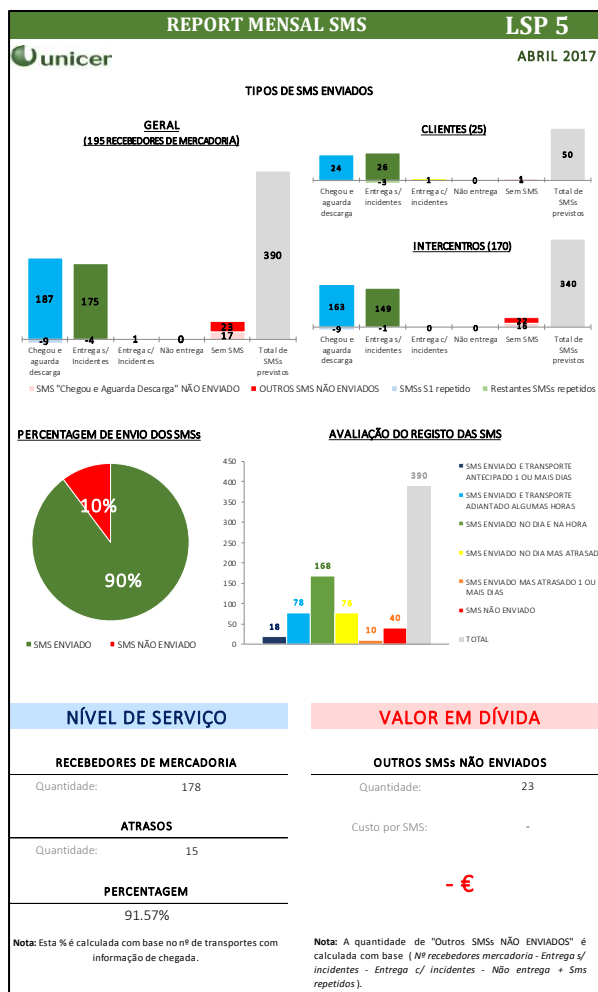


Figure 18 - Current Mensal Report Layout (legible data in Annex 6)

Source: Unicer Bebidas, SA documents

6. PICKING WAREHOUSE OPTIMIZATION

This chapter aims to answer the following research questions:

1. *How to develop a stack-up decision algorithm for mixed pallets?*
2. *How to verify the current storage locations assignment within the picking warehouse?*

The initial goal of the internship, in the Logistic Platforms area, was to develop an algorithm which would classify a picking pallet as a good or bad base for stacking purposes. Since this project was concluded before the end of the internship, a new project was proposed. There was a need to develop a tool which enabled the comprehension of the products allocated to each position, as well as an analysis of the optimal product allocations.

This chapter is divided in 3 main topics: the warehouse description, the decision algorithm development and the Storage Location Verification tool development. Firstly, the main characteristics of the company's warehouses are presented. Secondly, the algorithm is described as well as the action undertaken during its development and implementation. Lastly, the picking warehouse layout is described, in order to explain the tool developed to evaluate the storage location assignment process.

6.1. WAREHOUSING IN UNICER BEBIDAS, SA

Unicer Bebidas, SA has 13 activity centres (see Annexe 1). Its factories are located in *Leça do Balio*, *Pedras Salgadas*, *Caramulo*, *Castelo de Vide* and *Ladeira de Evendos* and all these facilities have warehouses. The remaining activity centres are only logistic platforms.

The company operates in both private and subcontracted warehouses. The main subcontracted warehouse is *Tojal*, which is rented entirely to Unicer by a logistic service provider. In turn, it is operated by another logistic service provider. There are other warehouses that the company rents, when its storage needs exceed the internal capacity.

According to the logistic platforms manager, the most expensive activity inside the company's warehouses is the order picking, as it was previously mentioned by De Koster *et al.* (2007). The main indicator tracked by the department of Logistic Platforms of Unicer is the cost per litre. This KPI is compared among platforms and evaluated throughout time. In fact, the higher the picking level, the higher the cost per litre.

As described earlier, there are several order picking systems that can be installed in a warehouse. Unicer performs under the PBS (pick by store) system. Once an order is placed, the picker moves to the different storage locations to pick the required products to fulfil the order. Other systems, as the PBL (pick by line), are more commonly used by large retailers once they receive order from Unicer, for example. In this system, the picker moves through all the lines of orders that need the product that he/she is in charge of allocating. In PBS, the driver is the store, while in the PBL, the driver is the line.

6.2. STACK-UP DECISION ALGORITHM

6.2.1. STACK-UP PROBLEM

The process of contracting shipments is usually performed by weight, in order to not exceed the maximum weight allowed and minimize the transportation cost per unit. When an order contains picking pallets, previously mentioned by Yaman and Şen (2008) as mixed-pallet, the objective is to stack those pallets on complete pallets, since the last ones are, generally, a good base. In *Santarém* (see Annexe 1), the stacking activity is performed by the forklift driver, according to his/her experience. In *Leça do Balio*, on the other hand, this task is performed by the truck driver, the person who is responsible for loading the products into the vehicle. Besides, in this facility, there is also an automatic warehouse, which has technology to stack pallets through an algorithm. When an order is retrieved from the automatic warehouse, the algorithm starts to analyse the number of pallets and how many of those are picking pallets. See the example below for a better explanation.

A 40 tons truck has 32 “floors”, which are the number of pallets that can be loaded without being stacked, therefore creating 32 pallet-sized spaces. Imagining that

there are 50 pallets to be loaded, this means that $50-32=18$ pallets must be stacked. The algorithm contains several rules for this process, including placing complete pallets under picking pallets. The first ones have information regarding which type of products can be placed under or above and the types of products that cannot serve as a base for stacking. 50L beer kegs (or barrels) are examples of good bases, while products with PET² packaging, CO2 bottles and 20L beer kegs aren't.

The major problem occurs when the load contains, mainly, picking pallets. In those cases, there is a need to stack picking pallets over picking pallets. As mentioned before, in *Leça do Balio*, there is a mechanism that can stack-up pallets. However, in case of picking pallets, this algorithm needs information about the stacking viability of each pallet.

It was already developed a double key decision-making process (Figure 19). On one side of the key, the picker is responsible for providing its opinion on pallet stability for being a good base; on the other side, the algorithm decision. The algorithm was not functioning until the internship began and, therefore, this decision was made only based on the pickers opinion. This confirmation tool was requested to minimize possible biases in the pickers' decision and to optimize the stacking operation through the existent stacking mechanism, leaving no extra-work for the driver.

		Picker's Opinion	
		Yes	No
Algorithm Decision	Yes		
	No		

 Can be used as a base for Stacking
 Cannot be used as a base for Stacking

Figure 19 - Double Key Decision
 Source: Author based on internship participation and interviews

² “Polyethylene Terephthalate, known commonly as PET or PETE is best known as the clear plastic used for water and soda bottle containers. As a raw material, PET is globally recognized as a safe, non-toxic, strong, lightweight, flexible material that is 100% recyclable.”
<https://www.ecostarplastics.com/pet-101/pet/>

If both the picker and the algorithm consider the pallet as a good base for stacking, then the final decision is positive. The other situations, where there is no match between the two intervenients' opinion or they don't classify the pallet as a good base, are rejected. Firstly, when the picker does not consider but the algorithm considers the pallet a good base is a tricky situation because, on one hand, there can be exclusive cases or instructions over a specific pallet and product and the picker must have the final decision. On the other hand, circumstances where the picker makes a mistake, there is no possibility for stacking as well. Secondly, the rejection of cases which the algorithm does not consider but the picker considers the pallet a good base is good because it decreases the risk of having wrong pallets being stacked. Lastly, situations in which both algorithm and picker don't classify a pallet as a good base for stacking should not be considered for stacking purposes.

There are some obstacles to picking pallet stacking: palletization rules and requirements. Some customers demand specific palletizations, which are against stacking. One of those situations is the column stacking, which is many times required by most of the large retailers. This represents an advantage for those clients, since it is easier to check the quantities ordered, once the product is visible. If it is possible to see that a pallet has 5 boxes of height, 2 of length and 2 of depth of a certain product, the total amount is 20 boxes. In the Capilar Distribution (see Section 5.1), the palletization strategy is called "chaotic" stacking. It has many rules, such as "if there are few units of product A, they should be on the top of the pallet". The goal of this stacking process is to facilitate the product withdrawal to deliver to the customer, instead of focusing on the conference. Other cases, such as layer stacking, facilitate the creation of a pallet which is a good base for stacking. The decision algorithm outcome will be maximized in those situation, as well as when customers don't require any specific palletization and cross-docking. The cross-docking operations include hundreds of pallets per day, so it can represent a significant advantage, in terms of time savings, in the loading process.

After the input/output point (I/O), there are several machines, including the mechanism used to make the stacking decision (Figure 20).

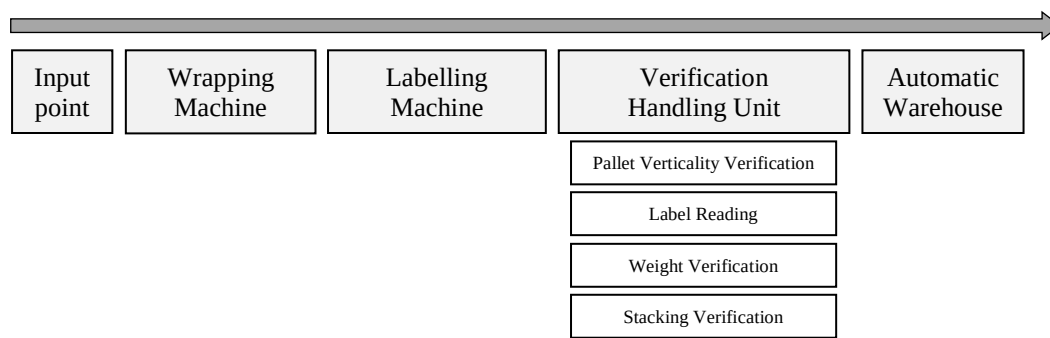


Figure 20 – Input point

Source: Author based on internship observation and interview (see Annexe 3)

After the pallet is inserted in the input point, it goes through the wrapping and labelling machines. Then, the handling unit, the pallet, is inspected: its verticality, label and weight are verified. In case the pallet is correctly assembled and its label and weight are accepted, it is sent to the automatic warehouse. If one of these criteria is not correct, the handling unit is rejected and the picker needs to solve the problem as well as introducing it in the input point. One example of these situations can be the existence of plastic outside the pallet's boundaries, which affects the measurement of its verticality.

In the same portico where is the Verification Handling Unit – VHU, it is also the sensor/scanner that measures the pallets' coordinates for the stacking analysis. It is composed by a rotating laser that measures the distance from the scanner to the pallet, through the reflex, calculating the height of each point of the pallet. Regarding the decision of the algorithm, its storage location within the automatic warehouse, is the same. This means that this analysis is not a relevant factor for warehousing decisions, since it is stored in the same location despite the algorithm decision.

The main goal of this decision algorithm is to optimize the time spent in the loading activity. This tool will provide the required information to enable the automatic stack-up of picking pallets. In turn, this will decrease the loading time, since the driver has no longer to stack the pallets himself/herself. More importantly, it will not only provide time savings but it will also reduce the possibility of mistakes. As stated in the beginning of this section, the driver is not an experienced person in pallet stacking and, therefore, it represents a risk reduction in this sense.

6.2.2. STACK-UP DECISION ALGORITHM DESCRIPTION

The decision process is divided in two phases. Firstly, the scanner measures the pallet height in several points. Secondly, this data is analysed by the system which provides a final decision regarding the stacking viability.

There are two scanners in the picking warehouse in *Leça do Balio*: scanner SCP14, located on the right, and scanner MCP15, located on the left (see Annexe 8, red cells). These sensors require different analysis, since each one is in a different portico.

In order to define the criteria for the algorithm, a computer application which enabled the coordinates data collection (x,y,z) was used (Figure 21). This program was developed by the engineering partner company, Efacec -Handling Solution, SA.

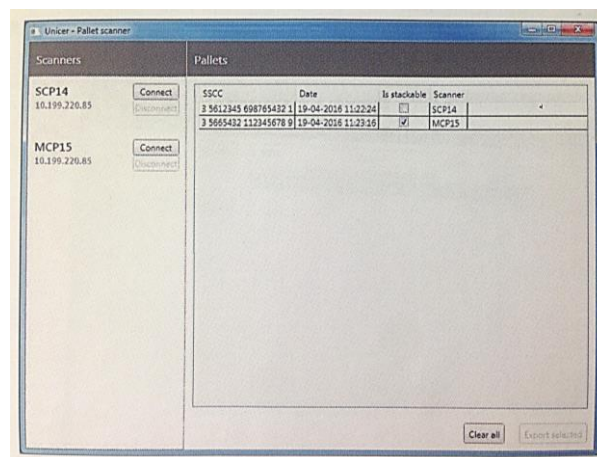


Figure 21 - Computer Application for data collection

Source: Unicer Bebidas, SA documents

In this program, it is possible to have one or both scanners connected at the same time. Once the pallet triggers the sensor, its SSCC³ is registered as well as the date and time, the scanner and the algorithm decision. The data collected from the program is an excel file, which contains the heights of several points of the pallet

³ “Serial Shipping Container Code (SSCC) can be used by companies to identify a logistic unit, which can be any combination of trade items packaged together for storage and/ or transport purposes; for example, a case, pallet or parcel.” <https://www.gs1.org/serial-shipping-container-code-sscc>

(Figure 22). Later, these coordinates are converted into a chart, which provides a better understanding of the scanner measurement. In the example below, the picture on the left shows the pallet before being wrapped, while the chart on the right exhibits the pallet coordinates after wrapping. The difference between these two images is the wrapping paper which is visible between and around the kegs.

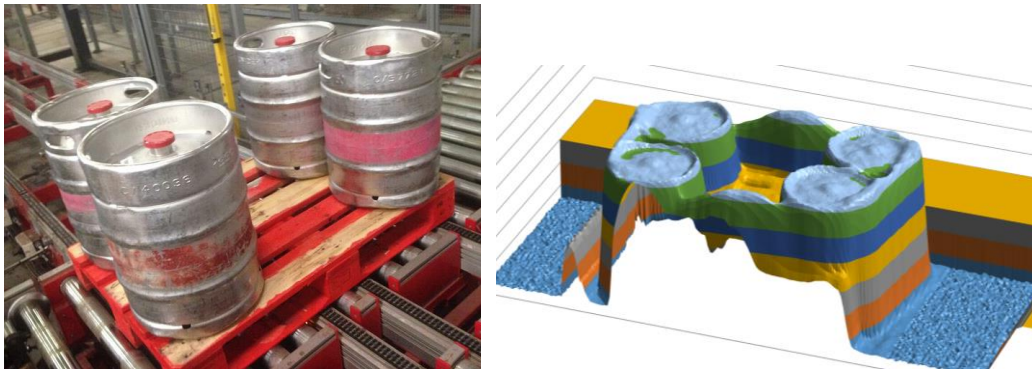


Figure 22 – Example of Picking Pallet (before wrapping) and its Pallet Coordinates (after wrapping)

Source: Author during the Internship

The data collection enables the analysis of the algorithm behavior as well as understanding what is being captured by the scanner. The algorithm behind the final decision was studied and improved during the internship. In order to create a stable stacking basis, the pallet should contain at least 4 stability blocks. The established rule was “If one of the corners (A1, A2, A3 or A4) is missing, the underlying side blocks (B1, B2, B3 and/or B4) must co-exist” (Figure 23).

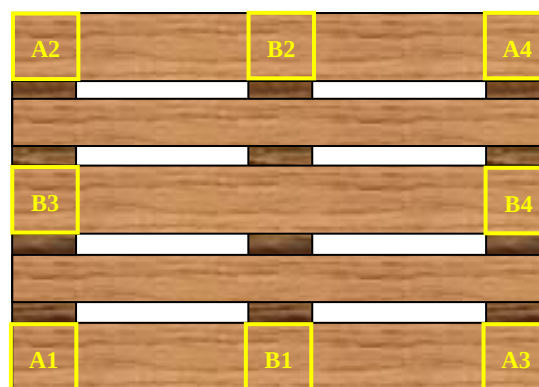


Figure 23 – Algorithm Logic

Source: Author based on internship

Figure 24 describes the possible scenarios, once this rule is applied:

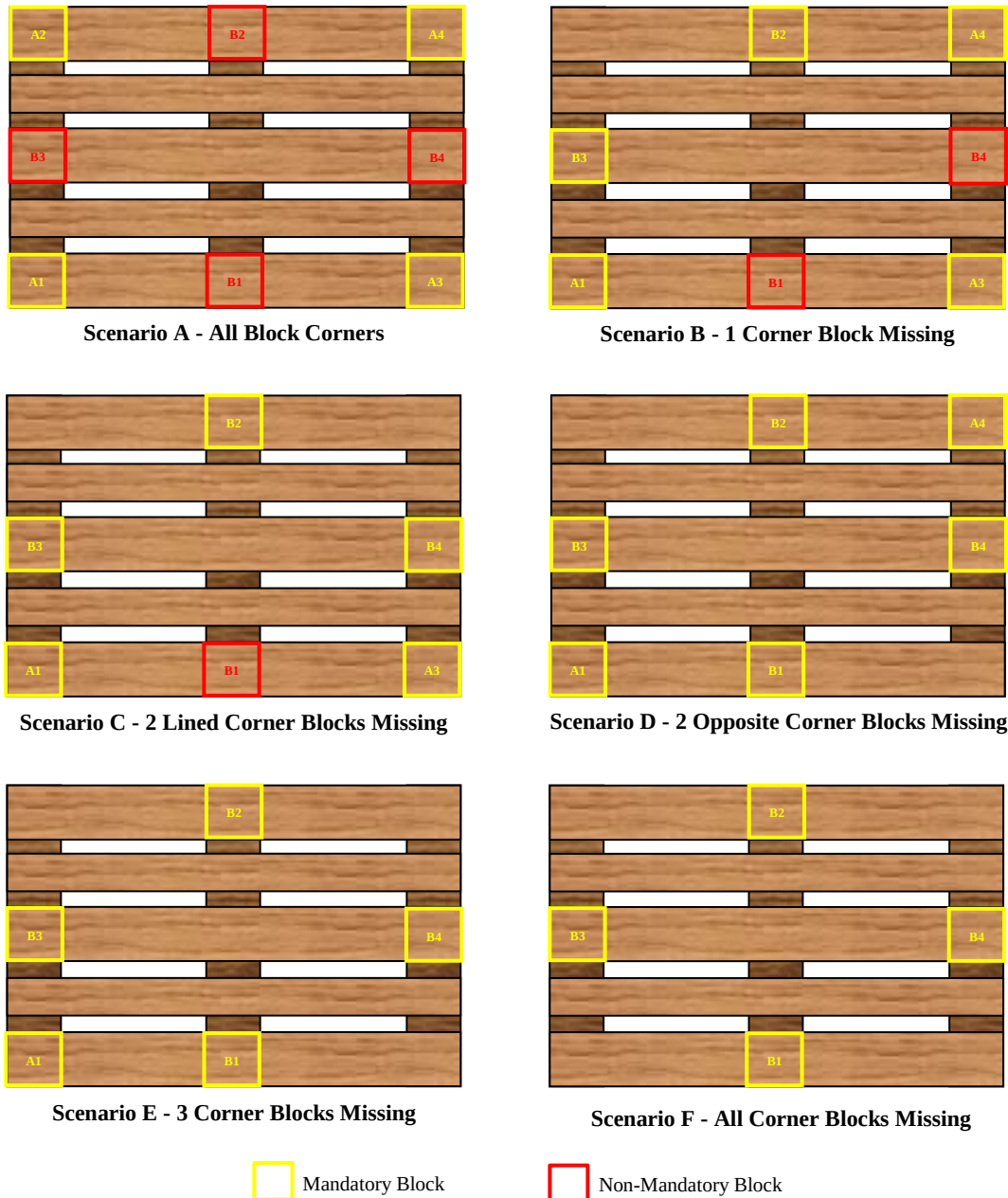


Figure 24 - Blocks Required Scenarios

Source: Author based on internship

In Scenario A, the pallet has all corner blocks (A1, A2, A3 and A4), so the underlying side blocks are not necessary (B1, B2, B3 and B4). If one of the corner blocks does not exist, A2 for example, then its underlying side blocks are necessary, B2 and B3 consequently (Scenario B). In case two lined corner blocks are missing, A2 and A4, for example, B2, B3 and B4 are mandatory (Scenario C). Lastly, all

underlying side blocks are necessary if two opposite corner blocks, three corner blocks or all corner blocks are missing (Scenarios D, E and F).

For a block to be considered, it should contain, at least, 5% of the total points detected by the sensor, with a tolerance of 40mm. The tolerance is the difference between the pallet higher point and the remaining points accepted for the support. This means that, every coordinate with a height difference of 40mm, from the highest point, would be considered as a support point. Regarding the number of points necessary, if one block contained 200 points, it would be considered for support purposes if it contained $200 \times 5\% = 10$ points. These variables were defined after observing a large sample of pallets, which demonstrated that those values were the most suitable.

As previously mentioned, this algorithm was already developed but it wasn't working. The purpose of this tool was not being achieved and, therefore, the pickers' opinion was the only decision driver. Figure 25 describes the process before the algorithm development and implementation.

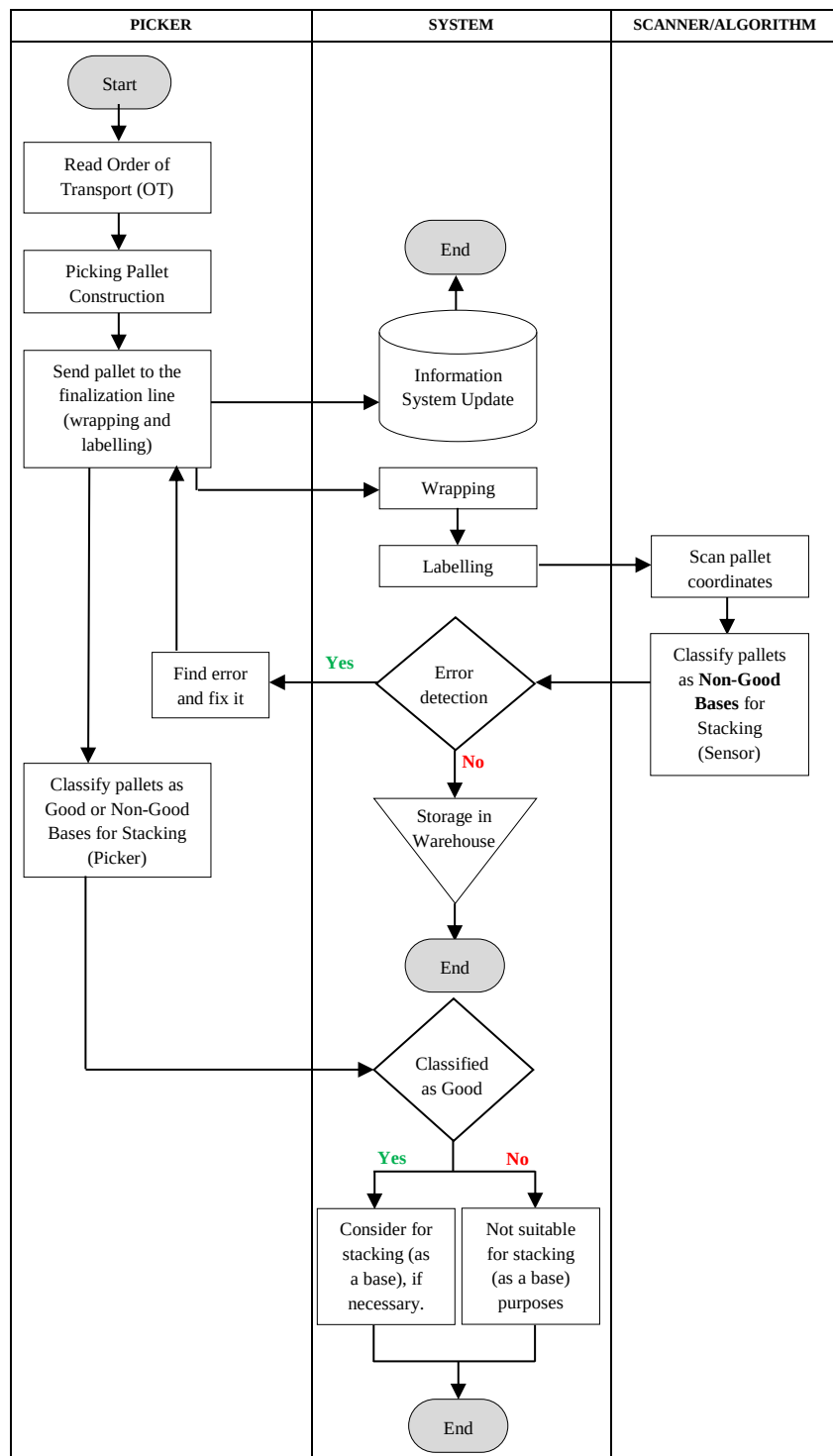


Figure 25 – Initial Process Mapping (before the algorithm development)

Source: Author based on internship

6.2.3. STACK-UP DECISION ALGORITHM DEVELOPMENT

This research started with the understanding of the state of the algorithm, when the internship started. This algorithm was created from a sample of around 700 pallets, observed during 17 non-consecutive days (Figure 26).

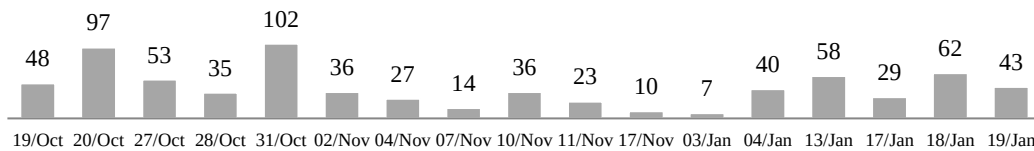


Figure 26 - Number of Pallets Observed for the algorithm creation

Source: Author based on internship participation

During this period, it is possible to identify 6 phases which compose the algorithm development (Figure 27) which will be described in detail, in this section.

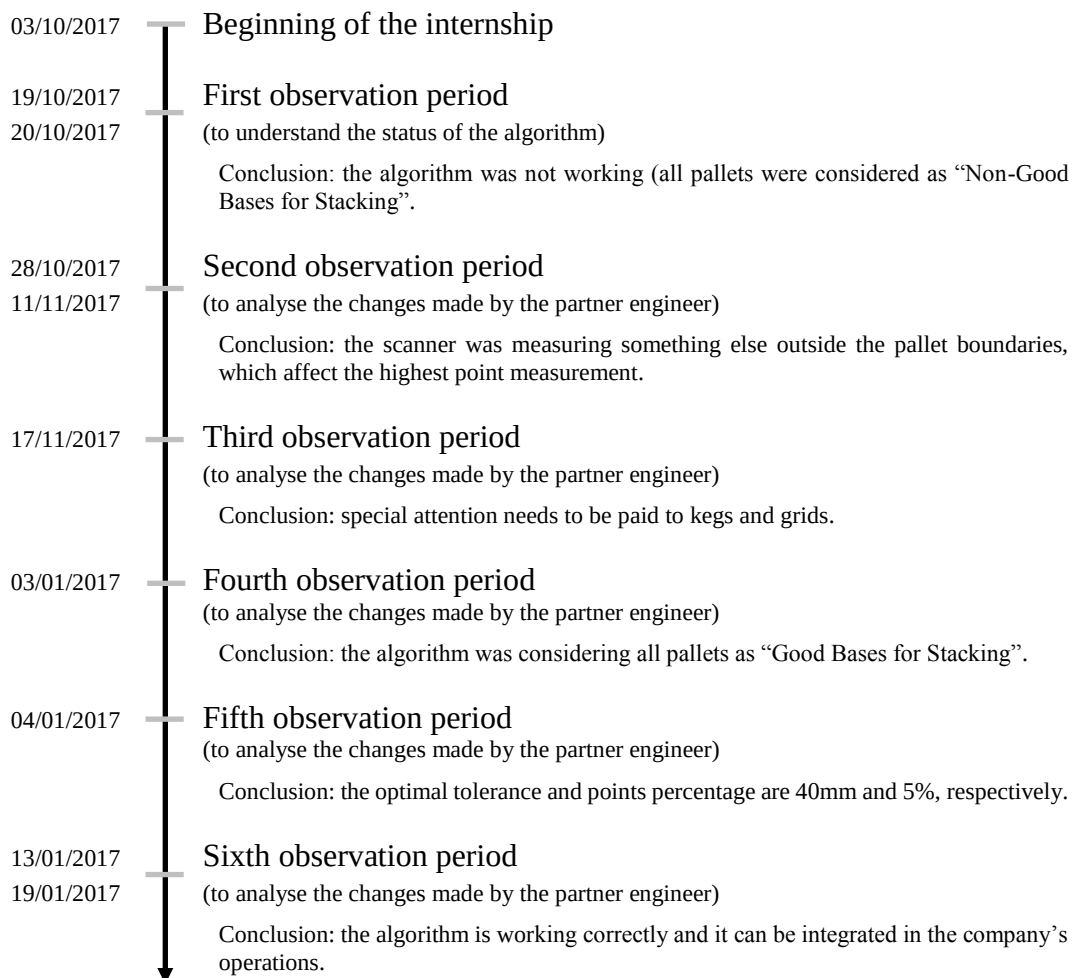


Figure 27 - Phases of the algorithm development

Source: Author based on internship

The process mapping of the stacking decision changed (Figure 28). Not only it became more complex, but it also concerned more people: the intern, the supervisor and the engineer.

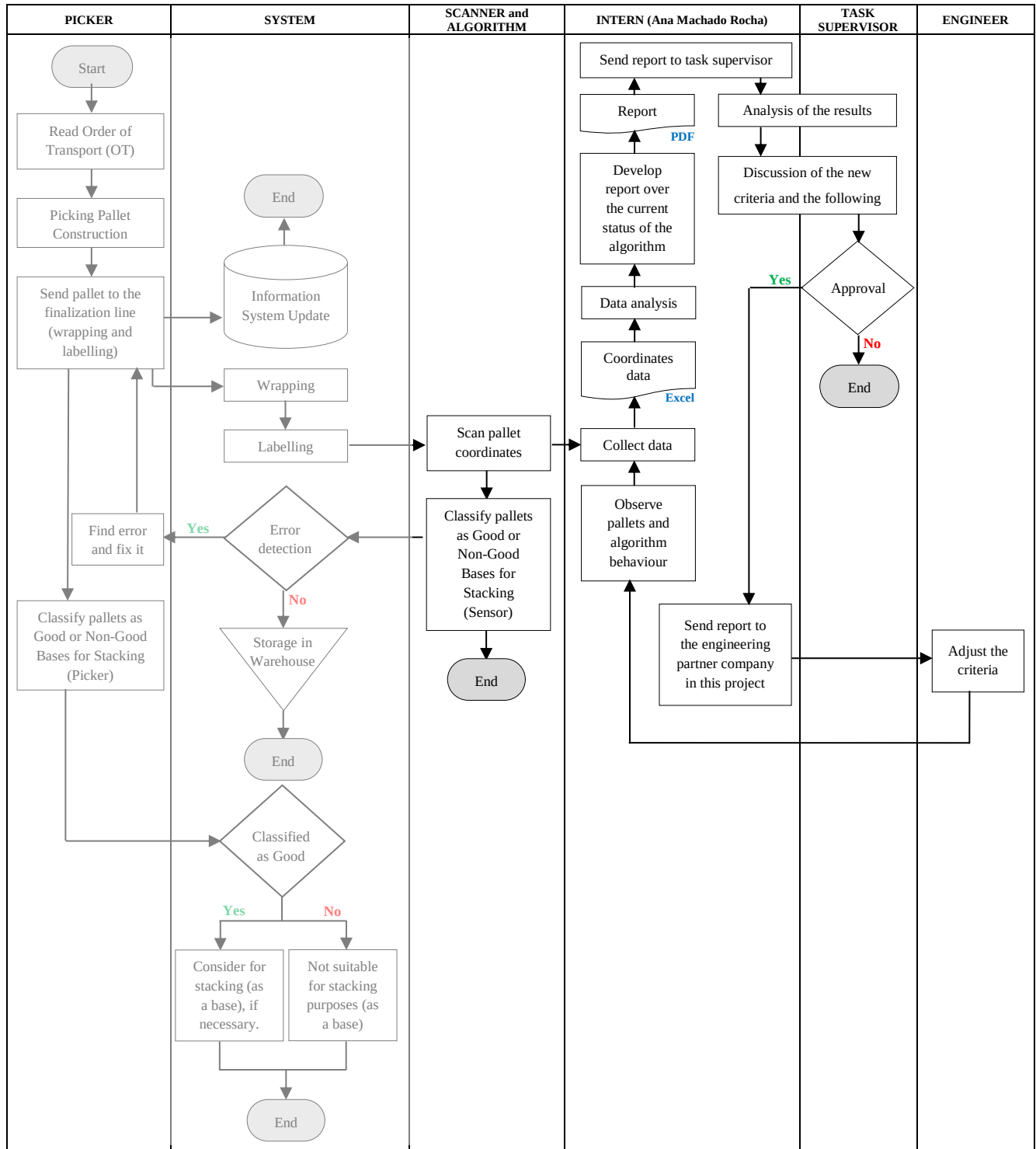


Figure 28 - Process Mapping during the algorithm development

Source: Author based on internship participation and observation

During the first days of observation (October 19th and 20th), the objective was to observe the largest amount and variety of pallets possible to understand the state of the algorithm. After observing 145 pallets, the conclusion was the algorithm wasn't working, since no pallet was considered a "Good Stack-up Base". From that total, 6 pallets should have been considered for stacking purposes (Figure 29).



Figure 29 - Examples of pallets mistakenly considered as "Non-Good Bases for Stacking"

Source: Author during observation in internship

Besides those cases, there were also situations where the pallets weren't even detected by the scanner. Later, it was possible to understand that the sensor only measured pallets whose height was less or equal to 175cm. Figure 30 demonstrates some examples of pallets with a height higher than 175cm.



Figure 30 - Examples of pallets non-detected by the sensor

Source: Author during observation in internship

The following step was the coordinates data collection, which enabled the understanding of what the sensor was measuring and why it was not working correctly. This phase of the research was conducted from October 27th to November

11th. Two major conclusions were drawn: firstly, the sensor was measuring something outside the pallet boundaries, which was affecting the detection of the higher point of the pallet; secondly, the pallets' dimensions were different depending on the pallet's height, which mean the higher the pallet was, the larger it would seem on the data collected from the excel.

After discussing those issues with the collaborator from Efacec – Handling Solution, SA, the measurement made by the sensor was modified, in order to measure only the pallet, excluding the possibility of detecting anything outside this area and affecting the determination of the highest point. At the same time, the width difference between higher and lower pallets was not a problem for the algorithm. In fact, it appeared on the excel file which was used to study the algorithm, but it didn't affect its final decision. The sensor sends laser beams to determine the distance between the portico and the points of pallet, which calculates the pallet height, consequently. The higher the pallet, more accuracy it has, since it captures more points per cm², as demonstrated in Figure 31.

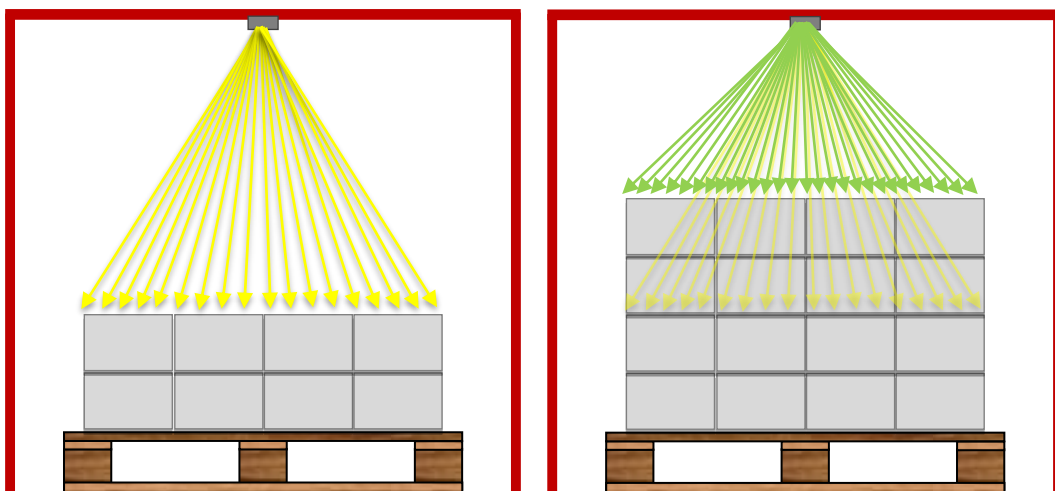


Figure 31 - Laser beams on lower pallet (left) and on higher pallet (right)

Source: Author based on internship

After observing 471 pallets with almost all products, the need to pay special focus to beer kegs and grid aroused. These types of packaging contained thin edges, which complicated the sensor measurement. Consequently, a special observation to these pallets was done, in order to evaluate those particular cases. The remaining products were being correctly detected by the sensor with lower or high tolerances. The beer

kegs and grids, which have thin edges, were the determinative products for the tolerance and percentage of points required.

The grids were barely being detected. On the other hand, the beer kegs measurement was showing significant results (Figure 32). Therefore, the focus of this special observation was mostly performed over grid pallets. From a total of 10 pallets, 9 of them were water and beer grids and 1 of beer kegs. The outcome was relevant for the optimal tolerance determination.

The charts on the right represent the points which were considered support points. They are calculated according to the highest point of the pallet and the tolerance chosen.

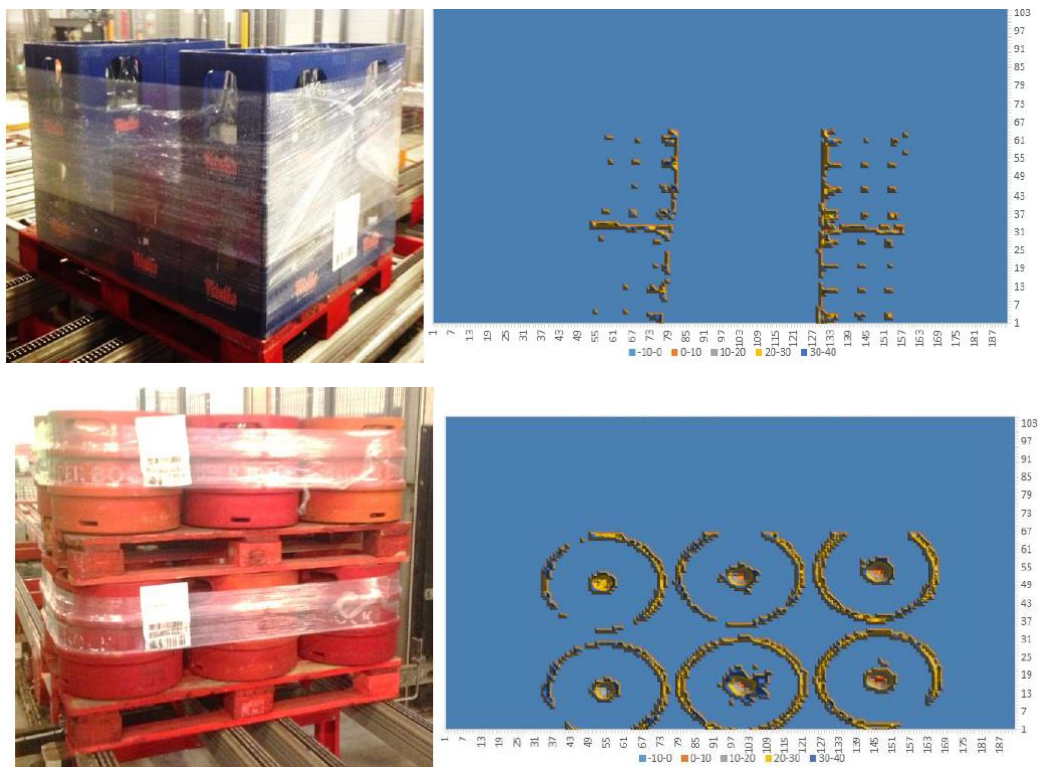


Figure 32 – Example of a Grid and Beer Pallets Measurement

Source: Author during observation in internship

After this analysis, the decision was to set a tolerance of 40mm. Besides this specification, the number of points required was also tested. As previously mentioned, different heights would display different width in Excel. This represented an obstacle to this analysis, since the number of points per pallet was constantly changing. For this reason, this evaluation was performed individually on

each pallet. The regular Euro pallet measures 12000mmx800mm and the blocks measure 150mmx100mm. In order to calculate each block, a manual adjustment was done, the respective lines of coordinates were registered and then, the number of existent points was counted. Since the number of existent points in the blocks differed from pallet to pallet, this variable was defined in relative instead of absolute terms. Therefore, the percentage of points required to consider a certain block as a support point was set as 5%.

The definition of the criteria was done by Unicer, while the adjustment of the algorithm was performed by the engineering company, Efacec – Handling Solutions, SA. Once they finished the adjustment, new tests were made to evaluate the algorithm stack-up decision. After observing 7 pallets, the conclusion was that the algorithm was considering every pallet as a good base for stacking. After asking for a new adjustment, 40 pallets were observed. Three problems were found: firstly, the height in the center of the pallet tended to be higher, even though it shouldn't (Error 1); secondly, the initial and final lines of points measured, were cutting the pallet (Error 2); lastly, the pallets were not stopping on the same place, so chosen coordinates to count the points would differ from pallet to pallet (Error 3).



Figure 33 - Error 1, Error 2 and Error 3

Source: Author during observation in internship

The example with the beer bottles pack, Example 1, it is noted that the centre of the pallet has the higher points. In the Example 2, it is possible to see the points missing in the side of the beer kegs, due to the cut of the horizontal lines. The initial lines are also cut, which means that the pallet is not stopping in the correct place, affecting the blocks position and measurement.

The last series of observations was performed from January 13th to 19th. During this period, 192 were observed, in order to verify the accuracy of the algorithm and the error percentage. Figure 34 describe the observations done as well as the disagreements between the algorithms and the intern visual decisions.

13 th January		Visual Opinion		
		Yes	?	No
Algorithm Decision	Yes	16	-	1
	No	2	-	39

17 th January		Visual Opinion		
		Yes	?	No
Algorithm Decision	Yes	4	-	0
	No	1	-	24

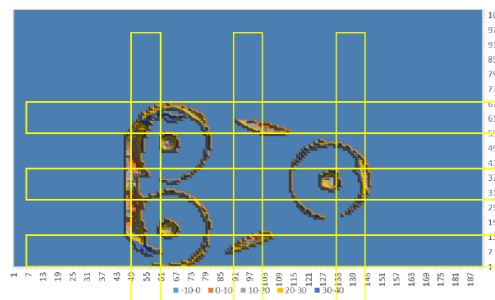
18 th January		Visual Opinion		
		Yes	?	No
Algorithm Decision	Yes	5	-	0
	No	1	-	57

19 th January		Visual Opinion		
		Yes	?	No
Algorithm Decision	Yes	8	-	0
	No	0	-	35

Figure 34 - Final Observation Statistics

Source: Author based on observation in internship

The cases where, visually, the pallet didn't seem a good base for stack-up, but the algorithm decided contrarily, was due to the plastic detection. As demonstrated in Figure 35, the pallet didn't have the blocks necessary to be considered as a good base.



The other disagreements, where the algorithm rejects the pallet but, visually, it seems to fit the criteria, are cases where the pallet was not stopping in the correct place. This error was corrected by amending the pallet trigger.

During this final verification, it was also found that the sensor, SCP14 and MCP15, were not measuring equality. Therefore, in order to examine that problem, a small sample of 6 pallets, was observed and analysed in both sensors. Since there are two different sensors, each one has its own specifications and they are allocated to different porticos, which also affects the measurement. The conclusion was that they were not calibrated with the same levelling. To guarantee that the sensors were at their maximum performance, two scanner verification tools were developed, one for each sensor (Figure 36).

VERIFICAÇÃO DO SCANNER MCP15

Pontos existentes em cada quadrante:	A1 150	A2 150	A3 150	A4 150	B1 150	B2 150	B3 150	B4 150
Total de pontos desta paleta de teste:	0	0	0	0	0	0	0	0
Altura média (MM):	0	0	0	0	0	0	0	0
Observações								
Diferencial médio dos eixos (Esquerda, Direita, Cima e Baixo)	(A1 + A2 + B4)				Esquerda			
	(A3 + A4 + B2)				Direita			
	(A1 + B1 + A3)				Cima			
	(A2 + B3 + A4)				Baixo			
EM RELAÇÃO AO EIXO B1-B3	DESVIO MÉDIO:				MM			
EM RELAÇÃO AO EIXO B2-B4	DESVIO MÉDIO:				MM			
RESULTADO								

GRÁFICOS

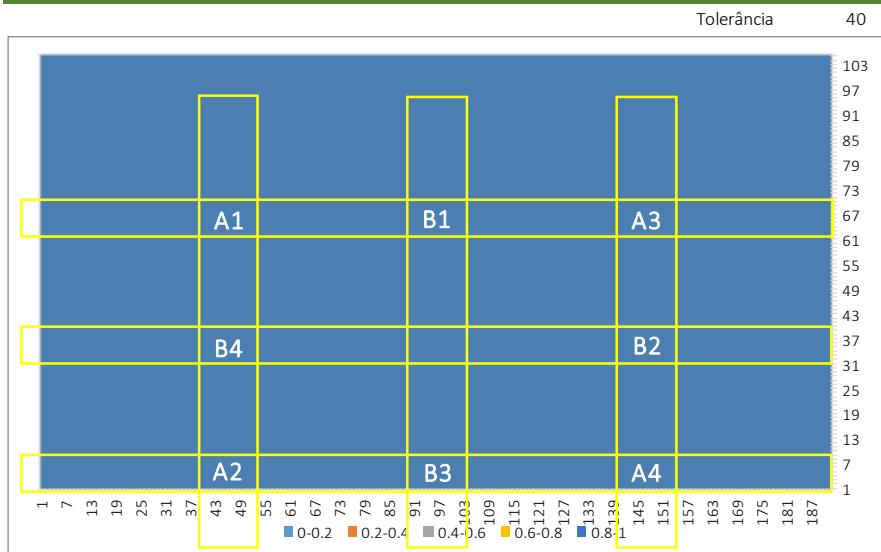


Figure 36 - Scanner Verification Tool for MCP15

Source: Author during internship

As mentioned before, the height of the pallet affects the number of points measured by the sensor. It was established a standard pallet, composed by a pile of 5 pallets, which is used to the scanners' verification. This way, it is possible to standardize the measurement of the number of points in the pallet. Besides, it was verified that

SCP14 was reading that test pallet 2cm higher than MCP15. Due to this question, tools for both sensors were developed, with different criteria in terms of the coordinates location. Nevertheless, the layout and the logic behind both verification tools is the same.

Figure 37 exhibits a verification example on scanner SCP14. Firstly, the measurement of the pallet height is verified. The reference value is 700mm and it is given a tolerance of 50mm, meaning that the pallet height is correct if it measures between 650mm and 750mm. In case the pallet is detected to be higher or lower than the standard pallet, the “*Observações*” (Observations) displays “*Erro: Altura da paleta maior*” (Error: High pallet height) or “*Erro: Altura da paleta menor*” (Error: Low pallet height), respectively. Then, a height comparison between the highest point of the pallet and the other points on each block is performed. In this phase, all block points are measured and a “*Diferencial médio de cada lado*” (Average Differential of Each Side) is determined. This value enables the determination of “*Desvio médio*” (Average Deviation) of the pallet, relatively to two different Axis: B1-B3 and B2-B4. The scanner is classified as levelled (“Scanner Ok”), if none of the “Average Deviations” exceeds or equalizes 10mm. If one of those values exceeds 10mm, the tool result will show “*Ajustar Scanner*” (Adjust Scanner).

VERIFICAÇÃO DO SCANNER SCP14

	A1	A2	A3	A4	B1	B2	B3	B4
Pontos existentes em cada quadrante:	150	150	150	150	150	150	150	150
Total de pontos desta paleta de teste:	98	119	121	121	120	140	135	130
Altura média (MM):	665	706	708	707	701	720	714	709
Observações	<u>PALLET HEIGHT OK</u>							
Diferencial médio dos eixos (Esquerda, Direita, Cima e Baixo)	(A1 + B4 + A2)		Esquerda				14.16	
	(A3 + B2 + A4)		Direita				10.01	
	(A1 + B1 + A3)		Cima				13.31	
	(A2 + B3 + A4)		Baixo				13.05	
EM RELAÇÃO AO EIXO B1-B3	PALETE MAIS ALTA DO LADO DIREITO DESVIO MÉDIO: 4.15 mm							
EM RELAÇÃO AO EIXO B2-B4	PALETE MAIS ALTA EM BAIXO DESVIO MÉDIO: 0.26 mm							
RESULTADO	<u>SCANNER OK</u>							

GRÁFICOS

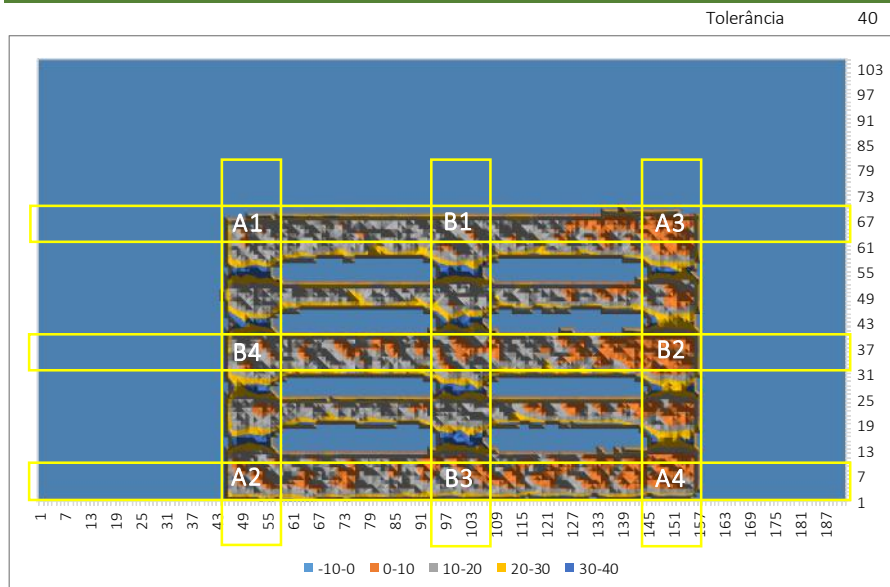


Figure 37 - Example of Scanner SCP14 verification

Source: Author during internship

The final process mapping, which describes the current stacking decision process, is presented in Figure 38. As initially stated as the main goal of the algorithm, it is part of the double-key developed by Unicer, in order to determine which picking pallets may be used as bases for stacking.

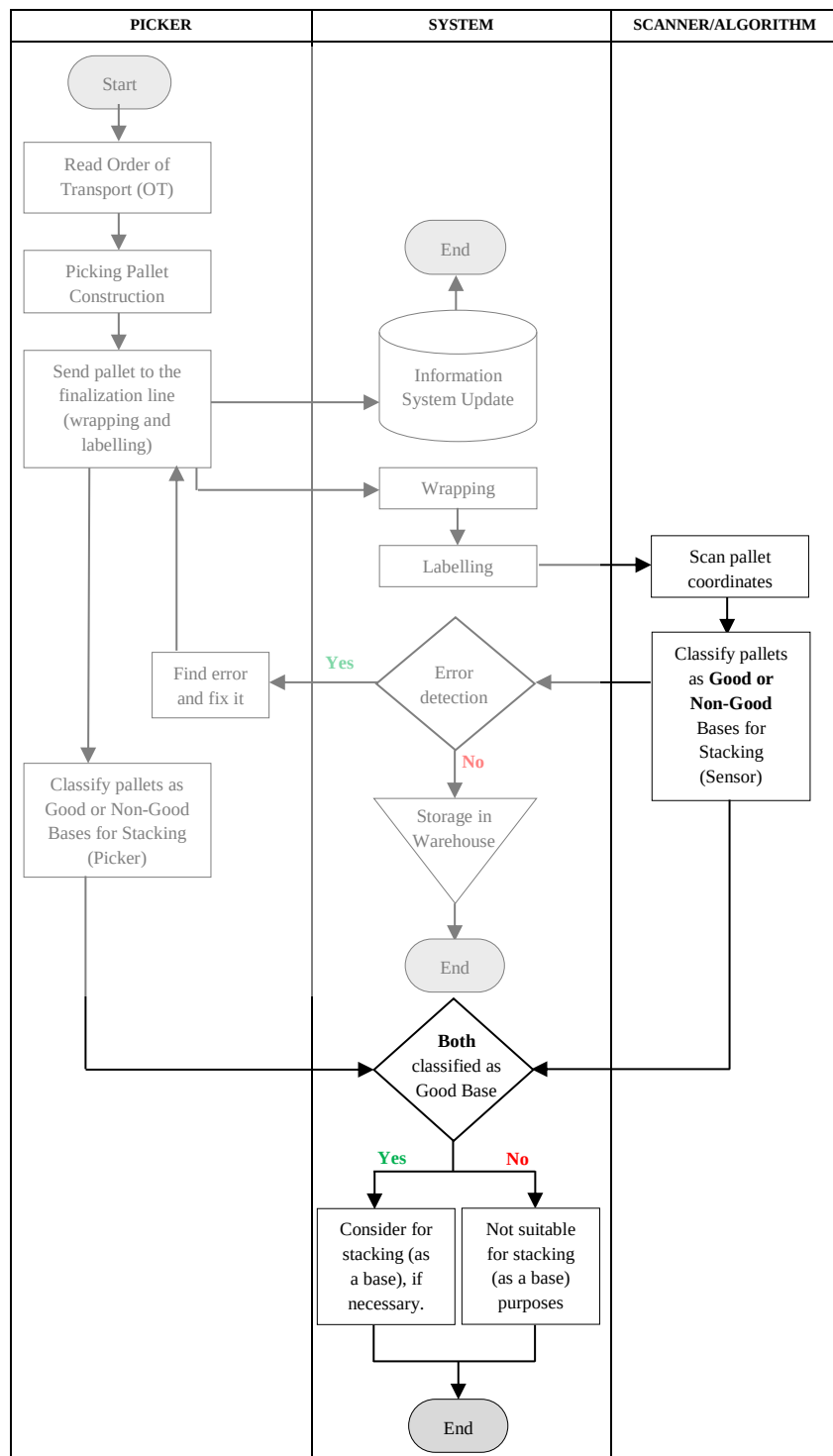


Figure 38 - Final Process Mapping

Source: Author based on internship observation and participation

Nowadays, this algorithm as well as the verification model are integrated in Unicer operations. There is still no statistics regarding the time savings that it is bringing to the company but the perspectives are that it will not have an enormous impact,

since there are still other issues that affect the stacking optimization. Firstly, this process is more used in the cross-docking operations. As mentioned in Section 6.2.1., there is a person responsible for the stacking operations and its supervision. The idea of this project is to be able to do it (exclusively) automatically, without this person's help. However, some other issues lie on this matter. One of them is the pickers' behaviour. Not only they tend to classify a pallet as "Non-Good Base for Stacking", but they also need to be instructed in terms of the pallet construction. There are cases where the customers specify the type of picking they desire, but in other many cases, this does not happen. This provides the pickers the freedom to perform the pick by layer, which maximizes the possibility of stacking. Most of the times, this is a difficult task, since a single pallet can have many diverse products. Nevertheless, there are still improvements to be done, in order to maximize the automatic stack-up process.

6.3. STORAGE LOCATION ASSIGNMENT VERIFICATION

6.3.1. PICKING WAREHOUSE LAYOUT AND DESCRIPTION

Unicer Bebidas, SA picking warehouse in *Leça do Balio* is organized in 3 pick aisles and 4 cross aisles, as it is shown in Figure 39 (see Annex 8 for a more detailed warehouse layout).

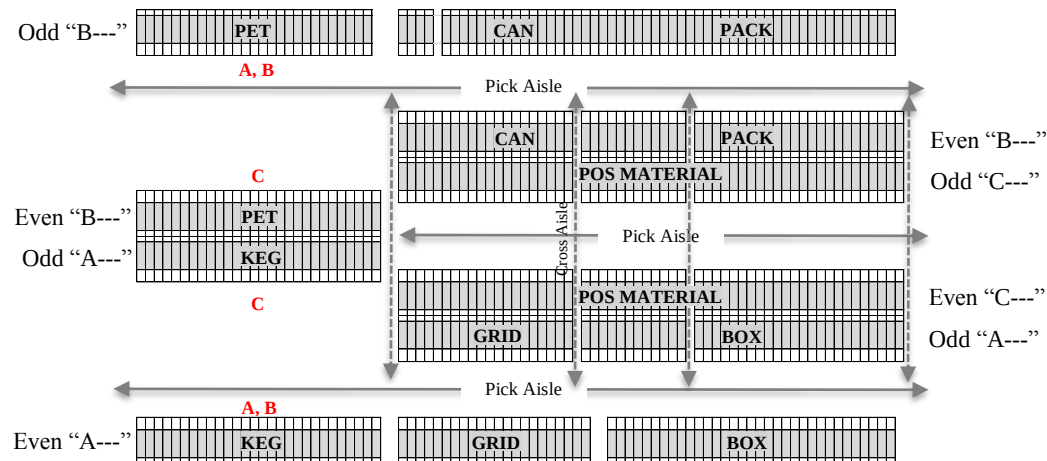


Figure 39 - Pick and Cross Aisles in Unicer Bebidas, SA Picking Warehouse

Source: Author based on observation in internship

The products are displayed in a logic of packing type: kegs, grids, boxes, packs, cans and PET. The more resistant are placed in the beginning of the warehouse, where the routing begins (see Annex 8), while the less resistant are placed in the end of this circuit. The ABC is applied inside each zone (keg, grid, box, pack, can and PET), in order to define to which type of position must be addressed an A, B and C product. The A and B products are located on the gravitational positions, which are represented by the even "A---" and odd "B---" positions (see Annex 8). These positions have storage capacity for 3 pallets and can be automatically supplied. The odd "A---" and even "B---" positions contain C kegs, grid, boxes, packs, cans and PET. These positions are composed by a single pallet floor position. Contrarily to the gravitational positions, these must be manually supplied. The picker needs to collect the pallet from one of the collection/returns positions, A002 or A052, and place it in the correct floor position, for future use. Lastly, the "C---" positions contain point-of-sale (POS) material: chairs, glasses, cup bases, posters, etc. This

area has the same storage structure as the odd “A---” and even “B---” positions, which are single pallet floor positions. Normally, the POS material is mainly composed by C products and there is enough space to storage the necessary products to fulfill the orders. Still, if there is a need to storage more products than the number of floor spaces available, those items can be stored on the shelves.

Additionally, there are products which have fixed positions and others which don't. This decision is made according to the ABC logic as well. However, this research only included the fixed positions, since they are handled by managers, while the non-fixed are managed by the system.

Regarding the warehouse layout, when there are promotions, the pickers tend to accumulate in the same positions to collect the promotional items, which has already led to some incidents and accidents. Carlsberg, one of Unicer's holders, has already proposed a layout based on the ABC analysis, excluding the packaging priority. However, Unicer believes that it will increase the incidents/accidents rate, since it will create more traffic in the A and B products zones. Nowadays, the direction of the route is merely indicative, but it need to be considered mandatory, in order to avoid these situations.

This is the layout and strategy implemented in the picking warehouse in *Leça do Balio*, the company's headquarters. However, most of the times, the products are not correctly assigned to the storage locations. This leads to an increase in travelling and sorting times. This problem was detected through the observation made in the warehouse, since it was easy to understand when a product was out of its zone. For example, in the kegs zone it was possible to find cans, packs or even PET. The products allocation is being performed randomly and it might affect the routing guidelines and the sorting process. Nevertheless, this usually happens with B and C products, which means that the complications are not so serious as they would be if this happened with A products. The warehouse managers should not allocate the products randomly but, in last case, if they need to, they should because the priority is the orders fulfilment. The major problem resides in the layout “cleaning” on the next day. If the managers allocate products just because that product is needed to complete an order and not because it is an A or B product, then they should clear

that storage position at the end of their shift. The information needs to flow from shift to shift and, most of the times, it does not happen. The positions aren't cleared, which leads to warehouse disorganization and affects the order picking performance. This creates a snowball effect, since the wrong positions will be wrongly fulfilled.

6.3.2. STORAGE LOCATION VERIFICATION TOOL (SVL TOOL)

As mentioned in the previous section, the need to create a tool, which enabled the storage location management, aroused in Unicer. Figure 40 displays the home page of the tool, one of the projects of the internship. It will be denominated as Storage Location Verification Tool (SLV Tool).

1º VERIFICAR OS CRITÉRIOS DEFINIDOS

Critério para posição Fixa (em dias)	
Número de dias com visitas	3

Critério para tipo de posição (número paletes consumidas numa semana)		
	Min	Max
Posição de chão (1 palete)	0	1
Posição gravitativa (2 paletes)	1	4
Posição gravitativa (3 paletes)	4	

Critério para Reposição	
Número de vezes por semana	2

Critério da Zona	
Classificação de cada posição por tipo de produto	
AQUI	

Classificação do tipo de produto por zonas						
BAR	BAR	TUB	C6	C12		
GRA	GRA					
CXA	CXA	BOX				
TAB	TAB	PAC				
LAT	LAT					
PET	PET					

2º INSERIR DADOS DO COCKPIT E DAS OTs

INSERIR DADOS COCKPIT
INSERIR DADOS OTs
LIMPAR TODOS OS DADOS

IMPORTANTE!

Os dados inseridos devem ser relativos a 5 dias úteis.
(não incluindo os fins-de-semana)

3º GERAR RELATÓRIO E VERIFICAR POSIÇÕES

Gerar Relatório
ZONAS

ACEDER A OUTRAS TABELAS

MATERIAIS
PALETIZAÇÕES

Figure 40 – Home Page of the SLV tool (legible data provided in Annex 9)

Source: Author during internship

The first step for the tool utilization is the definition and the confirmation of the criteria. In order to have a fixed position, managers should evaluate the number of days per week which a product is visited. A “visit” is every time a picker goes to a certain storage location to pick a product. If a product has 3 or more visits per week, it should be considered for a fixed position. Besides, the number of replenishments done per week must be defined. Usually, the storage locations are supplied once or twice per week. This process is performed on the gravitational positions, which are automatically supplied by the system. The floor positions should have stock for a week, in order to reduce the number of replenishments performed by the pickers.

The ideal type of position attributed to each product depends on the demand. This criterion is calculated according to the number of pallets consumed per week. If, during a week, 2 pallets of “SB ORIG. TP 0,33X24 CX” (24 beer bottles of 0,33L) are consumed, then that product must have one gravitational position of 2-pallets capacity. The minimum and maximum pallet consumptions are established according the number of replenishments per week and the position type. As previously stated, the floor positions must have products which have a maximum consumption of 1 pallet per week. The 2-pallets gravitational positions must have products which consumption is between 1 pallet and 2 times the number of replenishment. This means that if the replenishment criterion is set at 2, the maximum consumption accepted for that type of position is $2 \times 2 = 4$ pallets per week. On the other hand, if the replenishment is set at 3 days per week, the 2-pallet gravitational positions can be fulfilled by products which have a maximum consumption of $3 \times 2 = 6$ pallets per week. These criteria will be fundamental for the determination of the optimal number of fixed positions for each product.

The following step is the verification of the packing type zones. One of the main reasons for this tool creation was the wrong storage location allocation. The definition of the zones will guarantee that the products are placed in the intended storage locations.

The last criterion is the packing type categorization. In order to minimize the number of categories and to simplify the tool, 7 categories were defined: BAR, GRA, CXA, TAB, LAT, PET and UN: BAR is composed by all kegs, tubes and carbon bottles (C6 and C12); GRA category is composed by beer and water grids; CXA is constituted by all boxes; TAB is made by trays and packs; LAT is composed by all cans; PET by PET packing products and UN by POS material. These nominations can be adjusted accorded to the managers will.

The allocation of the zones to the warehouse layout is exhibited in Annex 10. Within this page, it is possible to save the criteria defined, in other words, the packing type per position, in the “Save Zones” button. This information can be changed and managed according to the users’ will. If the user already inserted the

required data to use to tool, it is also possible to check if the product allocated to each position is in accordance with the criteria defined (see Annex 10).

After confirming the criteria, the data must be inserted. This tool provides information on the correct use of the storage locations. Therefore, it works by crossing the data from the previous 5 workdays of orders of transport (OTs) and the current products allocated of each position, denominated as “Cockpit”.

The SLV tool is not integrated in Unicer Bebidas, SA operation yet. The interviewed warehouse manager wants to give his employees training on warehouse management, related to this issue. Therefore, this tool is expected to be put into practice in September or October, 2017, which is when the users will receive the required training.

It should be used at the end of each week, in order to evaluate what should be changed. The OTs data comprise the previous picking orders. This data enables the understanding of the orders’ trend and manage the products available in the picking warehouse according to this information. In turn, by crossing that information with the current positions allocation, it is possible to determine the optimal number and type of positions fulfilled by each product as well as the zone in which that product is placed.

The OTs and Cockpit data can be collected from SAP at any moment of time, whenever the warehouse managers decide to evaluate the warehouse organization. After inserting the data on the respective sheets, it is possible to generate a report (Figure 41).

HOME		Cockpit Positions		Weekly Consumption (in pallets)		Number of ideal positions			
Code	Product	PIF	PIC	Current Position	Ideal Position Type	DELETE	CREATE		
792008633	BRISA MARACUJIA LATA 0,33X6*4 SH	0	0		Floor Position	1	1		
792004025	BRISA MARACUJIA TP 0,25X24 CX	0	0		Floor Position	1	1		
940006033	CARAMULO PET 0,33X24 SH	1	1	B003 B005	Floor Position	1	1		
940006050	CARAMULO PET 0,50X24 SH	1	1	B041 B043	Floor Position	1	1		
940006615	CARAMULO PET 1,5LX6 SH	2	0	B046 B133	Floor Position	1	1		
940006206	CARAMULO PET 6LX2 SH	0	0		Floor Position	1	1		
120001130	CARLSBERG BARRIL 30L	1	1		2-pallets Gravitational Position	1	1		
160214633	CHEERS PRETATP 0,33X6*4 SH	0	0	AD46 AD48	Floor Position	1	1		
110704633	CRISTAL TP 0,33X6*4 SH BP	2	0	B073 B075	2-pallets Gravitational Position	1	1		
110423033	CRISTAL TP 0,33X24 GR	1	1	A078 A080	2-pallets Gravitational Position	1	1		
570718033	FRUTEA PÉSEGO LATA 0,33X24 SH M	2	0	B056 C186	Floor Position	1	1		
560076615	FRUTIS LARANJA PET 1,5LX6 SH M	1	1	B121 B123	2-pallets Gravitational Position	1	1		
560066615	FRUTIS LARANJA/MARACUJIA PET 1,5LX6 SH M	1	1	B117 B119	Floor Position	1	1		
990301210	GARRAFA CO2 10 KG	1	2	A007 A013 A017	2-pallets Gravitational Position	1	2		
170001130	GUINNESS BARRIL 30L	0	0		Floor Position	1	1		
290204633	MARINA TP 0,33X6*4 SH	0	0		Floor Position	1	1		
890004037	MONTE SACRO, V. MESA BR 0,375L	0	0		Floor Position	1	1		
890014037	MONTE SACRO, V. MESA TT 0,375L	0	0		Floor Position	1	1		
890014675	MONTE SACRO, V. MESA TT 0,75L	0	0		Floor Position	1	1		

Figure 41 - Report Example (legible information in Annex 11)

Source: Author during internship

Nowadays, the warehouse employees are already taking some decisions which are also one of the tool's suggestions. The products/positions which had no activity during the entire week are already being eliminated from the fixed positions. The missing part is the determination of the optimal number and type of positions. As previously mentioned, if a position has daily visits, it should have a fixed position but, for example, if it is consumed only 10% of 1 pallet per week, it should have a floor position. That analysis is not being performed with the desired frequency and it leads to a snowball effect of products allocated to the wrong positions. Over time, new promotions and new products emerge while, at the same time, some products become obsolete. To conclude, this means that this evaluation should become a weekly activity.

7. CONCLUSIONS, LIMITATIONS AND FUTURE IMPLICATIONS

This research aroused from an internship in Unicer, in the Logistics department, in “Transportation and Distribution” and “Logistic Platforms” areas. During this period, three main projects were developed, with the aim to answer to the following questions:

1. *How to improve the delivery quality indicator in the outsourced transportation services at Unicer Bebidas, SA?*
2. *How to develop a stack-up decision algorithm for mixed pallets?*
3. *How to verify the current storage locations assignment within the picking warehouse?*

These research topics are extremely relevant for Unicer’s performance and customer service, since they have impact on its operations and deliveries.

Transportation outsourcing has been increasing among companies. Due to its advantages of cost reduction and expertise of the LSPs, it is becoming an essential part of supply chains. However, managers face more difficulties in the delivery control, since there are legal restrictions which forbidden the absolute control over the LSPs drivers. Many companies have been trying to overcome these obstacles in order to improve their deliveries as well as the customer service.

Unicer developed an indicator which could provide the required information (time and status of the delivery). Once the internship began, this indicator was improved through the creation of an Excel tool which creates SMSs’ reports. This tool provides clear information for Unicer and LSPs. Nowadays it is implemented in the company’s operations and it has high importance, since it includes compulsory payments from LSPs to Unicer.

The indicator development goal was achieved and even surpassed through the introduction of new ideas and simplification of the information provided. However, there was no time to evaluate the LSPs opinion regarding this method, which could be an interesting point of view for future improvements. Therefore, future research should be conducted over this matter.

Managing warehouses is becoming a more sensible task, since customers are requiring smaller orders with smaller lead times. Since warehouses represents a large cost in supply chains, its management must be well addressed in order to avoid enormous expenses. The more expensive activity within a warehouse is order picking, as stated by many authors and confirmed by the warehouse manager of Unicer. Therefore, there are many improvements opportunities in order picking.

Mixed pallets are pallets which contain more than one SKU, with one or more types/sizes of packaging. The load of such products into one single pallet makes pallet stacking difficult, which can have significant impact in the loading activity afterwards. The need to load as much pallets as possible into a single vehicle arises aside with the need to reduce transportation cost. Therefore, the stacking optimization is one of the topics for improvement among companies.

Unicer developed a two-parts decision key to classify pallets as good or non-good bases for stacking. At first, this algorithm wasn't working but, after studying its behaviour and analysis the data collected from the scanner measurement, it was possible to achieve the goal. Nowadays, the algorithm is working correctly and it is integrated in the company's operations.

This decision key affects the loading activity, which is currently performed by a single person, who assesses the drivers during this task. With this new tool, the company is able to send the pallets already stacked, reducing the loading time.

There are no statistics regarding the effect of the algorithm, but it is expected to be low, due to the percentage of picking pallets which can be good bases for stacking. Nevertheless, there are still other issues that affect this process, such as the pickers training regarding the mixed-pallets creation. There are rules to produce those types of pallets but, in some cases, Unicer is able to set them up, in a way that better suits the following activities. So, there are some cases in which the pickers could construct stable mixed-pallets. Thereby, there is a need to train the pickers to develop stable mixed-pallet. This will very likely produce significant results, which will intensify the algorithms utilisation.

Lastly, regarding the warehouse layout optimization, it is known that the products allocation affects traffic times. Companies should design the layout that benefits their business the most, reducing the order picking activity time.

Unicer has a picking warehouse layout based on the type of packing, since they vary from kegs to PET packing. The company has previously detected products in the wrong zone of the warehouse and it affects the routing management as well as the pickers movement inside the warehouse.

In order to solve this issue, a verification tool was produced. This excel file crosses data from the current storage locations and the last 5 work-days orders of transport. This data crossing enables the understanding of the optimal fixed positions for each product.

Even though this tool is not implemented yet, it is expected to integrate the company's operations until the end of the current year (2017). The warehouse manager wants to provide training to his employees about "Warehouse Management" and this tool will be introduced then.

To conclude, these tools were very important in the development of each project. Other companies may benefit from these ideas, if they face similar problem in their operations. Even so, these projects should be followed by other researches in these fields, as previously mentioned.

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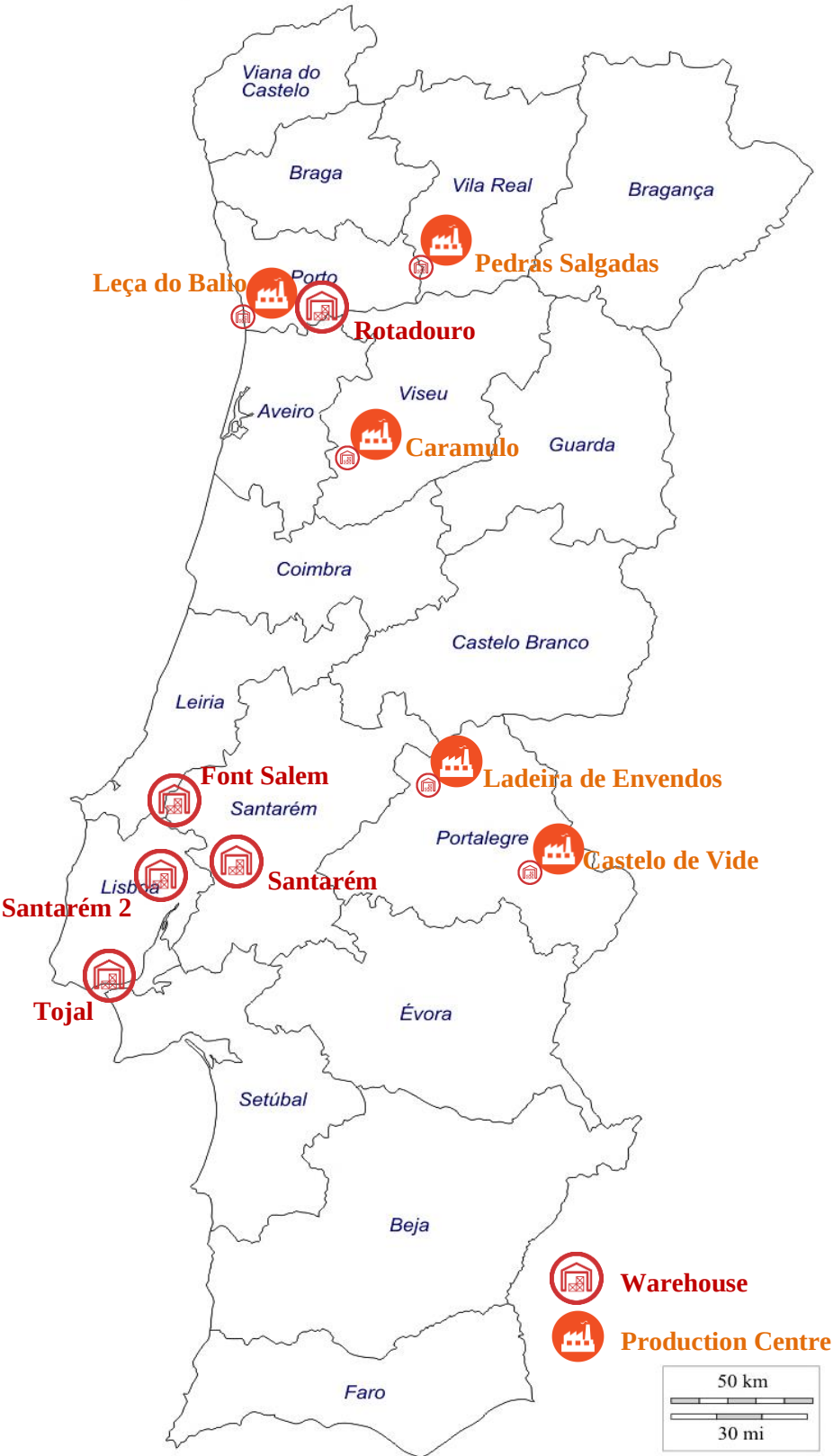
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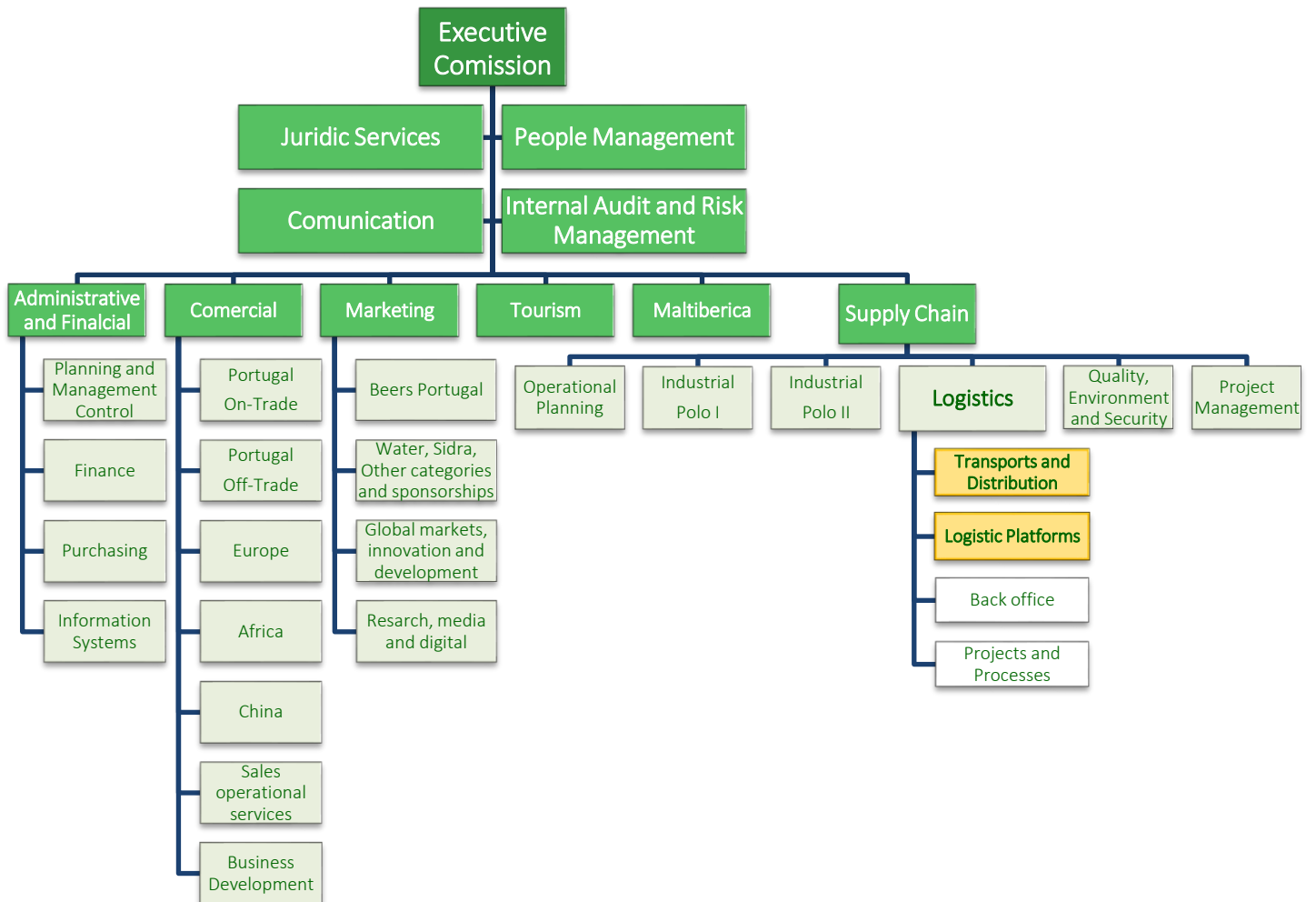
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ANNEXES

Annex 1 - Unicer Bebidas, SA Activity Centers



Annex 2 - Detailed Organization Structure



Interview Script – “Transportation and Distribution” manager

1. Which are the types of distribution within Unicer Bebidas, SA? Can you describe them individually?
2. Why the indicator was only implemented in Primary and Secondary Distributions?
3. What was the initial goal of the delivery indicator? Was it achieved?
4. What measures the customer service level in Unicer Bebidas, SA?
5. What was the deal made with the LSPs that led them to accept the new requirement of the SMSs?
6. Is it interesting for Unicer Bebidas, SA to have a LSP point of view over the indicator, through a questionnaire?
7. How many customers exist in Primary and Secondary Distribution, separately?

Interview Script – “Logistic Platforms” manager

1. How many warehouses and production centres exist in Unicer Bebidas, SA? And where?
2. Does the company have private and subcontracted warehouses?
3. What was the criteria to that decision?
4. What is the most expensive warehouse activity in Unicer Bebidas, SA?
5. From the existent OPSs, which one(s) is(are) used by the company?
6. How did the need to create the algorithm appear?
7. Are there any rules to the picking pallet construction, in order to try to create good bases for stacking or just picking by column and picking by layer?
8. What is the maximum piking pallet height?
9. When was the scanner mechanism developed and installed?
10. Why wasn't the algorithm developed before?
11. How is this program going to integrate Unicer Bebidas, SA operations?
12. Is it already implemented? Since when?
13. Is there any perspective of cost reduction after this implementation?
14. Why was the existent routing policy chosen?
15. What is the storage allocation policy?
16. Why the picking warehouse has that layout?
17. Which are the types of positions in this warehouse
18. How did the need to create the Excel tool appear?
19. How did you detected that the products weren't being correctly allocated?

Annex 4 - First Monthly Report

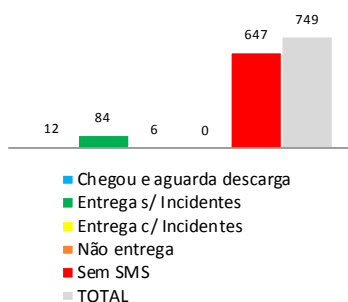
REPORT MENSAL SMS

LSP 3.1

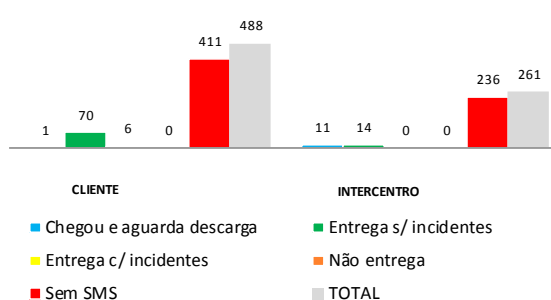


OUTUBRO 2016

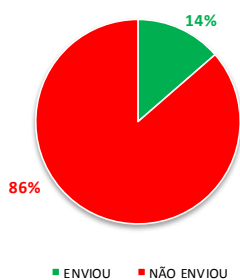
TIPOS DE SMS ENVIADOS



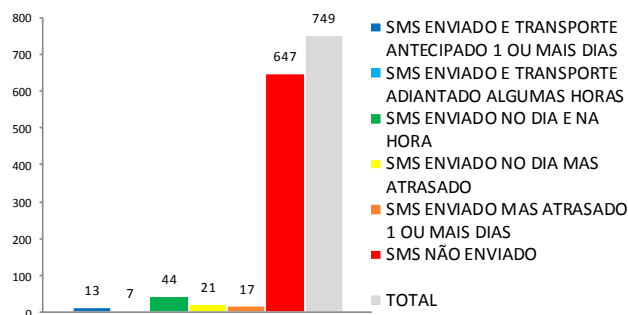
CLIENTES E INTERCENTROS



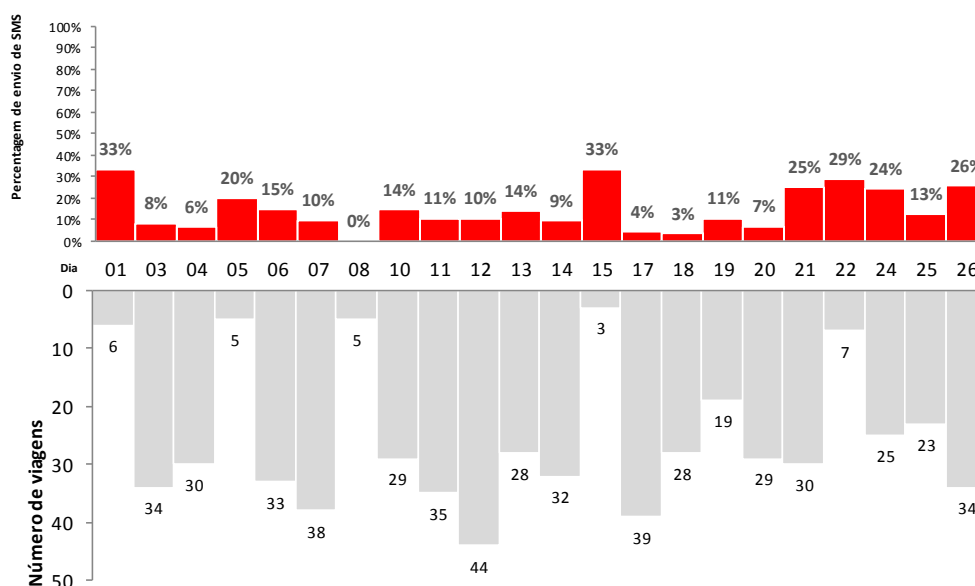
PERCENTAGEM DE ENVIO



AVALIAÇÃO DO REGISTO DAS SMS



AVALIAÇÃO DIÁRIA DO ENVIO DAS SMS

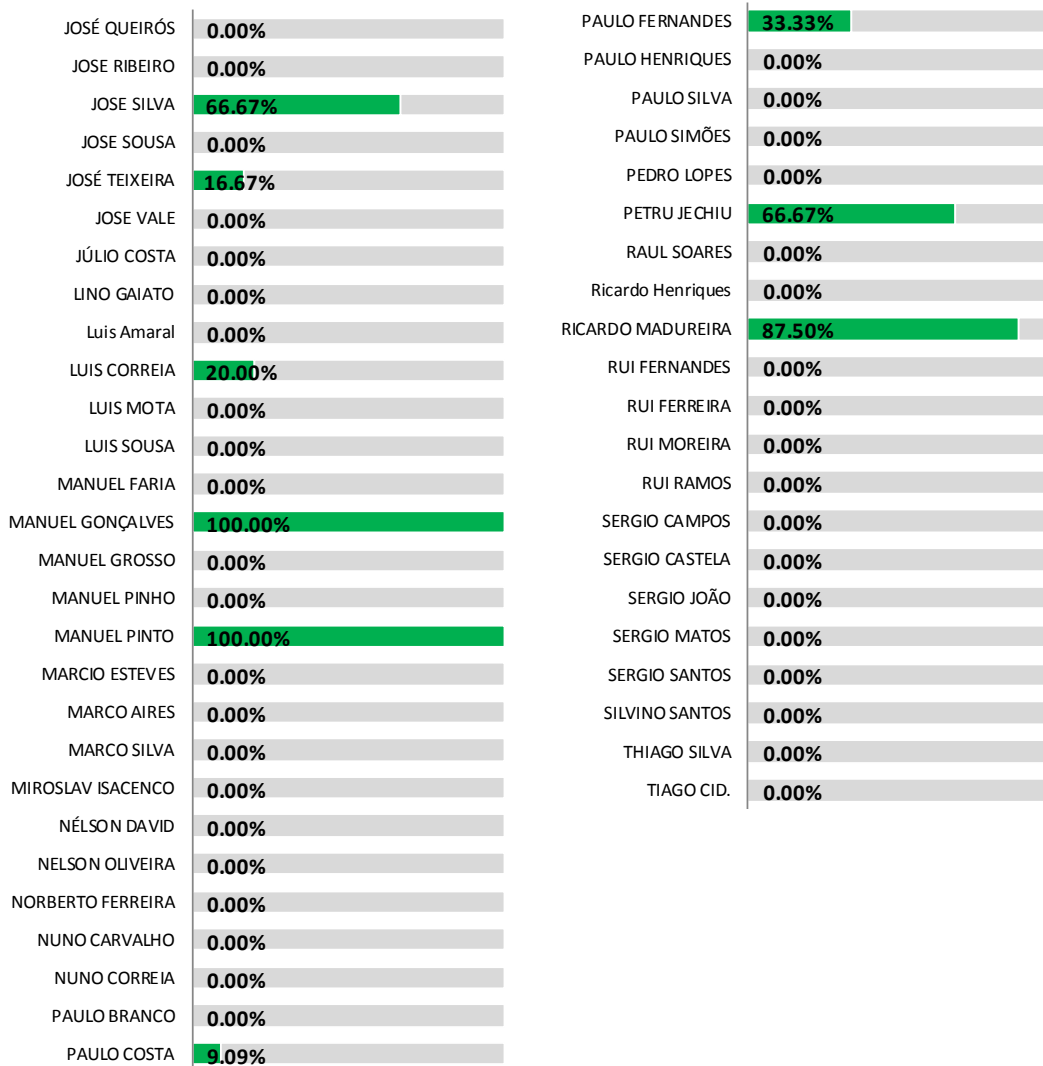




OUTUBRO 2016

REGISTO DE SMS POR MOTORISTA

S/ Motorista Associado	14.10%	ELIAS MESQUITA	0.00%
ADELINO AMADOR	50.00%	EMILIO FREIRE	0.00%
ADELO TEIXEIRA	0.00%	FERNANDO MOTA	0.00%
AFONSO MARQUES	0.00%	FERNANDO RIBEIRO	0.00%
AGOSTINHO AREIAS	0.00%	FILIPE BARBOSA	12.50%
ALFREDO CARVALHO	60.00%	FILIPE CARVALHO	0.00%
AMERICO FARIA	56.25%	FILIPE CONCEIÇÃO	0.00%
AMILCAR SILVA	82.35%	FILIPE FUZEIRO	0.00%
ANATOLIY KUSHNIR	0.00%	FRANCISCO DURAES	0.00%
ANDRE PINTO	0.00%	Gabriel Mateus	0.00%
ANIBAL NOGUEIRA	20.00%	GARRITO PRATES	0.00%
ANTONIO ANDRE	0.00%	GRIGORE POSTOLACHI	0.00%
Antonio Dias	0.00%	GUILHERME MARTINS	0.00%
ANTONIO FONSECA	0.00%	HELDER JORGE	0.00%
ANTÓNIO PERDIGÃO	0.00%	HELDER SILVA	0.00%
ANTONIO RODRIGUES	0.00%	HORACIO FERREIRA	0.00%
ANTONIO SILVA	0.00%	HUMBERTO CARLOS	0.00%
ANTONIO VALENTE	100.00%	IGOR PEREIRA	100.00%
ARMANDO JORGE	0.00%	JOÃO MORAIS	0.00%
ARTUR COSTA	100.00%	JOAO BIZARRO	0.00%
AUGUSTO CRUZ	0.00%	JOÃO CASTRO	0.00%
AUGUSTO TINOCO	0.00%	JOÃO COSTA	0.00%
BACNIB MIKMOW	0.00%	JOAO PAULO	0.00%
BRUNO FERREIRA	0.00%	JOAO RAPOSO	0.00%
BRUNO MOREIRA	0.00%	JOAO SANTOS	0.00%
BRUNO RAIMUNDO	0.00%	JOÃO VIEIRA	0.00%
BRUNO TAVARES	0.00%	JOAQUIM PINHEIRO	0.00%
CAMILO RODRIGUES	0.00%	JOAQUIM SANTOS	0.00%
CARLOS FARIA	0.00%	JORGE ALVES	0.00%
CARLOS GONÇALVES	0.00%	JORGE CASEIRA	0.00%
CARLOS JESUS	100.00%	JORGE MARQUES	50.00%
CARLOS MEIRELES	40.00%	JORGE PEREIRA	0.00%
CARLOS MENDES	0.00%	JORGE SOUSA	18.18%
CARLOS VAZ	0.00%	JORGE VENDA	0.00%
CLAUDIO SANTOS	0.00%	JORGE VILA VERDE	60.00%
CRISTIANO BENTO	0.00%	Jose Araujo	0.00%
DANIEL SAMPAIO	0.00%	JOSE CUNHA	0.00%
DIONISIO SILVA	0.00%	JOSÉ FELICIO	0.00%
DUARTE ANASTÁCIO	0.00%	JOSE GONCALVES	50.00%
EDUARDO JORGE	100.00%	JOSE PEDROSO	0.00%

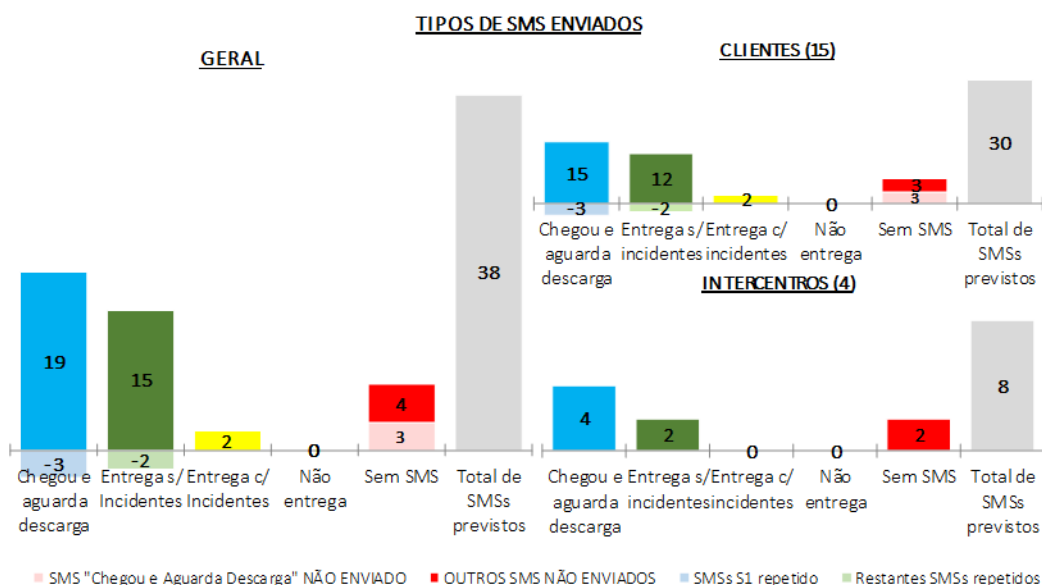
REGISTO DE SMS POR MOTORISTA

Annex 5 - Current Daily Report Model

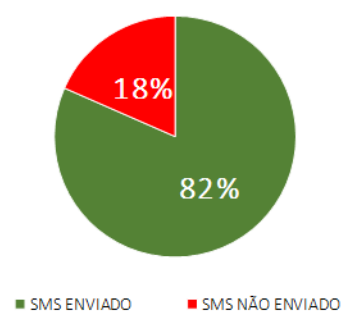
REPORT DIÁRIO SMS LSP4



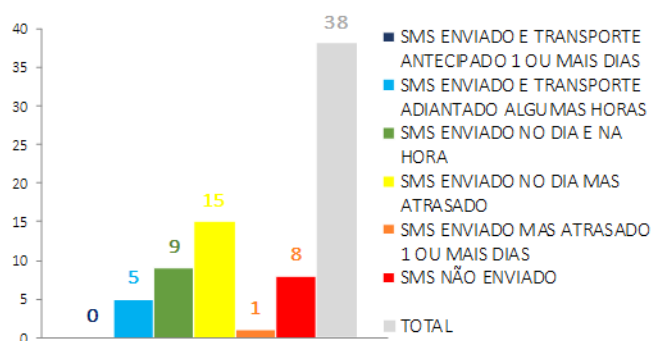
01.06.2017



PERCENTAGEM DE ENVIO DOS SMSs



AVALIAÇÃO DO REGISTO DAS SMS



NÍVEL DE SERVIÇO

RECEBEDORES DE MERCADORIA

Quantidade: 16

ATRASOS

Quantidade: 2

PERCENTAGEM

87.50%

Nota: Esta % é calculada com base no nº de transportes com informação de chegada.

VALOR EM DÍVIDA

SMSs NÃO ENVIADOS

Quantidade: 4

Custo por SMS: -

- €

Nota: A quantidade de "Outros SMSs NÃO ENVIADOS" é calculada com base (Nº recebedores mercadoria - Entrega s/ incidentes - Entrega c/ incidentes - Não entrega + Sms repetidos de entrega s/ incidentes).

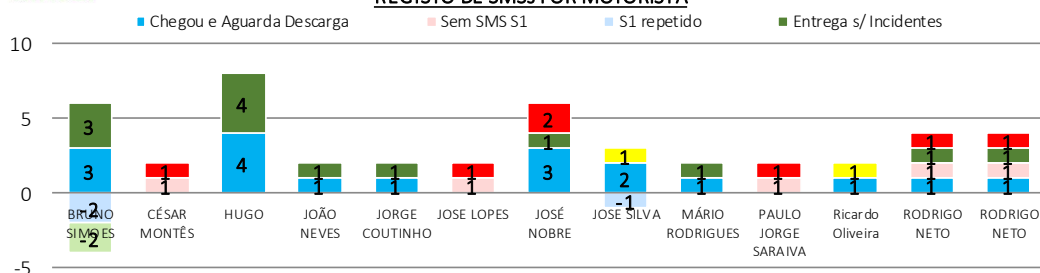
REPORT DIÁRIO SMS

LSP4



01.06.2017

REGISTO DE SMSs POR MOTORISTA



Nota: Quando o nome de um motorista aparece repetido, isto significa que fez transportes para cliente(s) e intercentro(s), respectivamente.

Recebedores de mercadoria 19

Total de SMSs previstos: 38

	SMSs ENVIADOS	SMSs EM FALTA	
S1: "Chegou e Aguarda Descarga"	16	3	19
S2: "Entrega s/ Incidentes"	13	4	19
S3: "Entrega c/ Incidentes"	2		
S4: "Não entrega"	0		
	31	7	38

	Nº de SMSs	Ocorrências comunicadas	
Entrega c/ Incidentes	2	2	100%
Não entrega	0	0	-

LISTA DOS SMSs REPETIDOS

Transporte	Remessa	Código	Rec. Merc.	Motorista	Documento	Matrícula	SMS	Data	Hora
5000078865	8604443146	303678	REGIONAL DE MERCADORIAS - ALCA	BRUNO SIMOES	11774836	84-CN-56	Chegou e Aguarda Descarga	01.06.2017	07:16:16
5000078865	8604441017	303678	REGIONAL DE MERCADORIAS - ALCA	BRUNO SIMOES	11774836	84-CN-56	Chegou e Aguarda Descarga	01.06.2017	07:18:17
5000078865	8604441016	303678	REGIONAL DE MERCADORIAS - ALCA	BRUNO SIMOES	11774836	84-CN-56	Chegou e Aguarda Descarga	01.06.2017	07:20:01
5000078865	8604441016	303678	REGIONAL DE MERCADORIAS - ALCA	BRUNO SIMOES	11774836	84-CN-56	Entrega s/ Incidentes	01.06.2017	15:24:38
5000078865	8604441017	303678	REGIONAL DE MERCADORIAS - ALCA	BRUNO SIMOES	11774836	84-CN-56	Entrega s/ Incidentes	01.06.2017	15:26:11
5000078865	8604441017	303678	REGIONAL DE MERCADORIAS - ALCA	BRUNO SIMOES	11774836	84-CN-56	Entrega s/ Incidentes	01.06.2017	15:27:46
5000078867	8604441014	303678	REGIONAL DE MERCADORIAS - ALCA	JOSE SILVA	4356739	76-DA-74	Chegou e Aguarda Descarga	01.06.2017	09:20:35
5000078867	8604441014	303678	REGIONAL DE MERCADORIAS - ALCA	JOSE SILVA	4356739	76-DA-74	Chegou e Aguarda Descarga	02.06.2017	14:15:54

SMS ENVIADOS POR RECEBEDOR DE MERCADORIA:



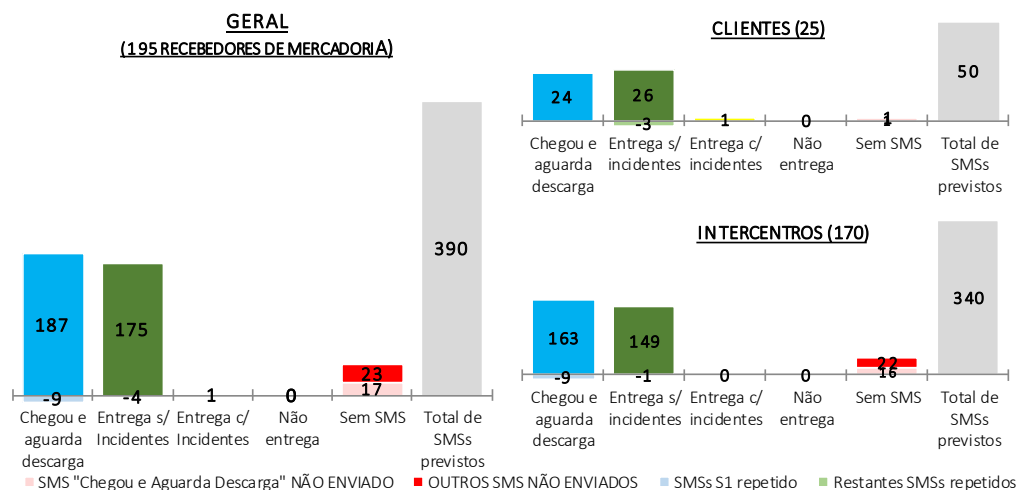
Caso as remessas tenham todas o **status** "Entrega s/ Incidentes", são esperados **2 SMSs** por cada **Recebedor de Mercadoria**

Caso haja alguma remessa **com incidentes ou não entrega**, deve ser enviado um **SMS específico** para essa.

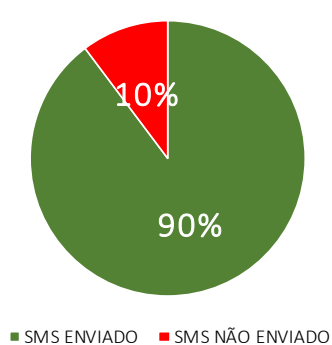


ABRIL 2017

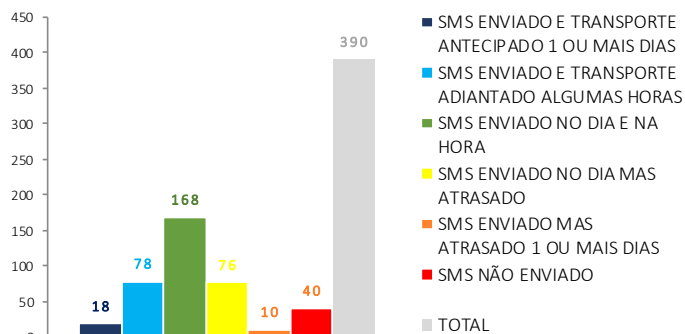
TIPOS DE SMS ENVIADOS



PERCENTAGEM DE ENVIO DOS SMSs



AVALIAÇÃO DO REGISTO DAS SMS



NÍVEL DE SERVIÇO

RECEBEDORES DE MERCADORIA

Quantidade: 178

ATRASOS

Quantidade: 15

PERCENTAGEM

91.57%

Nota: Esta % é calculada com base no nº de transportes com informação de chegada.

VALOR EM DÍVIDA

OUTROS SMSs NÃO ENVIADOS

Quantidade: 23

Custo por SMS: -

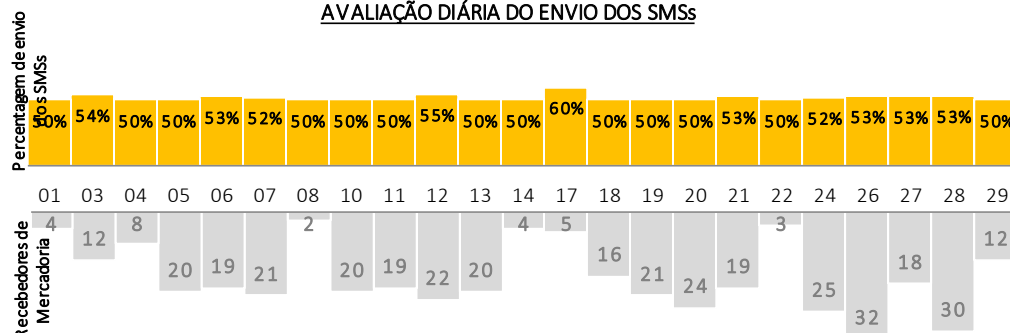
- €

Nota: A quantidade de "Outros SMSs NÃO ENVIADOS" é calculada com base (Nº *recebedores mercadoria* - *Entrega s/ incidentes* - *Entrega c/ incidentes* - *Não entrega* + *Sms repetidos*).



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AVALIAÇÃO DIÁRIA DO ENVIO DOS SMSs



RESUMO SMSs / OCORRÊNCIAS

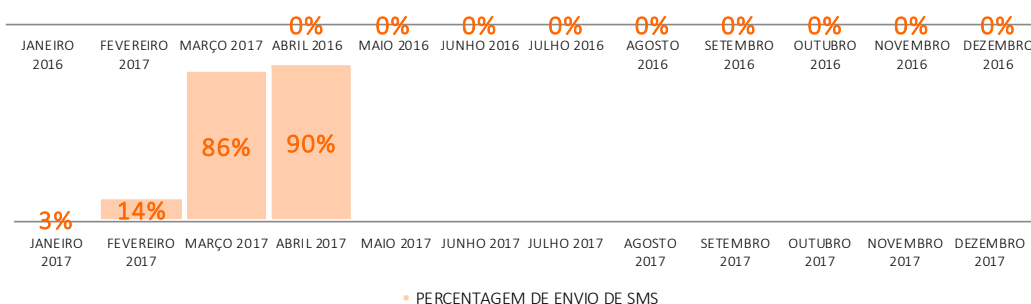
TOTAL Recebedores de mercadoria: 195

TOTAL de SMSs previstos: 390

	SMSs ENVIADOS	SMSs EM FALTA	
S1: "Chegou e Aguarda Descarga"	178	17	195
S2: "Entrega s/ Incidentes"	171	23	195
S3: "Entrega c/ Incidentes"	1		
S4: "Não entrega"	0		
	350	40	390

	Nº de SMSs	Ocorrências comunicadas	
Entrega c/ Incidentes	1	1	100%
Não entrega	0	0	-

EVOLUÇÃO DO ENVIO DOS SMSs



SMS ENVIADOS POR RECEBEDOR DE MERCADORIA:



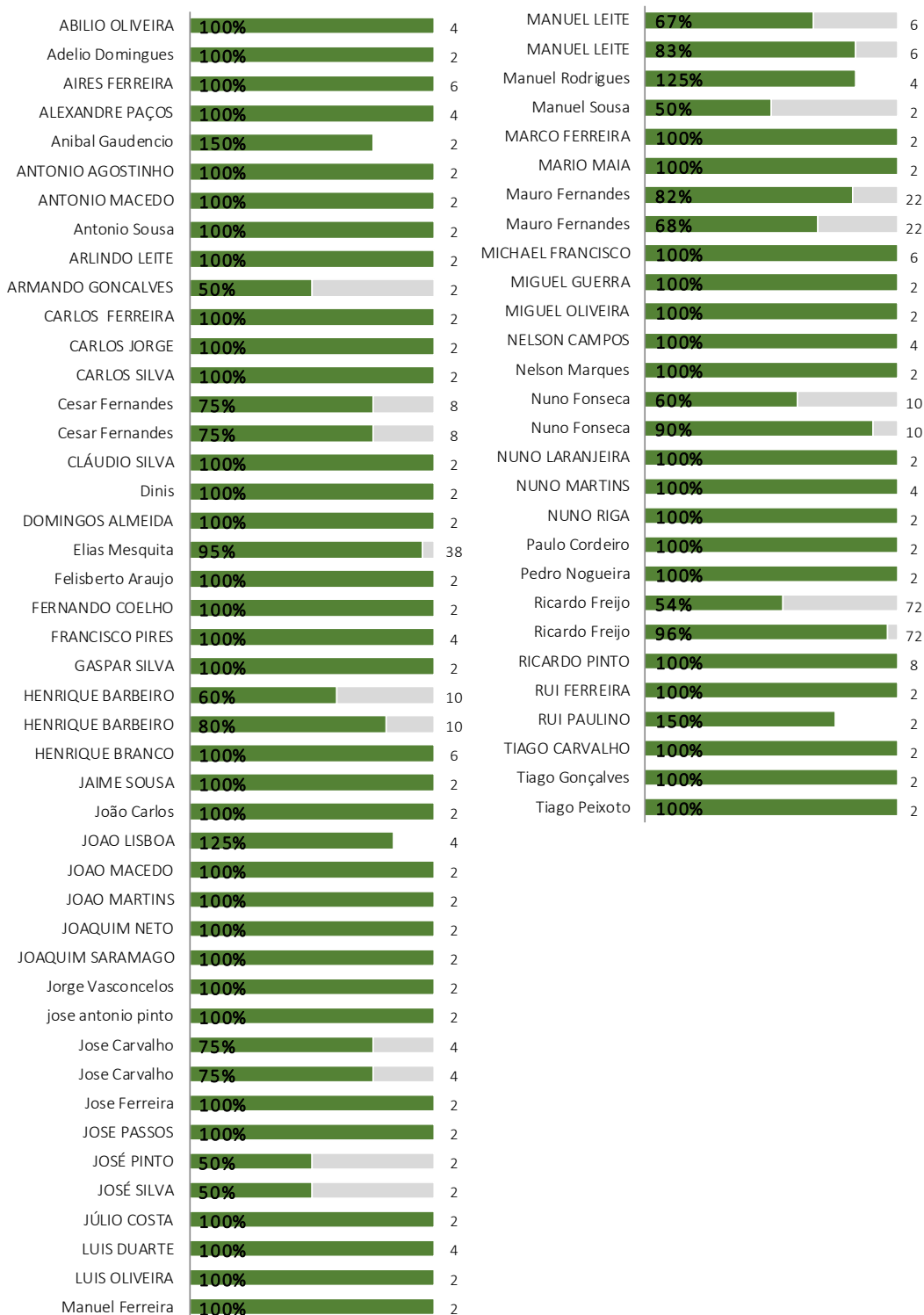
Caso as remessas tenham todas o **status** "Entrega s/ Incidentes", são esperados **2 SMSs por cada Recebedor de Mercadoria**

Caso haja alguma remessa **com incidentes ou não entrega**, deve ser enviado um **SMS específico para essa**.



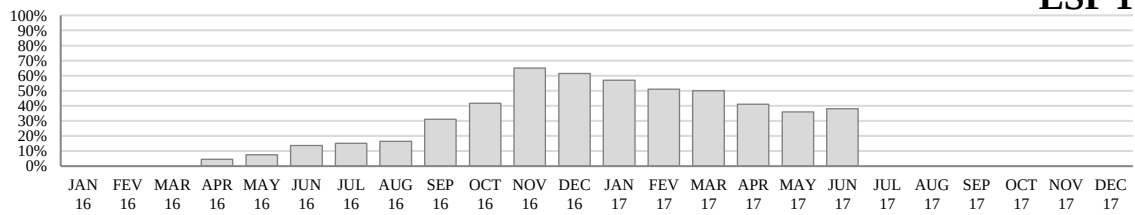
ABRIL 2017

REGISTO DE SMSs POR MOTORISTA
(PERCENTAGEM DE SMSs ENVIADOS E SMS PREVISTOS)

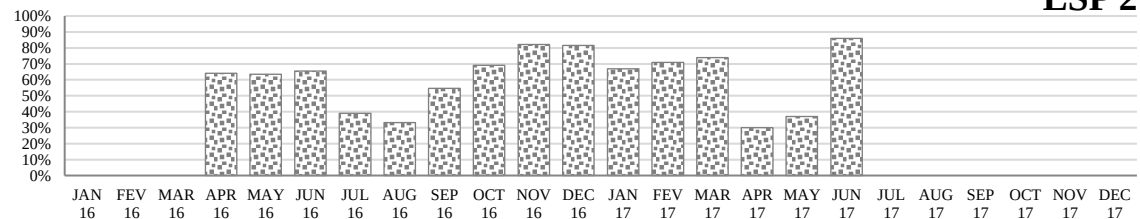


Annex 7 - Evolution of the SMSs sent (per LSP)

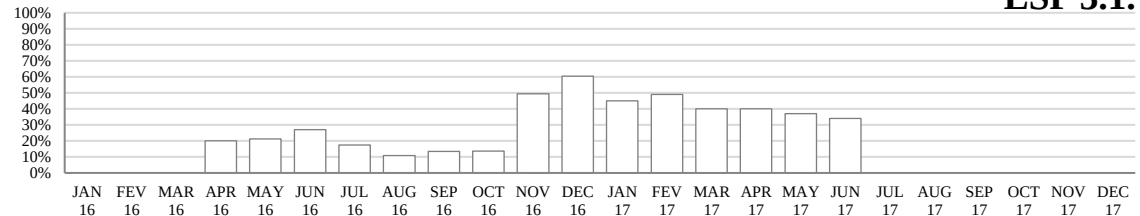
LSP 1



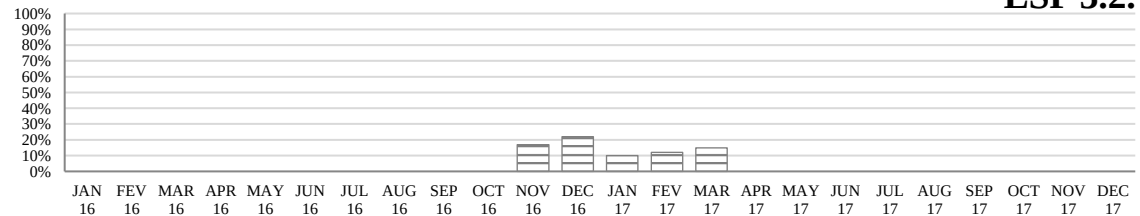
LSP 2



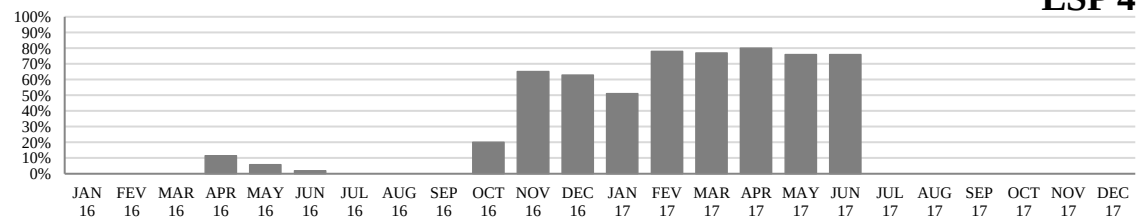
LSP 3.1.



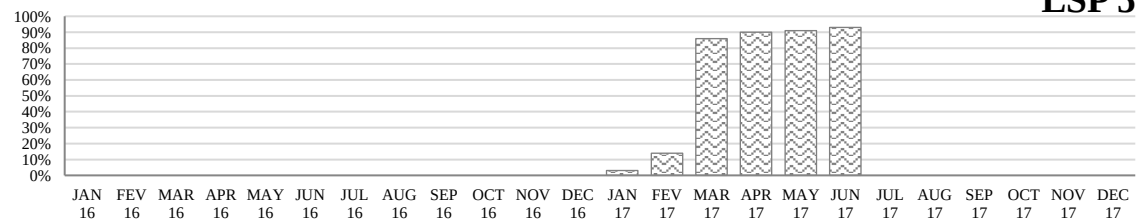
LSP 3.2.



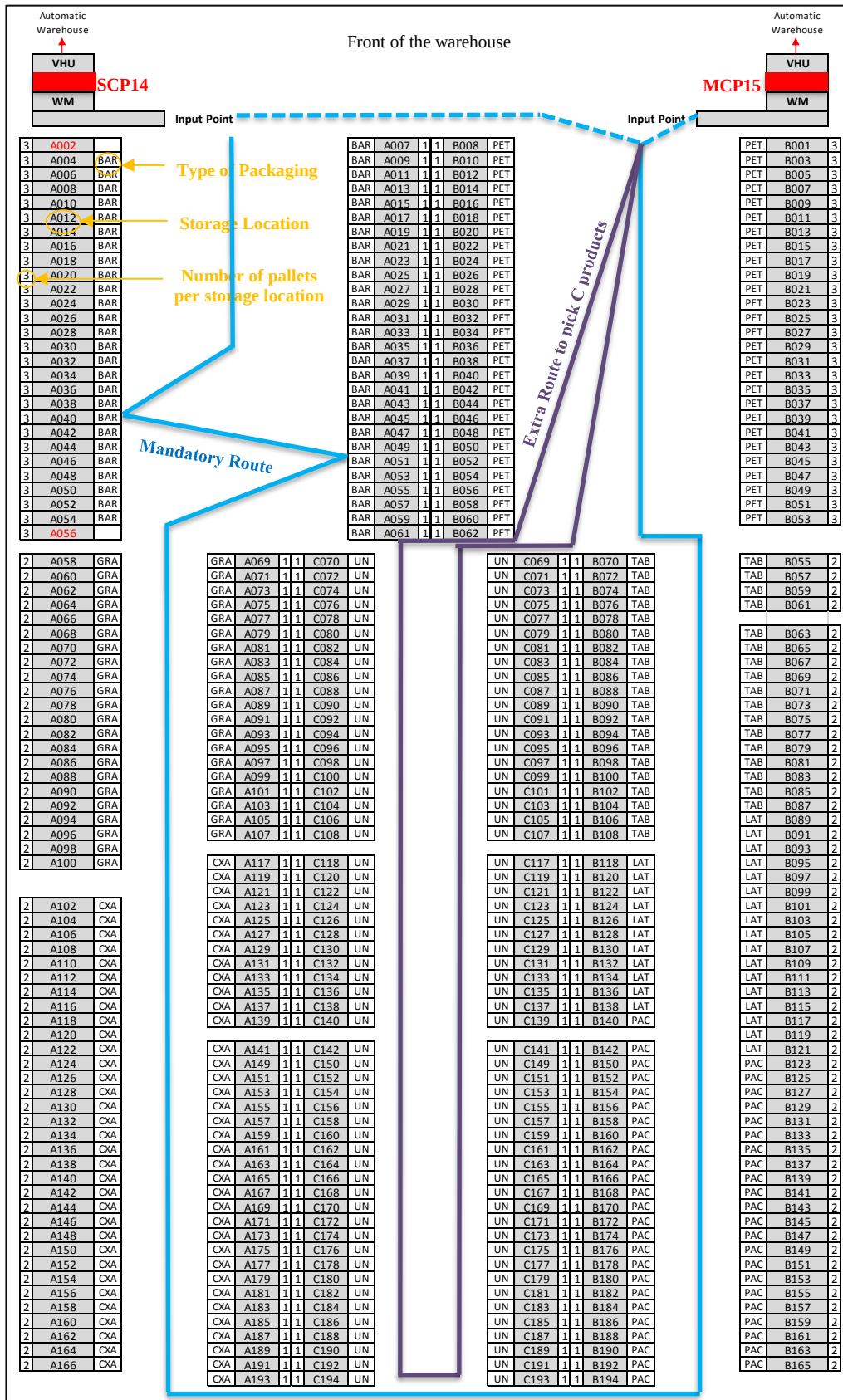
LSP 4



LSP 5



Annex 8 - Picking Warehouse Layout



Annex 9 - Home Page of the SLV Tool

Source: Author during internship

1º VERIFICAR OS CRITÉRIOS DEFINIDOS

Critério para posição Fixa (em dias)	
Número de dias com visitas	3

Critério para tipo de posição (número paletes consumidas numa semana)		
	Min	Max
Posição de chão (1 paleta)	0	1
Posição gravítica (2 paletes)	1	4
Posição gravítica (3 paletes)	4	

Critério para Reposição	
Número de vezes por semana	2

Critério da Zona	
Classificação de cada posição por tipo de produto	

AQUI

Classificação do tipo de produto por zonas									
BAR	BAR	TUB	C6	C12					
GRA	GRA								
CXA	CXA	BOX							
TAB	TAB	PAC							
LAT	LAT								
PET	PET								

2º INSERIR DADOS DO COCKPIT E DAS OTs

INSERIR DADOS COCKPIT

INSERIR DADOS OTs

LIMPAR TODOS OS DADOS

IMPORTANTE!

Os dados inseridos devem ser relativos a 5 dias úteis.
(não incluindo os fins-de-semana)

3º GERAR RELATÓRIO E VERIFICAR POSIÇÕES

Gerar Relatório

ZONAS

ACEDER A OUTRAS TABELAS

MATERIAIS

PALETIZAÇÕES

Annex 10 - Zones Confirmation and Product Allocation Verification – SLV Tool (Excerpt)

Source: Author during internship

VOLTAR AO INÍCIO			ZONAS										CONFIRMAR ZONAS			VERIFICAR PRODUTO POR ZONA							
2	A058	GRA	X	GRA	A069	1	1	C070	UN	X	X	UN	C069	1	1	B070	TAB	X	TAB	B055	2		
2	A060	GRA		GRA	A071	1	1	C072	UN			UN	C071	1	1	B072	TAB		X	TAB	B057	2	
2	A062	GRA		X	GRA	A073	1	1	C074			UN	UN	C073	1	1	B074		TAB	X	TAB	B059	2
2	A064	GRA			GRA	A075	1	1	C076			UN	UN	C075	1	1	B076		TAB		X	TAB	B061
2	A066	GRA	X	GRA	A077	1	1	C078	UN	X	X	UN	C077	1	1	B078	TAB	X					
2	A068	GRA		GRA	A079	1	1	C080	UN			UN	C079	1	1	B080	TAB		X	TAB	B063	2	
2	A070	GRA		GRA	A081	1	1	C082	UN			X	UN	C081	1	1	B082			TAB	TAB	B065	2
2	A072	GRA		GRA	A083	1	1	C084	UN				UN	C083	1	1	B084		TAB	TAB	B067	2	
2	A074	GRA	X	GRA	A085	1	1	C086	UN	X	X	UN	C085	1	1	B086	TAB	X	TAB	B069	2		
2	A076	GRA		GRA	A087	1	1	C088	UN			UN	C087	1	1	B088	TAB		TAB	B071	2		
2	A078	GRA		GRA	A089	1	1	C090	UN			UN	C089	1	1	B090	TAB		TAB	B073	2		
2	A080	GRA		GRA	A091	1	1	C092	UN			X	UN	C091	1	1	B092		TAB	TAB	B075	2	
2	A082	GRA	GRA	A093	1	1	C094	UN	X	UN	C093		1	1	B094	TAB	TAB	B077	2				
2	A084	GRA	X	GRA	A095	1	1	C096		UN	X	X	UN	C095	1	1	B096	TAB	X	TAB	B079	2	
2	A086	GRA		GRA	A097	1	1	C098	UN	UN			C097	1	1	B098	TAB	TAB		B081	2		
2	A088	GRA		GRA	A099	1	1	C100	UN	UN			C099	1	1	B100	TAB	TAB		B083	2		
2	A090	GRA		GRA	A101	1	1	C102	UN	UN			C101	1	1	B102	TAB	TAB		B085	2		
2	A092	GRA	X	GRA	A103	1	1	C104	UN	X	X	UN	C103	1	1	B104	TAB	X	TAB	B087	2		
2	A094	GRA		GRA	A105	1	1	C106	UN			UN	C105	1	1	B106	TAB		LAT	B089	2		
2	A096	GRA		GRA	A107	1	1	C108	UN			UN	C107	1	1	B108	TAB		LAT	B091	2		
2	A098	GRA																	LAT	B093	2		

Annex 11 - Report Model extracted from the SLV tool (Excerpt)

VOLTAR AO INÍCIO

Produto	Posições em Cockpit		Posições	Consumo Semanal (em paletes)	Tipo de posição ideal	Nº de posições fixas ideal	ELIMINAR	CRIAR
	PIF	PIC						
BRISA MARACUJÁ LATA 0,33X6*4 SH	0	0		0.01	Posição de chão	1		1
BRISA MARACUJÁ TP 0,25X24 CX	0	0		0.01	Posição de chão	1		1
CARAMULO PET 0,33X24 SH	2	0		3.95	Posição gravítica de 2	1	1	
CARAMULO PET 1,5LX6 SH	3	0		7.20	Posição gravítica de 3	2	1	
CARAMULO PET 6LX2 SH	0	0		1.63	Posição gravítica de 2	1		1
CARLSBERG BARRIL 30L	2	0	A046 A048	2.50	Posição gravítica de 2	1	1	
CARLSBERG LATA 0,33X12 SH SLEEK M	2	0	A052 C105	2.28	Posição gravítica de 2	1	1	
CARLSBERG TP 0,25X24 CX PAL 77	3	0		5.25	Posição gravítica de 3	1	2	
CARLSBERG TP 0,25X6*4 SH PAL 84	1	0		7.04	Posição gravítica de 3	2		1
CRISTAL TP 0,20X10*2 SH	2	0		3.37	Posição gravítica de 2	1	1	
CRISTAL TP 0,33X6*4 SH BP	2	0		14.44	Posição gravítica de 3	3		1
FRUTIS LARANJA PET 1,5LX6 SH M	2	0		4.23	Posição gravítica de 3	1	1	
FRUTIS LARANJA/MARACUJA PET 1,5LX6 SH M	2	0		2.68	Posição gravítica de 2	1	1	
GARRAFA CO2 10 KG	1	2	A007 A013 A017	2.67	Posição gravítica de 2	1	2	
GUINNESS BARRIL 30L	0	0		0.07	Posição de chão	1		1
MARINA TP 0,33X6*4 SH	0	0		7.27	Posição gravítica de 3	2		2
MONTE SACRO, V. MESA BR 0,375L	0	0		0.38	Posição de chão	1		1
MONTE SACRO, V. MESA TT 0,375L	0	0		0.26	Posição de chão	1		1
MONTE SACRO, V. MESA TT 0,75L	0	0		1.16	Posição gravítica de 2	1		1